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Poster Sessions

Poster Presentations A. Epidemiology

P-A-1
VERTIGO SYNDROME: OTOLARYNGOLOGY DEPARTMENT OF SOCIAL WELFARE INSTITUTE 4 YEARS. ASUNCION-PARAGUAY. 2014. EXPERIENCE

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Introduction: Acute vertiginous syndrome is a set of symptoms and signs characterized by impaired balance accompanied by nausea, vomiting, sweating, illness, some symptoms predominate over others depending on the etiology. One of the most frequent reasons for consultation nes the adult is vertigo (spinning sensation involves the patient) associated with different diseases. Although in most cases the etiology is benign, in others it is a serious manifestation of disease. As people get old in our country and the increase the average life expectancy of our population is vital importance and requires us to review and take action with respect the most common diseases in this population group. For the elderly the presence of vertigo is often associated with a worsening of quality of life. Intend in this paper to present the most frequent etiologies of vertigo syndrome as literature reviews and experience of our daily work and the management of patients to assure optimal care.
Objective: *Identify the most common causes of vertigo syndrome in our department of otolaryngology, Institute of Social Welfare.
Material and Method: A descriptive, observational study of transverse, retrospective. Given the inclusion criteria of patients attending ENT consultation, between 2010 and 2013, to present vertigo, collecting all the data in an annex containing ta complete medical history, underlying diseases and studies required. Exclusion: incomplete medical records.
Main Results: The study was performed in a total of 1140 patients of whom 740 (65%) were female and 400 (35%) male l. The age range of greater consultation was 51 to 70 years with a total of 456 patients (40%). The main symptoms reported were: 1000 patients (88%) had vertigo, followed by tinnitus present in 304 patients (27%). As the most common cause, identified at BPPV in a total of 856 patients (75%). As for improvement, 986 patients (86.5%) had good outcome in subsequent follow-ups.
Conclusions: The vertiginous syndrome is a prevalent disease in our service, which specialized consultation needs to collect all data that reflects the syndrome as well as exploration and additional studies. It was identified that the most common cause is benign paroxysmal positional vertigo, the age range of most frequent presentation is between 51–70 years and generally there is other comorbidities.

Keywords: Vertigo, BPPV, tinnitus.

P-A-2
PREVALENCE, DEMOGRAPHICS, AND CLINICAL CHARACTERISTICS OF VERTIGO DISORDERS IN A SPECIALIZED MULTIDISCIPLINARY OUTPATIENT CLINIC

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Introduction: Vertigo is a common complaint in the general population with a prevalence of between 20 and 30%. The Schwindelzentrum Essen, Germany, is a specialized, outpatient clinic which provides multidisciplinary care for patients with chronic vertigo. Between March 2010 and December 2013 6182 patients

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visiting the clinic for the first time took part in a standardized survey.
Methods: This paper-based multiple choice questionnaire assessed detailed demographic data and systematically reviewed key vestibular syndromes/concomitant symptoms. Symptom severity and personal burden were evaluated using standardized scores Vestibular Symptoms Score (VSS), Dizziness Handycap Inventory (DHI), and Short Form Survey (SF-12). Main diagnoses were taken from the final medical report of each patient and then systematically categorized.
Results: 6182 patients (3659 female = 59,2%; 2523 male = 40,8%) presented themselves to the clinic: The five most common diagnoses were phobic postural vertigo ($n = 1162$; 18.79%), benign paroxysmal positional vertigo ($n = 1003$; 16,22%), unilateral vestibulopathy/vestibular neuritis ($n = 712$; 11,52%), psychogenic vertigo ($n = 682$; 11,03%), and Ménière's disease (632; 10,22%). The average age was 56,3 years (range: 10 to 96 years, SD = 17,64) with a considerable variation between diagnoses. Symptom severity scores showed significant impairment in the patients abilities (DHI: mean 47,1; range: 0–100; SD 22,3; VSS: mean 33,63; range: 0–131; SD 19,6).
Conclusions: This large dataset will contribute to a more accurate picture of specific vestibular disorders and their clinical presentation. Furthermore it will provide insightful correlations to demographics and personal burden.

P-A-3
PROBLEMS IN EPIDEMIOLOGIC SCREENING OF THE VESTIBULAR SYSTEM

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The literature has few epidemiologic studies of the vestibular system. As part of an on-going series of experiments to improve the available screening tests and to evaluate some of the currently used tests we performed two experiments. Experiment 1 screened 300 people for vestibular disorders, using Dix-Hallpike maneuvers, head impulse tests and standing balance tests (CTSIB). We subsequently tested 69 of them in the ENG lab with objective diagnostic tests. In Experiment 2 we tested the usefulness of the Fukuda stepping test, the head impulse test and tandem walking to detect patients with known vestibular impairments compared to asymptomatic controls. In Experiment 1 we found the expected 1% of people with responses consistent with benign paroxysmal positional vertigo. The scores on the screening were related to the total ENG but odds ratios were not significant for some variables probably due to the small sample size. In Experiment 2 on Fukuda tests, both walking and marching in place, and on tandem walking patients differed from controls on some measures but the ROC values were all < 0.80, so those tests are not useful for screening. The head impulse test was unable to detect subjects with bi-thermal caloric weakness $< 60\%$ (ROC = 0.64) although it was better able to distinguish patients with caloric weakness $\geqslant 60\%$. ROC values were > 0.80 only for those subjects, with the highest values observed for subjects with severe caloric weakness and age $\geqslant 60$ (ROC = 0.88). Thus the head impulse is useful for screening people for more severe disease, especially older people, but a negative response might not indicate the presence of less severe disease. Supported by NIH grant DC009031 (HSC) and grants from the National Space Biomedical Research Institute through NASA NCC 9–58 (APM and JJB).

P-A-4
SEASONALITY OF DIZZINESS IN THE EMERGENCY DEPARTMENT: A REPORT FROM BRAZIL

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Introduction: Dizziness is a frequent complaint in the emergency department. Community studies estimated that up to 2% of the population seek medical consultations for that reason, in a given year. The epidemiology of dizziness may lead to better understanding of the possible underlying pathophysiological mechanisms.
Objective: To investigate the existence of a seasonal distribution of dizziness in a Brazilian emergency department.
Methods: Emergency consultation records of a public general hospital from Brazil, 2009–2012, were ana-

lyzed. 4,250 cases out of 276,076 emergency consultations reviewed presented complaint of dizziness (1.5% of the total). The incidence of dizziness complaints was calculated monthly. Seasonality was assessed using Cosinor analysis, considering a 12-month period.
Results: A significant seasonal pattern was evidenced for dizziness, with a peak in summer (December–January) and a trough in winter (June–July). Amplitude of variation between the highest and lowest incidences reached 17%.
Conclusion: There was a seasonal distribution of dizziness complaints in the emergency department of a public Brazilian hospital, peaking in summer.

P-A-5
EPIDEMIOLOGY OF PEDIATRIC VERTIGO AND BALANCE DISORDERS IN EMERGENCY DEPARTMENT

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Introduction: Acute vertigo and balance disorders are uncommon complaints in pediatric population, presenting a wide spectrum forms of diagnoses. Evaluation of children with these complaints may be difficult, because of the limited communication skills of the child to describe the symptoms and different incidence of the specific disorders in adults and children.
Objective: The aim of the study is to evaluate the epidemiology of the disorders causing acute vertigo and balance disorders in childhood.
Materials and Methods: We conducted a retrospective review of all children under 16 years of age who were referred to the Emergency Department of the S. Croce e Carle Hospital in Cuneo for acute vertigo or balance disorder in a period of 10 years (1st January 2004–31st December 2013).
Results: The study group consists of 114 patients aged 0–16 (average age 11). The most frequent causes of vertigo were migraine and Benign Paroxysmal Vertigo of Childhood (BPVC), occurring respectively in 28,1% ($n = 32$) and 19,3% of cases ($n = 22$). Other pathological conditions occurring less frequently were: neurological conditions, such as multiple sclerosis or epilepsy or Arnold Chiari Malformation, in 5,3% ($n = 6$); internal disorders in 7% ($n = 8$); psychogenic vertigo in 3,5% ($n = 4$); whiplash injury in 3,5% ($n = 4$); Benign Paroxysmal Positional Vertigo (BPPV) in 2,6% ($n = 3$); vestibular neuritis in 1,75% ($n = 2$); vertigo associated with acute media otitis in 2,6% ($n = 3$); unclassified in 26% ($n = 30$).
Conclusions: Acute vertigo and balance disorders are rare during childhood, especially if compared to the adult age. Vestibular migraine and BPVC are the most frequent causes of vertigo and balance disorders in childhood, but a lot of other pathological conditions may be present with these symptoms.

P-A-6
SUBJECTIVE IMPAIRMENT BY VERTIGO AND DIZZINESS IN VESTIBULAR AND NEURODEGENERATIVE DISORDERS

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Introduction: Although vertigo and dizziness are common and often cause relevant morbidity, the impact of specific diagnoses on subjective impairment and quality of life is unknown. Further, it is not clear which of the diagnoses presenting to a vertigo clinic cause most subjective dizziness related symptoms.
Objectives: To reveal the subjective limitations in daily life of patients with different vestibular and neurodegenerative disorders.
Methods: A retrospective cohort study was performed on a convenience sample of patients referred to a tertiary care outpatient clinic for vertigo and balance disorders at the German Center for Vertigo and Balance disorders (DSGZ). Patients were included if they had a confirmed diagnosis of benign paroxysmal positional vertigo (BPPV), Menière's disease (MD), vestibular paroxysmia (VP), phobic/psychogenic vertigo (PSY), vestibular migraine (VM), progressive supranuclear palsy (PSP), downbeat nystagmus syndrome (DBN), or cerebellar ataxia (CA). Patients were asked to complete the Dizziness Handicap Inventory (DHI) and the Short Form 12 (SF-12) questionnaires at their primary visit to the clinic.
Results: We included 2804 patients presenting to the DSGZ between 2010 and 2012 (18.0% BPPV, 13.8% MD, 5.8% VP, 37.6% PSY, 13.4% VM, 0.5% PSP, 2.2% DBN, 1.9% CA). Mean age of all patients was 56 years (59% female). Among all diagnoses seen in the DSGZ outpatient clinic the highest scores for DHI (balance problems for scores > 10) were found in neurodegenerative disorders (PSP 30.9, DBN 27.6, CA 26.6). Patients with vestibular disorders were less impaired (BPPV 23.3, MD 20.9, VP 18.1, PSY 22.6, VM 22.1). For overall quality of life (SF-12, mean for nor-

mal subjects: 50, sd 10, values < 50 are conspicuous) a similar pattern was found. Lowest values were found for PSP (32.3), DBN (34.6) and CA (35.7). Patients with vestibular disorders were less restricted (BPPV 39.4, MD 41.2, VP 40.8, PSY 38.9, VM 39.4).

Conclusions: Among all patients presenting to a tertiary care clinic for vertigo and balance disorders, patients with neurodegenerative disorders are most severely affected by their symptoms. Remarkably, in most of these patients the chief complaint is vertigo and dizziness and the underlying diagnosis has not been established before. In comparison, classical vestibular disorders are less affected in the chronic stage of the disorder. These results show that there is a need to include neurodegeneration into the differential diagnosis of dizzy patients and that the subjective dizziness in these patients might be more severe than in vestibular disorders.

P-A-7
SOCIODEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF PATIENTS WITH VERTIGO AT CLÍNICA OCCIDENTE DE OTORRINOLARINGOLOGÍA, MEDELLÍN, COLOMBIA: A DESCRIPTIVE STUDY

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Introduction: Vertigo and dizziness account for an estimated 20 to 30 percent of primary care clinic visits, and it is even more common among older adults. To date, there are few papers published about clinical characteristics of individuals with balance disorders. In Colombia there is no data about this issue. A good anamnesis and physical examination can be done in most of the cases, which are mandatory aspects to achieve a successful diagnosis and treatment of this disorder.

Objetives: To describe the sociodemographic and clinical characteristics in outpatients with vertigo at Clínica Occidente de Otorrinolaringología (Medellín, Colombia) between October of 2010 and March of 2013.

Methods: Clinical charts of the patients older than 18 with vertigo and balance disorders were reviewed in an attempt to determine several variables including sex, age, clinical characteristics and symptoms improvement.

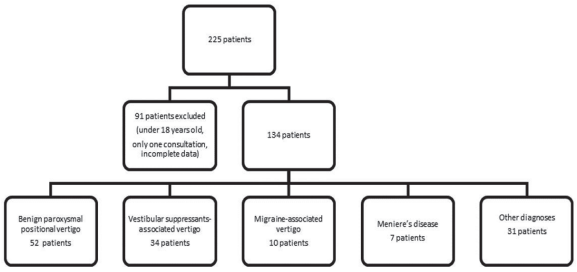
Results: One hundred and thirty-four patients were included. The mean age was 57.43 years. Most patients were female (76.9%). The most common complaints were vertigo (85.8%), balance disorders (67.8%) and head fullness sensation (46.3%). The median time between onset and first consultation was 36 months (P25: 6, P75: 120). Fifty-three percent of the patients used vestibular suppressants more than three months before the first consultation, and 81.3% used them less than three months before. The definitive diagnoses were benign paroxysmal positional vertigo (38.8%), vestibular suppressants-associated vertigo (25.4%), migraine-associated vertigo (7.5%), Meniere's disease (5.2%), and other disorders (23.1%). All vestibular suppressant drugs were discontinued in 71.6% of the cases. In more than 60% of the cases, a concordance between the first consultation diagnosis and definitive diagnosis was found. Clinical improvement was achieved in 56.7% of the cases with an increasing successful rate (69.18%) at the end of the treatment.

Conclusions: Vertigo is more common in female patients regardless of cause. The most frequent diagnoses were benign paroxysmal positional vertigo and vestibular suppressants-associated vertigo. In the last one the more common symptom was the balance disorder in contrast to all other diagnoses in which vertigo was the predominant symptom. All patients in this study had chronic progression of symptoms, and most of them were using vestibular suppressants at the time of the first consultation. This finding implies that drugs to treat vertigo are being taken indiscriminately, which affects the diagnosis, control and improvement of the patients. Further studies are needed to assess the outcomes indicators in vertigo.

Sociodemographic and clinical characteristics

		Benign paroxysmal positional vertigo	Vestibular suppressants-associated vertigo	Migraine-associated vertigo	Meniere's disease
Age (years)	Mean	62	58	49	43
	SD	17	15	13	16
Sex (%)	Female	45 (87%)	27 (79%)	9 (90%)	4 (57%)
Time between onset and first consultation (months)	Median	42	36	13	120
	Percentile 25	5.2	12	3.2	6
	Percentile 75	174	78	117	324
Vertigo		49 (94%)	26 (76%)	8 (80%)	7 (100%)
Balance disorders		27 (52%)	31 (91%)	6 (60%)	3 (43%)
Head fullness		19 (37%)	21 (62%)	5 (50%)	1 (14%)
Hearing loss		6 (12%)	3 (9%)	2 (20%)	2 (29%)
Tinnitus		12 (23%)	14 (41%)	4 (40%)	5 (71%)
Headache		13 (25%)	12 (35%)	7 (70%)	2 (29%)
Vestibular suppressants more than three months before the first consultation		25 (48%)	21 (62%)	6 (60%)	4 (57%)
Vestibular suppressants less than three months before the first consultation		43 (83%)	34 (100%)	5 (50%)	6 (86%)
Concordance between the first consultation diagnosis and definitive diagnosis (%)		70.59%	75%	80%	62.5%
Clinical improvement at the end of the treatment (%)		84%	66%	72%	67%

Key words: Vertigo. Dizziness. Balance disorders. Vestibular suppressants. Benign paroxysmal positional vertigo. Migraine-associated vertigo. Meniere's disease.



P-A-8
GENDER AND PERIPHERAL NEUROPATHY ON THE POSTURAL STABILITY OF PATIENTS WITH TYPE 2 DIABETES MELLITUS

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Aim: To assess the interaction between gender and peripheral neuropathy on the postural stability of patients with type 2 diabetes mellitus.
Methods: 150 patients with type 2 diabetes mellitus gave their informed consent to participate in the study. They were aged 30 to 80 years (57 ± 9.7, mean $\pm$ S.D.) and 106 (70%) were females. They had no history of otology, neurology, orthopaedic or balance disorders. After a clinical interview and neuropathy assessment with electromyography, postural stability was evaluated by static posturography (eyes open/closed on hard/soft surface) and the "Up & Go" test. Statistical analysis was performed using "t" test, linear correlation and multivariate analysis of covariance; the significance level was set at 0.05.
Results: During static posturography, on soft surface, the length of sway was consistently related to age, gender and the evidence of peripheral neuropathy (multiple R $= 0.6$, $p < 0.001$), the influence of neuropathy was larger in males than in females, and closing the eyes increased further the difference between genders (MANCoVA, $p < 0.02$); on hard surface, the length of sway was consistently related to age, body mass index, gender and the evidence of peripheral neuropathy (multiple $R = 0.5$, $p < 0.001$), with no significant interactions. The mean time to perform the "Up & Go" test was 11.7 ± 2.2 sec, which was related to age (Pearson's R $= 0.34$, $p < 0.001$), with no influence of peripheral neuropathy, the gender or the body mass index,
Conclusión: In patients with type 2 diabetes mellitus with no history of balance disorders, in order to preserve the static control of upright posture, male patients may be more vulnerable than females during conditions with sensory deficit.

P-A-9
INFLUENCE OF THE BODY MASS INDEX ON THE OCCURRENCE OF FALLS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

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Introduction: Obesity is one of the main factors related to type 2 diabetes mellitus. Compared to non-obese subjects, the postural stability of obese subjects may be more vulnerable.
Aim: To assess the influence of the body mass index on the occurrence of falls in patients with type 2 diabetes mellitus, receiving primary health care, with no history of sensory dysfunction apart from corrected refraction errors.
Methods: 134 patients with type 2 diabetes mellitus gave their informed consent to participate in the study. They were aged 57.4 ¡À9.4 years (mean ¡ÀS.D.) (69.4% were females). None of them were seeking medical care due to sensory or balance decline or had history of otology, neurology, psychiatry or orthopaedic disorders, or postural hypotension. Their mean body mass index (BMI) was 29.2 ¡À4.9 and 63.4% (95%C.I. 54.9%–71.5%) had HbA1c $> 7\%$. After a clinical interview, patients replied to a self-administered questionnaire of symptoms related to balance, their sensory function was assessed, and they performed the Up & Go test. The occurrence of falls, during the previous 6 months and during a follow up of 6 months, was assessed according to the definition of the World Health Organization. After the follow up, patients were classified in 2 groups, according to the occurrence of falls during the preceding year: I. no falls ($N = 91$), and II. at least one fall ($N = 43$). Statistical analysis was performed using "t" test for means, "t" test for proportions, chi square, multiple regression analysis and analysis of covariance, the significance level was set at 0.05.
Results: Compared to group I, the proportion of women and the proportion of patients with HbAc1 $>$ 7% was higher in group II, as it was the mean BMI

($p < 0.05$), with a higher proportion of patients with a BMI ¡Ý35 ($p < 0.01$); the patients in group II also showed a higher score on the questionnaire of symptoms related to balance, with a slower performance on the Up & Go test ($p < 0.05$). Analysis of covariance showed an influence on the occurrence of falls of the following characteristics (multiple R = 0.29; F = 4.2, $p = 0.007$): the BMI (beta = 0.21, 95%C.I. 0.04–0.38), the age (beta = 0.19, 95%C.I. 0.006–0.35) and the gender (beta = 0.18, 95% C.I. 0.03–0.36), independently from sensory deficits.

Conclusión: In patients with type 2 diabetes mellitus, a BMI ¡Ý35 may have an influence on the occurrence of falls, independently from sensory deficits.

P-A-10
COMPARISON OF ICF SCALE FOR DISABILITY IN DIZZY PATIENTS WITH ADL SCALE IN CZECH REPUBLIC

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The aim of study was to compare ICF scale with routinely used ADL scale for dizzy patients in Czech republic. In the study participated 2876 patients (1080 males and 1796 females) of mean age 67 years (± years 68 men, 65 women). the patients completed the Vestibular Disorders Activties of Daily Living Scale, which is a self-administered scale of independence in activities of daily living. On each of the three subscales, i.e., functional, ambulation, and instrumental, scores were assessed. The results were compared to Czech version of ICF. Statistical evalutaion revealed some difference in the two approaches, some activities are not specified in ICF scale.

FUNKCE

F1	F2	F3	F4	F5	F6	F7	F8	F9
d 4103	d 4104	d 5400	d 5400	d 5400	d 5402	XXX	d 5101	d 4450

AMBUL.

A13	A14	A15	A16	A17	A18	A19	A20	A21
d 4500	d 4502	XXX	XXX	d 4503	XXX	XXX	XXX	XXX

INSTR.

I22	I23	I24	I25	I26	I27	I28
d 4751	XXX	d 640x	d 640x	d 920x	d 850x	d 4751

Crossed item are not included in ICF. The outcom for evaluation of handicap in dizzy patients is discussed

P-A-11
SPINAL ARTERY AGENESIS, INDICATED BY PULSATILE TINNITUS AND DIZZINESS. ASUNCION – PARAGUAY. 2014. REPORT OF A CASE

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Introduction: The vertiginous syndrome: is a set of symptoms and signs characterized by balance disorders accompanied by nausea, vomiting, sweating, malaise, and bradycardia, some symptoms predominate over others depending on the etiology and severity of the box. Pulsatile tinnitus is caused by increased blood flow or vessel stenosis. Pulsatile tinnitus can be classified as arterial or venous as the original container. Results of magnetic resonance angiography of the event causing the absence of the right vertebral artery pulsatile tinnitus and dizziness was demonstrated. Kao et al. (2003) reported a case of unilateral agenesis of the vertebral artery.
Objective: To describe the association of pulsatile tinnitus and agenesis of the vertebral artery.
Presentation of clinical case: Female 21 years old patient presented to our department with pulsatile tinnitus on the right side and dizziness, accompanied by nausea and vomiting. He suffered from pulsatile tinnitus in the right ear of one year of evolution Temporal bone CT was performed, tympanogram were within limits, audiometry shows moderate sensorineural hearing loss in the right ear and left ear in anacusia. Angiography cervico-cranial MRI shows absence of the right vertebral artery. There were no other clinical findings to justify the pulsatile tinnitus. The patient was discharged from the hospital with di betahistine hydrochloride treatment. After a month, pulsatile tinnitus and dizziness had reduced their intensity.
Discussion: Agenesis of the vertebral artery is even more rare than the absence of the cavernous internal carotid artery. Causes of pulsatile tinnitus are atherosclerotic carotid disease, pulsatile tinnitus objective may be the first manifestation of ACAD, by turbulent blood flow in stenotic segments of the carotid artery. In our case, there were murmurs in the common carotid artery and its branches. In intracranial vascular abnormalities, the most common abnormality was arteriovenous fistulas (AVF) and aneurysms (except dissection) exhibit no pulsatile tinnitus. On the other hand, we observed in our case FAV. Magnetic resonance angiography confirmed that these vessels were

clear, open and light without atherosclerosis, presenting only agenesis of the right vertebral artery. The incidence of congenital atresia or hypoplasia of the left vertebral artery is 3.1%, and the right vertebral artery is 1.8%.
Conclusion: Among the various etiologies of arterial pulsatile tinnitus, the absence of the vertebral artery, should be taken into account, as explained in our case the same pathogenesis as inadequate cause vertebrobasilar circulation, explaining both dizziness. The introduction of magnetic resonance angiography has allowed better and more accurate detection of vascular variants without invasive angiography.

Keywords: Agenesis, vertebral artery, pulsatile tinnitus.

P-A-12
LONG-TERM OUTCOME OF VERTIGO AND DIZZINESS ASSOCIATED DISORDERS FOLLOWING DIAGNOSIS AND TREATMENT IN SPECIALIZED TERTIARY CARE

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Background: Disorders of vertigo and dizziness are among the most frequent complaints in contemporary medicine. More and more specialized tertiary care centers emerge to engage this common problem. Therefore, we aim to investigate the long-term effects of specialized, elaborative diagnosis and treatment in one example neuro-otology institution to determine a persistent healthcare benefit on patients after two-years.
Methods: 1553 patients with different disorders of vertigo and dizziness were recruited prospectively from the Essen Vertigo and Dizziness Center between March 2010 and April 2011. Patients were clinically assessed and treated according to their diagnosis. Different surveys were obtained (Dizziness Handicap Inventory (DHI), Vertigo Symptoms Scale (VSS), Quality of Life Questionnaire (SF-12), General Depression Scale (ADS), Stait-Trait Anxiety-Index (STAI), Whitely-Index and a custom health related questionnaire. These surveys were assessed again during a personal telephone interview after two years.
Results: Primary outcome variable of this observational study was the DHI. 72.1% of patients improve in DHI score comparing baseline and follow-up after two years. Patients report a significant reduction in DHI score of 29.2% ($p = 0.02$). Most frequent disorders were somatoform vertigo, benign peripheral paroxysmal vertigo (BPPV), unilateral vestibulopathy, central vestibular disorders, Menière's disease, vestibular migraine, bilateral vestibulopathy, and vestibular paroxysm.
Conclusion: Long-term outcome following diagnosis and treatment in a specialized tertiary care center appears to be favourable and persistent after two-years. These results are reassuring and may emphasize the importance of specialized units for the treatment of patients with complicated disorders or time-consuming clinical work-up.

P-A-13
VESTIBULOTOXICITY AFTER GENTAMICIN – A PROSPECTIVE STUDY IN WELLINGTON HOSPITAL, NEW ZEALAND

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Introduction: Gentamicin may cause vestibulotoxicity through damage to the hair cells in the semicircular canals, but the incidence of vestibulotoxicity with modern dosing regimens is unknown.
Objectives: Our primary objective was to estimate the incidence of vestibulotoxicity with modern gentamicin dosing regimens. We also aimed to test the feasibility of routine head-impulse testing for all hospital patients treated with gentamicin.
Methods: Adult patients receiving gentamicin had serial recording of their vestibulo-ocular reflex (VOR) gain by Eyesee Cam video-oculography head impulse testing. Full attention was given to technical points to obtain reliable recordings with passive head movement. Hospital patients were recruited by informing doctors and nurses and latterly by an automatically generated notice on the electronic medication dispensers. Exclusion criteria included any patients with a history of a vestibular disorder, alcohol abuse, neck injury or severe debility. Testing was done at time zero (within 4 hours of the administration of gentamicin), repeated every day of drug treatment and at 24, 48 and 72 hours following the last dose. A small proportion of eligible patients approached were excluded from study participation because of physical limitations, degree

of illness or refusal to participate. VOR gains were recorded at 40, 60 and 80 ms. Vertical and horizontal dynamic visual acuity (DVA) were assessed at 2 Hz. Patients were also asked to rate imbalance or unsteadiness on a 0–10 scale, and also received a further phone call 10 days after their initial dose of gentamicin to enquire about symptoms.

Results: Fifty patients were included in the study, most of whom had had 3 days or less of gentamicin treatment. All patients were tested according to the protocol, with the exception that a small proportion missed one day of analysis between day 1 and 4; however this did not affect their final assessment at 3 days after the last dose of gentamicin. None of the patients had impairment of VOR gain as defined by our 2 standard deviation lower limit of normal for vHIT gain of < 0.79 at 80 ms. No patients reported significant imbalance or oscillopsia. No significant changes occurred in the serial measurement of dynamic visual acuity.

Conclusions: With no cases of vestibulotoxicity from 50 patients, using the 'rule of threes' (less than 1 in n/3 individuals) we can be 95% confident that vestibulotoxicity occurs in less than 6% of patients. This may be an overestimate but is affected by the relatively small number of patients tested. We found no evidence for 'subclinical' vestibulotoxicity.

P-A-14
BALANCE DISORDERS IN CHILDREN

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Introduction: Although vertigo is a relatively common symptom in adults, it is rarely found in children. Difficulties in the anamnesis and the impossibility of children to describe the symptoms complicate adequate management.

Aim: To identify the most frequent causes of balance disorders in childhood and to determine if there is a significant association between the symptoms and the presence of headache, a family history, and motion sickness.

Methods: A retrospective, longitudinal, and observational study was conducted. All patients with vertigo or dizziness seen at the department of otolaryngology either presenting directly at the outpatient clinic or referred from other department of the hospital (emergency, neurology, or emergency) between January 2012 and January 2014 were included. All patients underwent a thorough anamnesis, ENT examination, and vestibular exam (tests: Romberg, Barany, Unterberger, head thrust test (HTT), eye tracking test, nystagmus testing without fixation suppression, and dysmetria and dysdiadochokinesis assessment). According to the needs of each individual patient, audiometry and imaging studies (computed tomography scan or magnetic resonance imaging) were requested.

SYMPTOMS	HEARING LOSS	DIAGNOSIS
ATAXIA (12)	0	LEUKOENCEPHALOPATHY/HIV
		ATAXIA TELANGIECTASIA
		INTERMITTANT ATAXIA
		CEREBELLITIS
		SUBACUTE ATAXIA
		ACUTE ATAXIA
		CYST IN THE IV VENTRICLE
POST-TRAUMATIC VERTIGO (9)	0	TRAUMA (9)
VERTIGO OR DIZZINESS + SEIZURES (6)	0	FOCAL EPILEPSY
		EPILEPSY
VERTIGO OR DIZZINESS + HEADACHE (53)	CONDUCTIVE HEARING LOSS (3)	CHRONIC OTITIS MEDIA
		ADHESIVE OTITIS MEDIA
		CHARGE SYNDROME
	MODERATE-SEVERE SNHL	USES HEARING AID (3)
		SUDDEN SENSORINEURAL HEARING LOSS (1)
	DEEP SNHL (1)	COCHLEAR IMPLANT
		8 SINUSITIS (4 SPHENOID)
		3 MEDICATED WITH FLUNARIZINE
VERTIGO (29)	CONDUCTIVE HEARING LOSS (7)	OME (7)
	MODERATE UNILATERAL SNHL	SEROUS LABYRINTHITIS
	SEVERE UNILATERAL SNHL	LABYRINTHITIS (POST AOM)
	UNILATERAL CONDUCTIVE HEARING LOSS	PERILYMPHATIC FISTULA
	0	BENIGN VERTIGO OF CHILDHOOD (6)
		VESTIBULAR NEURONITIS
		BENIGN PAROXYSMAL POSITIONAL VERTIGO (3)
		EMOTIONAL VERTIGO (3)
		MIGRAINE POST-ENCEPHALITIS (1
DIZZINESS (8)	DEEP SNHL	CALIBRATION COCHLEAR IMPLANT (1)
		POSTERIOR FOSSA TUMOR IN THE IV VENTRICLE (1)
		EMOTIONAL (1)
CONGENITAL NYSTAGMUS (2)	UNILATERAL NSHL	OCULAR ALBINISM
INSTABILITY (5)	MODERATE UNILATERAL CONDUCTIVE HEARING LOSS	UNILATERAL DYSGENESIA (1)
	CONDUCTIVE HEARING LOSS	OME (2)

Results: One hundred twenty five patients were included in the study, of whom 52.8% (66/125) were male and 47.2% (59/125) female. The distribution according to the symptomatology of the patients with balance disorders was: Ataxia 12 patients (9.6%); posttraumatic vertigo 9 (7.2%); vertigo or dizziness + seizures 6 (4.8%); vertigo or dizziness + headache 53 (42.4%); vertigo 29 (23.2%); dizziness 8 (6.4%); congenital nystagmus 2(1.6%); instability 5 (4.0%); motion sickness 1 (0.8%). Overall, 42.4% (53/125) had headache associated with balance disturbances; 60.38% (32/53) of these were girls. Of the patients with headache, 66.1% (35/53) had a family history and 56.7% (30/53) motion sickness. Table 1: Causes of bal-

ance disorders in children. Associations among symptoms, hearing loss, and final diagnosis
Conclusions: Headache accompanied by vestibular symptoms was the most frequently found clinical entity in our series of patients. The male/female ratio was similar and the association with family history was statistically significant. The following most frequent causes of labyrinth-related etiology, being otitis media with effusion and benign vertigo of childhood. Patients with OME improved after treatment.

Poster Presentations B. Microgravity Investigations

P-B-1
HUMAN PERCEPTION OF ROLL TILT IN HYPER-GRAVITY: EXPERIMENTS AND MODELING

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Introduction: Altered gravity environments, such as microgravity, hypo-gravity, and hyper-gravity, influence human orientation perception. In hyper-gravity the graviceptor signals, like those from the otoliths, yield larger responses to body tilt, while the semicircular canal cues are relatively unaffected. This paradigm provides a unique paradigm to study the integration of otolith and semicircular canal cues in orientation perception. While human perceived tilt has been quantified for static tilts, little is known about semicircular canal contributions during dynamic tilts in hyper-gravity environments. Furthermore, current models of canal-otolith integration cannot predict the characteristic perceptual overestimation of roll tilt expected in hyper-gravity and are thus limited to a normal 1 Earth G environment.
Objectives: We aim to quantify human perception of roll tilts in hyper-gravity, for both static and dynamic tilts. This dataset will then be used to modify an existing Observer-type canal-otolith interaction model for spatial orientation perception, such that it can be extended and validated in hyper-gravity environments.
Methods: A long-radius centrifuge was utilized to study perception of both static and dynamic whole-body roll tilt in hyper-gravity, across a range of angles, frequencies, and net gravito-inertial levels (referred to as G-levels). In the dark, subjects reported their roll tilt perception using a somatosensory indicator task, whereby they attempted to align a bar with their perceived horizontal.
Results: Consistent with earlier reports, static roll tilt was overestimated in hyper-gravity ($p < 0.0005$), with more overestimation at larger angle and higher G-levels, across the conditions tested. Dynamic roll tilt was also consistently overestimated in hyper gravity ($p < 0.0005$) at all angles and frequencies tested, again with more overestimation at higher G levels. However, the overestimation was not as large at high angular velocities ($p = 0.006$), consistent with semicircular canal sensory integration. We propose the central nervous system treats otolith stimulation in the utricular plane differently than stimulation out of the utricular plane. This is implemented in the model by adjusting the feedback gain on the linear acceleration error to depend upon the orientation relative to the utricular plane. With the modification, the model was able to quantitatively simulate both the static and dynamic roll tilt overestimation observed experimentally. Simulations from the modified model matched the available data in several altered gravity paradigms: 1) static roll tilt in hypo-gravity, 2) dynamic roll tilt in hyper-gravity across a wide range of frequencies, and 3) static pitch tilt in hyper-gravity.
Conclusions: We quantified static and dynamic roll tilt perception in hyper-gravity. Perceived tilt during static tilts qualitatively mimicked published data. Perceived tilt during dynamic rotations that simultaneously stimulated the semicircular canals and otolith organs demonstrated systematic overestimation that depended in magnitude upon the angular velocity of the rotation. A previous Observer-type canal otolith interaction model was modified to replicate the perceptual responses experimentally observed across a range of altered gravity conditions. The model, now extended beyond the normal 1 Earth G, can predict human orientation perception in altered gravity environments.

P-B-2
STUDY OF THE VESTIBULO-AUTONOMIC REFLEX IN 13 COSMONAUTS AFTER 6 MONTHS OF SPACEFLIGHT

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Introduction: Between 2007 and 2013, the vestibulo-autonomic reflex was investigated in 13 cosmonauts before and after 6 months duration spaceflight. Cosmonauts were rotated on the mini-centrifuge VVIS, installed in Star City. Initially, this mini-centrifuge flew on board of the Neurolab mission (STS-90), and served to generate intermittent artificial gravity during that mission, with apparent very positive effects on the preservation of the orthostatic tolerance upon return to earth in the 4 crew members that were subjected to the rotations in space. The current experiments SPIN and GAZE-SPIN are control experiments to test the hypothesis that intermittent artificial gravity in space can serve as a counter measure against several deleterious effects of microgravity. Additionally, the effect of microgravity on the gaze holding system during centrifugation is studied as well, followed by an operational tilt test to study the cardiovascular reflexes.
Material and Methods: Cosmonauts from a long duration stay in the International Space Station were tested on the VVIS (1 g centripetal interaural acceleration; consecutive right-ear-out anti-clockwise and left-ear-out clockwise measurement) on 5 different days. Two measurements were scheduled about one month and a half prior to launch and the remaining three immediately after their return from space (typically on R + 2, R + 4, R + 9; R = return day from space). The ocular counter roll (OCR) as a measure of otolith function, as well as the gaze holding system were measured before, during and after rotation in the mini centrifuge, using infrared video goggles. The perception of verticality was monitored using an ultrasound system. After the centrifugation part, the crew was installed on a tilt table, and instrumented with several cardiovascular recording equipment (ECG, continuous blood pressure monitoring, respiratory monitoring), as well as with impedance measurement devices to investigate fluid redistribution throughout the operational tilt test. To measure heart rate variability parameters, imposed and controlled breathing periods were included in the test protocol. After 6 minutes baseline in supine position, all subjects were subjected to a passive tilt test of 60 degrees, during 16 minutes, followed by a 3 minutes recovery period in supine position.
Results: The results show that cosmonauts clearly have a statistically significantly reduced ocular counter rolling during rotation upon return from space, when compared to the pre-flight condition, indicating a reduced sensitivity of the otolith system to gravito intertial acceleration. None of the subjects fainted or even approached presyncope. However, the resistance in the calf, measured with the body impedance method, showed a significant increased pooling in the lower limbs. Additionally, this was statistically significantly correlated ($p = 0.024$) with a reduced otolith response, when comparing for each subject the vestibular and autonomic reflex data. This result shows that the vestibulo-autonomic reflex is reduced after 6 months of spaceflight. When compared with Neurolab, the otolith response in the current group of crew members that were not subjected to in-flight centrifugation is significantly reduced, corroborating the hypothesis that in-flight artificial gravity may be of great importance to mitigate the deleterious effects of microgravity.

Poster Presentations C. Visual-vestibular Interaction

P-C-1
VELOCITY-SELECTIVE ADAPTATION OF THE HORIZONTAL AND CROSS-AXIS VESTIBULO-OCULAR REFLEX IN THE MOUSE

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Introduction: One commonly observed phenomenon of vestibulo-ocular reflex (VOR) adaptation is a frequency-selective change in gain (eye velocity/head velocity) and phase (relative timing between the vestibular stimulus and response) based on the frequency content of the adaptation stimulus. The neural mechanism behind this type of adaptation is not clear, especially because frequency-selectivity of individual cells or synapses has never been demonstrated. On the other hand, there is a basis for the existence of "velocity-channels" and "acceleration-channels" given that at the primary vestibular afferent level both head velocity and acceleration information is encoded.
Objectives: Our aim was to determine whether velocity and acceleration sensitive pathways are capable of producing parameter-selective effects on VOR adaptation; specifically velocity- and acceleration-selective changes in the horizontal VOR gain and phase. We also wanted to determine whether parameter-selectivity was also in place for cross-axis adaptation training,

which in our case was a visual-vestibular training stimulus that elicited a vestibular-evoked torsional eye movement during horizontal head rotations.
Methods: We measured VOR gain and phase in 9 C57BL/6 "wild-type" mice (both sexes, aged 13–15 weeks). Each mouse was tested without prior adaptation (ideal gain is unity) and after the VOR was adapted using sinusoidal gain-increase and gain-decrease visual-vestibular training over two separate sessions. The adaptation training stimulus had peak-velocity 20°/s and 50°/s over two separate sessions. For all adaptation training the sinusoidal frequency was kept constant at 0.5 Hz and the adaptation time was strictly kept to 40 minutes. In addition, we tested 8 mice after cross-axis adaptation (torsional eye velocity/horizontal head velocity gain driven to unity, during sinusoidal training at 20°/s). Following adaptation we measured the sinusoidal (0.1–10 Hz, at peak velocities 10, 20, 50 and 100°/s) VOR gain in darkness using a binocular 3D video-oculography system sampling at 220fps.
Results: Our results show pronounced velocity-selectivity during VOR adaptation. The difference in horizontal VOR gain after gain-increase versus gain-decrease adaptation was maximal when the sinusoidal testing stimulus matched the adaptation training stimulus peak-velocity. When the sinusoidal testing stimulus peak-velocity was 20°/s the average gain difference between the two adaptation conditions (gain-increase minus gain-decrease conditions; averaged across all frequencies) was ∼0.30 after adaptation training at 20°/s, and lower at ∼0.05 after training at 50°/s. Conversely, when the sinusoidal testing stimulus peak-velocity was 50°/s, the average gain difference between the two adaptation conditions was ∼0.08 after adaptation training at 20°/s, and higher at ∼0.19 after training at 50°/s. There was no marked effect of adaptation frequency and acceleration on the VOR responses.
Conclusions: This study demonstrates velocity-selecivity of VOR adaptation as a result of sinusoidal visual-vestibular adaptation training. VOR adaptation was maximal when the vestibular testing stimulus had the same peak-velocity as the vestibular training stimulus. We suggest that frequency-selectivity could be a manifestation of both velocity and acceleration-selectivity because when one of these is absent, e.g., acceleration-selectivity in the mouse, then frequency-selectivity is also reduced.

P-C-2
VISUO-VESTIBULAR SELF-MOTION CUES ARE OPTIMALLY INTEGRATED DURING BOTH CLOCKWISE AND COUTERCLOCKWISE PASSIVE WHOLE BODY ROTATIONS IN PATIENTS WITH UNILATERAL PERIPHERAL VESTIBULAR LOSS. CONDUCTED AT EPFL, LAUSANNE, SWITZERLAND

Maire, raphaël[1]; gale, steven[2]; Kaliuzhna, Mariia[2]; Prsa, Mario[2]; Blanke, Olaf[2]
[1]centre hopitalier universitaire vaudois; [2]Laboratory of Cognitive Neuroscience, Brain-Mind Institute, École Polytechnique Fédérale de Lausanne

Introduction: When perceiving the world, humans integrate multisensory information to reduce perceptual uncertainty. Previous research has shown that healthy volunteers effortlessly combine visual and vestibular information about own-body translations and rotations, and do so in a statistically optimal manner.
Objective: Here we explore whether such optimal integration takes place in the presence of an unilateral peripheral vestibular deficit.
Methods: Patients with unilateral peripheral vestibular loss were seated in a rotating device while observing a 3D visual field simulating optic flow. They made size comparisons between two successive whole body rotations using only visual, only vestibular, and both modalities together. Experimentally measured thresholds in the bimodal condition were compared with theoretical predictions derived from the single cue thresholds (Bayes-optimal integration model).
Results: Our results show that patients with unilateral vestibular loss optimally integrate visuo-vestibular cues about self-motion. Interestingly, the level of integration did not differ between rotations to the healthy and the damaged side.
Conclusion: This finding suggests that despite the presence of a peripheral unilateral vestibular deficit patients benefit from multisensory integration in a similar way as healthy volunteers and in accordance with statistical optimality.

P-C-3
DIZZINESS FOLLOWING TRAUMATIC BRAIN INJURY: A CLINICAL POPULATION

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A poorly understood cause of chronic dizziness is traumatic brain injury (TBI). Although the mechanism of

injury varies between patients, a significant proportion report chronic dizziness and/or headaches with nausea following TBI. Here we present demographics of an on-going study assessing the structural brain correlates of dizziness in a group of TBI patients who were assessed on a range of standard vestibular tests. Twenty patients (12 male) with TBI were included in this study (mean age 44.7 $\pm$ 13.6 years, range 19–69). All patients were tested at least four weeks after admission for brain injury. First standard vestibular testing was conducted via cold (30o) and warm (44o) caloric irrigation of both left and right ears. There was no significant overall asymmetry between right cold (mean = 29.4o/s +/ 12.9) and left cold (28.6o/s $\pm$ 14.3) response ($p > 0.5$), or between right warm (mean = 35.2 o/s $\pm$ 21.3) and left warm (36.7 o/s $\pm$ 15.6) response ($p > 0.8$). The mean canal paresis was 11.3% $\pm$ 17.2 (range 0–70%) and the directional preponderance was 13.5% $\pm$ 12.2 (range 0–40%). Time constants (TC) and gain of the vestibular ocular reflex (VOR) was examined using chair rotations. There was no significant asymmetry in leftward (0.59 $\pm$ 0.12) or rightward (0.62 $\pm$ 0.11) VOR gain ($p > 0.2$), or duration of time constants for leftward (12.57s $\pm$ 5.2) or rightward (13.2 $\pm$ 4.8) rotations ($p > 0.5$). TBI patients with chronic dizziness provide an opportunity to study the impact of cortical lesions of grey and primarily white matter on symptoms of dizziness and/or de novo migrainous headaches. One potentially significant observation from this data set is that all patients report chronic dizziness, but not all patients exhibit significant canal paresis. This may suggest sub populations within TBI patient populations which are liable to suffer from dizziness due to different cortical aetiologies.

P-C-4
EFFECTS OF CALORIC STIMULATION ON SUBJECTIVE VISUAL VERTICAL AND VISUAL DEPENDENCY

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Background: Visual dependency (VD) – the extent to which a person relies on their vision to make judgements about gravitational vertical – plays a part in clinical outcomes in vestibular patients. Since pre-morbid measures of visual dependency are rarely available for vestibular patients, it is important to understand the extent to which a vestibular nystagmus affects judgements of subjective visual vertical (SVV) and VD. In this study we used caloric irrigation to mimic the effects of a peripheral vestibular lesion and measured the influence which this had on standard measures of VD and SVV.

Methods: Twenty eight healthy volunteers participated in this study. Participants were seated in a chair reclined such that the head was angled at 30o to horizontal. All participants were required to set a central line to vertical in the presence of a stationary or rotating moving background (the rod-and-disk test). In experiment 1, baseline measurements of visual dependency were recorded and then repeated following a standard 40s cold (30o) caloric irrigation of the right or left ear. Following the right ear caloric the direction of disk rotation was clockwise, and during the left ear caloric the direction was anticlockwise. In experiment 2, a further eight participants repeated this experiment but the direction of rotation following the caloric was reversed. In experiment 3, the participants repeated the visual dependency measurements following a right cold caloric and a right warm caloric for clockwise motion. In experiment 4, performed the same task with a static background at baseline and following cold calorics of right and left ears.

Results: In experiment 1, cold caloric stimulation of the right ear during clockwise visual motion significantly increased visual dependency (i.e. larger disk-induced tilts of the SVV) compared to baseline ($p < 0.05$), as did stimulation of the left ear during anticlockwise visual motion ($p < 0.05$). In experiment 2, cold caloric of the right ear during anticlockwise visual motion significantly reduced visual dependency ($p < 0.05$), and there was a trend towards a significant reduction following stimulation of the left ear during clockwise visual motion ($p < 0.07$). Combining the findings of experiments 1 and 2 demonstrated that there was an overall effect of caloric stimulation on visual dependency ($p < 0.05$). In experiment 3, cold caloric during clockwise visual motion again increased visual dependency ($p < 0.05$), but the right warm caloric had no significant effect on visual dependency during the same clockwise motion ($p > 0.1$). In experiment 4, there was no significant effect of caloric stimulation on visual dependency with a static background ($p > 0.2$).

Conclusions: These findings suggest that the direction of visual motion with respect to the slow phase eye movements of a vestibular nystagmus can amplify or negate individual biases in visual dependency and SVV. The results of experiment 3 suggest that this cannot be explained by an alerting affect to one side of

space as right cold and right warm calorics had different effects on visual dependency judgements. There was an overall effect of caloric irrigation on visual dependency, and an interaction with the direction of rotation of the disk. These findings indicate that a caloric induced nystagmus can significantly affect visual dependency judgements, and is sensitive to the direction of peripheral visual motion.

P-C-5
FUNCTIONAL MEASURE OF GAZE SHIFTING
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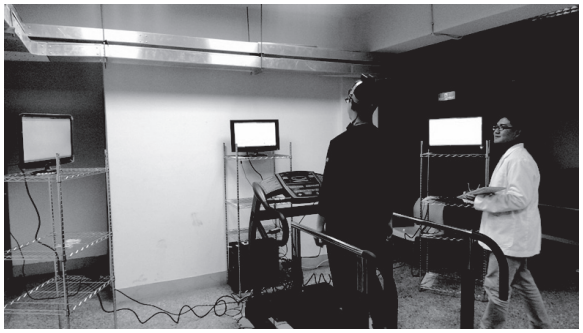
Background: Gaze shifts are combined eye and head rotations to bring the fovea of the retina to a visual target of interest, common for targets that are positioned beyond the horizontal range of oculomotor function ($>$ 45deg). Because uncompensated vestibular hypofunction causes gaze and gait instability during head rotation, both of which can result in falls, we have developed a functional measure of gaze shifting while walking as a proxy to concurrently examine gaze and gait stability. We intend to develop this method as a form of monitoring recovery with vestibular rehabilitation.
Method: Subjects walked on a treadmill at a self-selected pace viewing a monitor placed 2 m in front of them. Two additional monitors were placed 60d to the right and left of the centered monitor.



When the subjects head was within 15d of neck neutral for $>$ 2 seconds, an arrow flashed on the centered monitor directing the subject to gaze shift right or left. Once the subject's head rotated $\sim$60 degrees, an optotype flashed on the eccentric monitor and the subject was asked to identify its orientation. An examiner enters the subject's response, and the optotype disappeared.

Results: To date we have collected data on $n = 2$ healthy young adults (mean 26.5 $\pm$ 3.5 yrs) and $n = 5$ healthy elderly (mean 71.8 $\pm$ 6 yrs). Our data suggests reaction time for rightward or leftward directed gaze shifting is lengthened in the elderly compared with the younger adults (2.26 $\pm$ 0.07 sec vs. 1.37 $\pm$ 0.01 sec). However there was no difference in dynamic visual acuity while gaze shifting across the two age groups.
Conclusion: Our pilot data suggests that healthy controls have similar gaze stability during gaze shifting regardless of age. We expect the effect of vestibular hypofunction will involve longer reaction times and significantly reduced gaze stability during gaze shifting. We believe this technique will be a useful metric of recovery with vestibular rehabilitation protocols.

P-C-6
A QUANTITATIVE BEDSIDE TEST OF BALANCE FUNCTION: THE VIDEO VISUALLY ENHANCED VESTIBULO-OCULAR REFLEX (VVOR)
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Introduction: Initially utilized to investigate the visual -vestibular interaction, the visually enhanced vestibulo-ocular reflex (VVOR) has only recently found clinical utility in the form of a qualitative bedside test. We describe the next increment in the evolution of the clinical application of the visual-vestibular interaction, by describing the quantitative bedside VVOR, which employs rapid video-oculographic (VOG) diagnosis of vestibulo-cerebellar disease. Portable VOG is a new field of diagnostic eye movement quantification, whose utility has been facilitated by the recent development of a lightweight, minimum-slip high-speed video eye tracking system. Underlying the efficacy of the VVOR as a robust and sensitive clinical sign is the knowledge that its perturbation represents a compromise in all three compensatory oculomotor reflexes; smooth pursuit (SP), optokinetic nystagmus (OKN) and vestibulo-ocular reflex (VOR). The clinical utility of the VVOR sign is it's unique ability to simultaneously test for the co-existance of vestibular and cerebellar pathology. Conditions with this compound deficit include spinocerebellar ataxia 3 and 6, Friedreich's ataxia, cerebellar ataxia with neuropathy and

vestibular areflexia syndrome, multiple system atrophy predominantly of the cerebellar subtype and idiopathic cerebellar ataxia with bilateral vestibulopathy.
Objective: To identify a robust and easily performed quantitative bedside clinical test of vestibular and cerebellar function.
Methods: A prospective observational study.
Results: We present data on 131 patients with combined vestibular and cerebellar pathology; 61 with cerebellar ataxia with neuropathy and vestibular areflexia syndrome, 23 with Friedreich's ataxia, 16 with spinocerbellar ataxia (SCA) 6, 7 with SCA3, 15 with multiple system atrophy of the cerebellar subtype and 9 with idiopathic cerebellar ataxia with bilateral vestibulopathy.
Conclusions: This test readily allows identification and quantification of combined vestibular and cerebellar pathology at the time of consultation, a process which previously involved referral for specialised neuro-otology testing and so, improves clinical pathway efficiency and directs the diagnostic algorithm.

Poster Presentations D. Vestibular Testing

P-D-1
CAN VERTICAL COMPONENT ALONE DETECT DEFICITS FROM HEAD IMPULSES IN VERTICAL CANAL PLANES?

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Introduction: The head impulse tests (HIT) in horizontal and vertical semicircular canal planes assess individual canal functions by measuring vestibulo-ocular reflex (VOR) gain and compensatory saccades. Can we perform vertical canal plane (LARP/RALP) HIT in 2D, i.e. without recording torsion and obtain clinical useful result regarding vertical canal deficits? This is important because conducting HITs in the LARP/RALP planes maximizes vertical canal selectivity.
Objective: Our study examined the performance of 2D to the gold-standard 3D search coil measurements of LARP/RALP HIT in a representative vestibular disorder such as vestibular neuritis (VN).
Materials and Methods: We studied 23 (5 complete, 14 superior, 4 inferior) unilateral VN with the 3D HIT to examine their individual semicircular canal function and compensatory saccades and compared the 2D (horizontal and vertical) analysis to the 3D data analysis.
Results: Our published 3D study showed that the head impulse VOR gain in pitch plane was ($\sim$1.0) and in roll plane ($\sim$0.7). In inferior VN, 3D VOR gain of the posterior canal was about (0.1) but the vertical-only gain was about (0.4). The VOR gain of the remaining five semicircular canals was about (0.9). In superior VN, the 3D VOR gain of the anterior canal was (0.1) but the vertical-only gain was (0.5). Horizontal canal VOR gain was (0.1) while the unaffected 4 semicircular canals was ($\sim$0.9). There was little difference between compensatory saccade amplitudes in vertical component compared to the 3D LARP/RALP component.
Conclusion: Despite the tendency to underestimate the VOR deficits in vertical canals, recording vertical component only in LARP/RALP HIT may still yield meaningful results which can be applied to 2D search coils or video-oculography.

P-D-2
VERTICALITY PERCEPTION IN VESTIBULAR SYNDROMES

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Introduction: The human's internal estimate of verticality is constructed and updated by integrating vestibular, somatosensory and visual input. It can be assessed by the subjective visual vertical (SVV) and the subjective postural vertical (SPV). The SVV and the SPV are supposed to reflect different aspects of verticality perception: Patients with vestibular disorders in general show SVV deviations, while the SPV is preferentially affected in patients with impaired upright body orientation. However, research is insufficient and further investigation is needed for a better understanding of the inner model of verticality.
Objectives: The aim of this study was to investigate the SPV and SVV in patients with vestibular syndromes. For the first time, the SPV is measured in standing in both the pitch and roll plane.
Methods: The SPV (in standing using the Spacecurl) and the SVV (using the hemispheric dome or the bucket test) were assessed in patients with vestibular neuritis ($n = 4$), Wallenberg syndrome ($n = 4$), cerebellar stroke ($n = 4$) and thalamic stroke ($n = 5$).
Results: For all patient groups, the mean SPV deviations in both planes were within the ranges of normal-

ity (pitch: $\pm$ 2.0°; roll $\pm$ 1.5°). However, in cerebellar and thalamic stroke patients we found a systematic tilt of the SPV to the contralesional side (1.3 $\pm$ 1.6° and 1.1 $\pm$ 0.6°). The SVV in contrast, showed abnormalities for patients with vestibular neuritis (6.9 $\pm$ 5.4° to the ipsilesional side), cerebellar stroke (3.6 $\pm$ 4.7° contralsional) and Wallenberg syndrome (5.4 $\pm$ 4.2° ipsilesional).
Conclusions: Patients with cerebellar stroke showed a transmodal tilt of verticality perception, while other lesions produced dissociation between SPV and SVV. This supports the assumption, that the SPV and SVV are differently regulated and reflect different aspects of verticality control. In vestibular dysfunctions the deviation can be largely compensated by somatosensory cues during SPV estimation, but not during SVV estimation. SVV therefor remains the gold standard for testing verticality perception in vestibular syndromes. SPV might be a valuable tool in hemispheric syndromes with thalamic and cortical dysfunction, including pusher syndrome.

P-D-3
THE GROWING NEED OF VESTIBULAR ASSESSMENT IN COCHLEAR IMPLANT CANDIDATES AND USERS

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Conventional electronystagmography can be performed in CI candidates with the purpose to preoperatively choose the optimal ear. Taking into account the recent increase of very young and very old CI recipients, it is important to know which preop variables could predict postop vestibular degradation. Unfortunately, ENG/VNG is not always possible in young children. This study analyzes in CI subjects ($n > 500$) the predictive value of preop ENG on postop vestibular degradation and evaluates – besides standard ENG – the analysis of two different vHIT methods, which were performed in adults as well as in very young children, with and without the use of goggles. Results: an update of ongoing research on several predictive variables using regression analysis revealed that in contrast to other variables (such as e.g. implant device, type of surgery, hearing loss) 'age' was the main significant predictor for postop vestibular loss or degradation. Besides conventional ENG data, results of vHIT appeared to be more consistent in children and adults than ENG. Besides, the vHIT method without goggles showed to be less invasive and more child-friendly than ENG. Data show that vHIT was in agreement with bithermal caloric outcomes in 93% of the subjects, despite its difference in frequency specificity. vHIT seems to be able to detect (almost) complete vestibular losses and to be a sufficiently sensitive tool to diagnose abnormal of absent VOR. No deviant VOR gains were found in patients with a normal ENG. Besides these objective data, behavioral data was assessed using the Dizziness Handicap Inventory (DHI). Conclusion: with rapidly changing CI criteria (i.e. less stringent), vestibular function should be assessed in every CI candidate and patient. A higher preop age implies a higher risk factor for postop vestibular degradation. Regarding the elderly, the still increasing age of implant candidates and numbers of geriatric (!) CI users, makes it of utmost importance that vestibular function should be assessed pre- ánd postoperatively, to evaluate possible long-term vestibular degradation after CI. Clinical application of vHIT in CI candidates show that this method can be successfully used in the preop selection and counseling procedures when calorics are not possible. Regarding young children (age $<$ 9 years), in which ENG/VNG is more difficult to perform, vHIT revealed to be a very fast and handy tool to assess preop vestibular loss in babies children, combining friendly child-parent interaction, less unwanted head movements (less noise), illuminated room circumstances without any goggles, making this method even more child-friendly.

P-D-4
COMPARISON OF CALORIC AND HEAD IMPULSE TESTING WITH VIDEO-OCULOGRAPHY IN SUB-ACUTE/CHRONIC VESTIBULAR PATIENTS. DEPARTMENT OF NEUROLOGY, WELIINGTON HOSPITAL, NEW ZEALAND

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Introduction: Caloric testing assesses low frequency while head impulse testing assesses high frequency semicircular canal function.
Objectives: To compare results with the video horizontal Head Impulse Test (hHIT) using video-oculography (EyeSeeCam) with caloric testing in the routine assessment of vestibular function.
Method: Sub-acute or chronic vestibular patients were seen at least 10 days post onset of their vestibular

symptoms. Same day investigation was performed with calorics and the video horizontal Head Impulse Test (hHIT) using video-oculography (EyeSeeCam). Horizontal head impulses were brief, unpredictable, passive, high-acceleration (up to 4000 degrees/s), low-amplitude (20–30 degrees) head rotations. We have established the 2SD lower limit of a normal horizontal VOR gain on hHIT using video-oculography (EyeSeeCam) as 0.76 (Mossman et al. 2012). Standard bithermal water calorics tests were regarded as abnormal with a canal paresis when there was a reduced vestibular response in one ear with a greater than 25% difference between slow phase velocities on the Jongkees formula.

Results: Data from 36 patients revealed abnormal results from either one or both of the tests. Fifteen of 36 (42%) of the patients had abnormal results on both tests, 18/36 (50%) had abnormal calorics results but normal hHIT results (VOR gain > 0.76) and 3/18 (8%) had abnormal hHIT (VOR gain < 0.76) with normal calorics results.

Discussion: Caloric testing in a sub-acute/chronic group of vestibular patients was in general though not always more sensitive than testing with the video hHIT. Video HIT has many advantages in comparison to caloric testing but can not always be guaranteed to assess horizontal semicircular canal function with the same sensitivity as caloric testing.

Conclusion: A normal result with the video hHIT requires caloric testing to fully assess horizontal semicircular canal function.

P-D-5
THE TEMPERATURE SETTING IN THE CALORIC TEST – AN HISTORICAL REVIEW

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Introduction: The caloric test is an evoked response in which, both warm and cold water is used to stimulate the vestibular system creating horizontal beating nystagmus. The technique originally described by Robert Bárány in 1906 involved irrigation of the external ear with large volumes of water at 30°C and 20°C respectively until nystagmus appeared. The procedure today involves irrigation with water temperatures of 44°C and 30°C and sequentially recording the nystagmus generated. The modification of Bárány's original technique was described by Gerald Fitzgerald and C.S. Hallpike in 1942 and is still recognized today as the accepted method for assessing vestibular function. The temperature of the water used to stimulate the canals is 7°C both above and below mean body temperature, but a recordable caloric response can be elicited even by thermal stimuli differing by less than 7°C from mean body temperature. Why were these parameters chosen for this test?

Objectives: To elucidate how the caloric test temperatures were determined.

Methods: Historical literature review.

Results: Caloric responses can be produced by thermal stimuli differing by 0.5°C from mean body temperature. The duration and slow phase eye speed velocity of the caloric response increases as the stimulus temperature's difference from mean body temperature increases. When temperatures that differ by more than 7°C from body temperature are used the symptomatic reaction of vertigo, nausea and pain increase but the duration of nystagmus does not increase substantially. The technique for caloric stimulation using water temperature of 44°C and 30°C was designed to cause moderate stimulation with little discomfort to the patient.

Conclusions: The stimulus parameters used today, similar to does described by Fitzgerald and Hallpike in 1942, are aimed at producing a recordable response within the limits of patient comfort and are not aimed at producing the maximal vestibular response.

P-D-6
A COMPARISON BETWEEN PRE AND POST-OPERATIVE AIR CALORIC TEST IN CHRONIC OTITIS MEDIA

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Introduction: The caloric test is one of the most important vestibular function tests. When tympanic membrane perforations or external auditory canal diseases are presented, air caloric stimulation is useful.But the air caloric test results in chronic otitis media patients were sometimes variable.

Objective: To analyze the variability of air caloric test for chronic otitis media (COM) without vertigo history and to compare the results after successful tympanomastoid surgery.

Method: Thirty cases of COM without vertigo history were participated in this study. There were 18 cases of unilateral tympanic membrane perforation, 2 cases of bilateral tympanic membrane perforation, 5 cases of no perforation with attic destruction. The partici-

pants were performed the air caloric test before and about 2 months after surgery at complete heal up state. We compared the characteristics of nystagmus, slow phase velocity and presence of unilateral weakness in air caloric test before and after COM surgery.
Results: In pre-operative test, only eleven patients had normal caloric responses. Five patients had ipsilateral canal paresis and 1 patient had contralateral canal paresis(CP). Thirteen patients could not be evaluate caloric function because they had inverted nystagmus (caloric inversion) during the warm air caloric test, preoperatively. Among 13 cases of caloric inversion, 8 patients had large tympanic membrane perforation. Ten of 13 caloric inversion response were normalized after tympanomastoid surgery. And two of 11 cases on normal type were changed to ipsilateral CP after tympanomastoid surgery.
Conclusion: COM patients even without vertigo history could be showed abnormal caloric response in air caloric test. But, after successful tympanomastoid surgery, most of these abnormal caloric results might be normalized.

P-D-7
THE EFFECT OF DIRECTION OF ROTATION ON DYNAMIC SUBJECTIVE VISUAL VERTICAL (DSVV) AND OCULAR MOVEMENTS DURING ON-AXIS ROTATIONAL TESTING
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Introduction: One current technique for assessing utricular function typically involves the subjective estimation of verticality during eccentric rotation. The expense and possibly limited availability of clinical equipment capable of performing and/or analyzing these techniques may preclude their use in some facilities. In light of this, the assessment of utricular function by using centric rotation has been proposed (Helling et al., 2006). Those authors used static subjective visual vertical (sSVV) as well as dynamic subjective visual vertical (dSVV) during on-axis rotation. Amongst other findings, their results found that nearly 20% of normal individuals had abnormal dSVV that was not found in the static condition. It is unclear whether these trends hold true when performing on-axis testing bidirectionally.
Objectives: The purpose of this study was to examine whether the direction of on-axis angular rotation has an effect on perceived verticality. While previous research may have found differences in sSVV and dSVV during rotations, it is unclear whether clockwise rotations provide differing responses than do counterclockwise. Testing was performed at the Vestibular Clinic of Bloomsburg University of Pennsylvania (USA) with a Neuro-Otologic Test Center (NOTC) rotational chair (Neuro-Kinetics, Inc., Pittsburgh, PA USA).
Methods: Each participant initially completed six sSVV tests prior to being subjected to a pair of on-axis rotational testing with randomized starting directions. A maximum velocity of 300°/s was achieved following an initial acceleration of 5°/s2 over 60 seconds. This terminal velocity was maintained for 90 seconds prior to performance of six dSVV trials. Each rotation was concluded by decelerating subjects at a rate of 3°/s2 following completion of dSVV. All estimations of verticality were performed by participants through the use of pushbutton controls mounted on the armrest of the rotational chair. Participants were given ten seconds to manipulate the SVV stimulus prior to the angle of verticality being recorded by the test software. Average static and dynamic SVV values were calculated and utilized for the analysis. Participants wore VNG goggles to assess ocular movements that occurred during rotational testing.
Results: Preliminary data revealed a difference in the means of dSVV when direction of rotation was compared. The observed trend was such that a bias appeared to be present where clockwise rotations elicited dSVV values that were more positive than those obtained during counterclockwise rotations. During on-axis rotation, ocular torsion was not observed in all subjects. However, for those subjects in which ocular torsion was present, it did not appear to be symmetric when considering the direction of rotation.
Conclusions: The data obtained appear to support the possibility that clockwise and counterclockwise rotations may not stimulate the vestibular end organs in a symmetric fashion. The clinical importance of this may lie in the determination of whether unidirectional assessment is sufficient in comprehensive bilateral vestibular assessment. Additionally, it may be appropriate to consider rotation direction when comparing on-axis to eccentric rotation data. These assessments are ongoing, and additional findings of this study will be shared.

P-D-8

FALSE NEGATIVE BEDSIDE HEAD IMPULSE TEST (BHIT): COMPARED WITH VIDEO HEAD IMPULSE TEST (VHIT)

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Introduction: Compared with the caloric test, the head impulse test is very simple and useful bedside test to identify the peripheral vestibular loss. But the bedside head impulse test (bHIT) with naked eyes often overlooked vestibular loss by missing the corrective saccade. Sensitivity of bHIT compared with caloric test has been reported, but the false negative result of bHIT may be partly due to different range of test frequency between two tests. For this reason sensitivity of bHIT compared with vHIT, which is more accurate to identify the vestibular loss than bedside test, is necessary.
Objectives: The purpose of this study is to identify the sensitivity of bHIT compared with vHIT and the causes of false negative result of bHIT.
Methods: vHIT positive 51 ears from 47 patients who visited our outpatient clinic due to dizziness were included in this study. The bHIT was performed by quickly turning the head 10 times in each direction to right and left on the horizontal plane. When we saw the refixation saccades, we marked it as positive. The vHIT was performed using ICS impulse„?(Otometrics, U.S.A.) on horizontal plane and was repeated about 20 times in each direction. Calculated VOR gain below 0.8 which is below the two standard deviation of average gain from our normative data, or the occurrence of corrective saccade (covert or overt) was decided as positive which is abnormal. Occurrence rate of overt saccade was calculated by dividing the number of overt saccade, which occurred during the repeated tests, by total repeated number of test.
Results: Eighteen ears among total vHIT positive 51 ears showed bHIT negative, so the false negative rate of bHIT was 35.3%. Among those bHIT false negative 18 ears, 2 ears (11.1%) showed only low gain without corrective saccade, 1 ear (5.6%) showed only covert saccade, and other 15 ears (83.3%) showed both covert and overt saccade. There was no case presenting overt saccade solely. This occurrence pattern of corrective saccade was similar in bHIT positive group also. (Pearson Chi-square test, $P = 0.065$) The occurrence rate of overt saccade in bHIT negative group was 37.06¡Ó25.97%, which was lower than those (82.7¡Ó18.37%) in bHIT positive group. (Independent T-test, $P = 0.000$) When we categorized the ears according to the occurrence of covert saccade, occurrence rate of overt saccade in covert-positive group was 47.2¡Ó40.5%, while it was 81.9¡Ó28.5% in covert-negative group. (Independent T-test, $P = 0.000$)
Conclusions: Most of bHIT negative (false negative) ears showed both covert saccade and overt saccade on vHIT. The occurrence rate of overt saccade was lower in false negative bHIT group than in positive bHIT group, and it was lower when the covert saccade occurred. In conclusion, false negative result of bHIT is caused by low occurrence rate of overt saccade which is influenced by the occurrence of covert saccade.

P-D-9

COMPACT, INEXPENSIVE, AUTOMATED, MOTORIZED HEAD-ON-BODY MOTION DEVICE YIELDS HIGHLY REPEATABLE HEAD IMPULSES, SINUSOIDS AND VELOCITY STEPS FOR TESTING 3D VESTIBULO-OCULAR REFLEX IN ANY CANAL PLANE

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The head impulse test (HIT) has become a standard part of the physical exam during clinical evaluation of patients with suspected vestibular disorders. To date, most quantitative HIT testing has been performed using head movements delivered manually by an examiner, with eye movements measured using either scleral coils or video-oculography (VOG). Manual delivery of head movements is less precise than can be achieved using a motorized system. Motorized rotary chairs suitably powerful for whole-body rotation HIT testing are large and expensive to install, so interest has grown in development of a smaller unit able to deliver head-on-body rotations in a physician office setting. We designed, constructed and refined a small, inexpensive HIT testing device comprising of a high-torque but fail-safe goniometer coupled to the patient's head via a bite bar. Combining this device with high speed, low mass VOG goggles, we tested the device on 5 healthy volunteers. We recorded head movement using an integrated circuit gyroscope and calculated gain, asymmetry and latency of the horizontal vestibular-ocular reflex (VOR) while subjects viewed a distant target. During horizontal head impulses, peak head velocity was

very repeatable at 136 ± 1.6 deg/s (mean ± SD). Mean acceleration was 2161 ± 272 deg/s2. The mean VOR gain (mean eye movement velocity divided head velocity during the constant acceleration portion of head movement) was 0.92 ± 0.11. Mean VOR latency was 7.6 ± 3.5 ms, and the mean asymmetry of acceleration gain was 4.2 ± 5%. Because the device yields such precisely controlled and repeatable head motion, VOR gain can be measured during very small amplitude head rotations (less than ∼ 8 deg) that are well within a subject's documented comfortable range of motion. Sinusoidal (0.2–10 Hz) and constant-velocity step motions, with peak velocity determined by the subject's comfortable range of motion, also yielded highly repeatable motion. In each case, the low variance in motion waveforms allowed acquisition of data in fewer trials, and therefore more quickly and efficiently, that manual impulse testing performed by an experienced examiner. The device can be reoriented within < 10 sec to deliver rotations in the left-anterior/right-posterior (LARP) and RALP planes. In contrast to large rotary chairs, the entire system fits on a portable table or cart and can be powered by either 220 or 120 V, making it well suited for use in an exam room or shared clinic space.

P-D-10

VESTIBULAR AND MOTOR PERFORMANCE IN CHILDREN WITH UNI-AND BILATERAL COCHLEAR IMPLANT

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Introduction: Over the last 20 years, cochlear implants (CI) have improved the rehabilitation of children with a severe to profound sensorineural hearing loss. However a CI is not without risk to the nearby vestibular canals and otolithic organs (Bonucci et al. 2008; Filipo et al. 2006; Jacot et al. 2009; Licameli et al. 2009; Migliaccio et al. 2005; Tien and Linthicum 2002; Wagner et al. 2010). Unfortunately, the risk of a vestibular impairment after implantation is likely to be underestimated in children. Moreover, the findings about the impact of a CI on the motor development and the balance performance in children are unclear.
Objectives: The current study examined the vestibular and motor performance after a second implantation in unilaterally implanted children.
Methods: Thirty children (22 girls, 8 boys, mean age 7y3m, range: 3y1m-12y2m) participated in this study. The first group entailed children without any auditory or vestibular complaints (control group) (11 girls, 4 boys, mean age 7y3m) and the second group represented hearing impaired children with a unilateral CI (11 girls, 4 boys, mean age 7y3m; mean age of first CI: 3y1m). The latter group received a second CI at a mean age of 7y5m and these children were tested before and after this second implantation. The vestibular test protocol consisted of three sinusoidal rotations (0.01 Hz; 0.05 Hz; 0.1 Hz at 50 °/s) and collic vestibular evoked myogenic potential (cVEMP) measurements. For the motor test battery three clinical balance test were examined (balance beam walking, one-leg hopping, one-leg stance) as well as the movement assessment battery for children – second edition (MABC-2) (subitems manual dexterity, aiming and catching, balance).
Results: A trend of lower rotatory gain values and significantly lower interpeak cVEMP amplitudes ($p < 0.001$) were noticed for the unilaterally implanted children in comparison to the control group. After the second implant rotatory and cVEMP responses were still present, although a significant decrease in interpeak cVEMP amplitude ($p < 0.05$) was measurable. For the clinical balance tests, the unilaterally implanted children obtained significantly lower scores in comparison with the control group ($p < 0.001$ for balance beam walking; $p < 0.01$ for one-leg hopping; $p < 0.05$ for one-leg stance). The MABC-2 demonstrated significantly lower motor performance for the subitems manual dexterity ($p < 0.01$) and especially balance ($p \leqslant 0.001$) in the hearing impaired group. After implantation a significant interaction effect was seen for the balance beam walking ($p < 0.001$), one-leg stance ($p < 0.05$) and the balance subitem of the MABC-2 ($p < 0.001$) when comparing results of the implanted children with the control group, demonstrating a reduced progress of the motor performance after implantation.
Conclusion: Although no clear absence of vestibular responses after implantation, significant changes in some response parameters were measured, with a clear impact on the gross motor development. These findings indicate that cochlear implantation requires a multidisciplinary approach with the inclusion of vestibular and motor testing. Evaluation of vestibular and motor functioning testing before and after implantation could help in decision-making about the side of implantation, unilateral versus bilateral implantation, sequential versus simultaneous implantation and the necessity to start early motor intervention.

P-D-11 THE BEDSIDE MINIMAL ICE TEST IN MIGRAINOUS PATIENTS WITHOUT VERTIGO COMPLAINS

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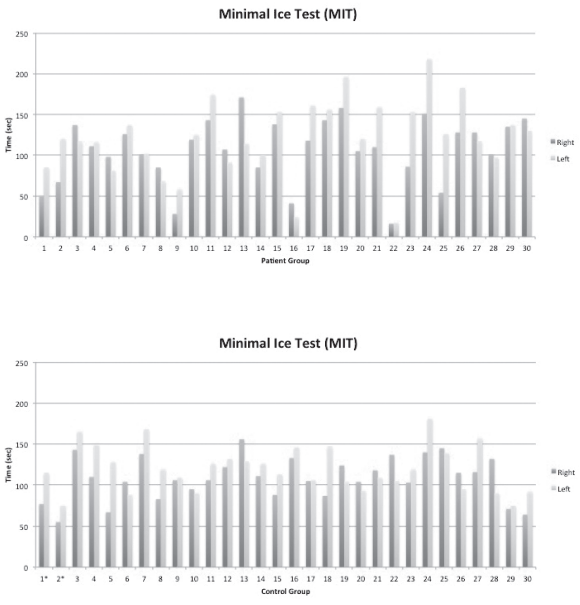
Introduction: Dizziness and headache are prevalent complains in any medical facility. Since 1906, when Robert Bárány introduced the ice water induced nystagmus to investigate the vestibular function, different authors tried to establish which would be the best water amount and temperature for this test. The Minimal Ice Test (MIT), described by Linthicum in 1964, and reviewed by Nelson in 1969 among others, proved to be effective. Numerous studies have identified an association between headache disorders and vestibular symptoms, such as dizziness, vertigo, and motion sensitivity. In this study we evaluated the MIT in 30 vertigo-free migraineurs as compared with controls. Objective: To test the hypothesis that vertigo-free migraine patients present vestibular dysfunctions as detected by the MIT.
Patients and Methods: Thirty migraine patients according to the ICHD 3rd edition; 25 women, 19 to 62 y-o (median 39.3 years) without vertigo complain, and 30 sex and age paired controls participated in the study. Subjects were first examined to rule out the presence of spontaneous nystagmus and the external ear canals (EEC) were inspected to both dispel any cerumen obstruction and to evince the canal shape trough the tympanic membrane. A paper cup was half filled with water and three ice cubes, which usually maintain the temperature between 1° to 3°C throughout the period of testing. A 1 mL syringe was filled with 0.2 mL ice water for instillation into the EEC. A stop watch was used to time the duration of nystagmus. The use of infrared Frenzel goggles was essential for better detection of the small nystagmus beats throughout the test. Subjects were in the supine position with the head bended 30° forward. The head was rotated to the side so that the ice water was instilled in a single plunge and trickled by gravity to the eardrum. The subjects were left in this position for ten seconds and then turned straight ahead. While observing for nystagmus, continuous questioning kept the persons alert. If no nystagmus was observed after instillation, the procedure was repeated five minutes later with 0.4 mL. After the end of nystagmus, a five minutes interval was used before the same procedure was performed on the other side. This study was approved by the local Ethics Committee.
Results: From 60 individuals (120 ears), all but one presented nystagmus in response to 0.2 mL MIT. One responded with 0.4 mL bilaterally. Among the patients the nystagmus duration ranged from 16 to 218 seconds – Right ear: 16 to 158 seconds (mean: 106.2 $\pm$ 39.4 seconds); Left Ear: 17 to 218 seconds (mean: 121.2 $\pm$ 45.8 seconds). The unilateral weakness average between R-L ears in the patients group was 20.97 $\pm$ 15.9%. In the control group the nystagmus duration ranged from 55 to 165 seconds. Right Ear: 55 to 156 seconds (mean: 108.5 $\pm$ 26.3 seconds); Left Ear: 75 to 165 seconds (mean: 119.7 $\pm$ 27.8 seconds). The unilateral weakness average between R-L ears in the control group was 18 $\pm$ 11.5%. (Fig. 1). Differences between patients and controls were not statictically significant at the p level 0.05.
Conclusion: Although not statistically significant, the migraine patients consistently showed unilateral vestibular weakness average when compared with healthy controls. Further studies are necessary to determine if this asymmetry points to a migrainous subclinical vestibular system dysfunction.



P-D-12
A HEAD POSITION DETECTABLE "AIR MICRO FRENZEL" GLASSES

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Introduction: The positional and positioning tests are essential when we see patients with vertigo. Recently we examined nystagmus with glasses with CCD infrared cameras which suppress nystagmus. This enabled us to detect even the slightest nystagmus, and to record them. However, one of the problems is that we cannot record the head position, so when we review the record afterwards, we do not know the head position of the moment the nystagmus were released. In order to solve this problem we developed a device which enables us to see both the eye movement and concurrent head position at once on the remote display terminal such as an iPad or iPhone. Device: We applied the "Air Micro Frenzel" glasses of Scala Company and improved them so that the pictures of the eye movement detected by a C-MOS sensor are sent via wireless fidelity at thirty pictures per second to the remote receiver such as iPad or iPhone etc. to be shown and/or recorded. Moreover, we equipped a gravity sensor near the CCD camera so that the information of the head position is also shown on the same remote display. As the result, our newly developed device enabled us to observe nystagmus and concurrent head position at the same time on the identical display. Advantages: The other device which detects the eye movement and head position simultaneously had been previously developed by Nagashima Medical Instruments Company in 2009. This system uses a three dimensional acceleration sensor to see the head position. It detects the head position only in the plane selected. However, it does not detect head orientation in the position with 45 degrees looking rightward or leftward. Our system, on the contrary, can give information on any head position in which we conduct an ordinary clinical examination. The gravity sensor of our system consists of simple device such as a spirit level. We usually employ two types of head positioning examinations; Stenger and Dix-Hallpike methods. Our device is more useful because it gives us information concerning the head orientation during either methods. Furthermore, our device transports data via wireless fidelity which enables us to use it wherever the patients are, such as in the emergency room or in the ward. Problems: There are some problems which need to be improved. First, the device is heavy because it consists of a gravity sensor, an infra-red camera, and batteries. This make it difficult to stabilize it tightly to the patient's head. Sometimes the device needs to be fixed to the patient's head with both tape and the examiner's hand. Another problem lies in the operation of the remote display recorder. We need a second person to switch the recorder on to start its recording. We have to improve this so that the recording starts automatically at the moment we start the examination. Furthermore, we have to improve the resolution of the pictures by making the transfer rate quicker. Conclusions: Our newly developed device, "Air Micro Frenzel" glasses enabled us to record the concurrent head position as well as nystagmus by a simple gravity sensor. We can apply it to both Stenger and Dix-Hallpike methods. Both nystagmus and the concurrent head position are shown on the remote display terminal via wireless fidelity. There are some technical problems such as stabilization of the glasses to the patient's head.

P-D-13
BILATERAL CALORIC AREFLEXIA: A SPECTRUM OF DISEASE

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Introduction: Peripheral bilateral vestibular loss (BVL) is an uncommon but devastating condition. Little is known about the extent to which clinical signs and investigations vary in patients with this condition. Usually diagnosed as caloric areflexia ($< 2°$/s slow phase velocity nystagmus to iced water calorics), the full range of vestibular function is often poorly assessed and the residual vestibular function of patients with apparent BVL is often overlooked. This is of importance when considering likely functional impairment, rehabilitation planning and prognosis.
Objective: To describe the clinical signs, symptoms and results of vestibular function testing in patients diagnosed with peripheral BVL on the basis of caloric areflexia.
Methods: 24 patients presenting sequentially to a tertiary balance clinic were assessed. The details of the neurological history and examination were compared along with the results of special vestibular function testing.

Results: There was an equal sex distribution. 46% of cases were caused by ototoxic medications. All had symptoms of imbalance, but only 1/3 had hearing loss or tinnitus. 2/3 had oscillopsia. High velocity head thrust testing was abnormal bilaterally in 20/23, normal in 1 and unilateral in 2. Only 1 patient had post head shake nystagmus. Cervical VEMP testing revealed a unilateral loss in 2/3 of patents with the remainder equally split between bilateral losses and normal results. Magnetic Scleral Search Coil (MSSC) testing demonstrated gains ranging from 0.024 to 1.01 with a mean of 0.292 (IQR = 0.36–0.51).
Conclusions: Although bilateral vestibular loss is often thought to be a condition with consistent findings, there appears to be a spectrum of dysfunction of the vestibular system as evidenced by variable findings in c-VEMP and MSSC findings. This variability in residual function may explain the wide range of symptom burdens carried by patients with caloric areflexia.

P-D-14
WHETHER OR NOT CONGENITAL NYSYTAMUS MAY BE NOT CONJUGATE EYE MOVEMENTS?

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Introduction/Objective: Congenital nystagmus (CN) is almost always conjugate (Gresty M at al. J Neurol Neurosurg Psychiatry 1984). Often, CN may be not conjugate, in smooth pursuit and OKN in our cases. To clarify this discrepancy, we examined CN patients' ocular dominance and stereopsis as a near vision. And we investigate CN by using each eye recording ENG and a new goggle with bilateral infra-red CCD cameras (ON-1), we have developed, which can record bilateral eye movements simultaneously.
Methods: We asked two healthy male, patients with CN (born in 1972 and 1981). We examined ocular dominance based on the hole-in-card test and stereopsis by using the Titmus stereotest. We employed each eye recording ENG under the condition of smooth pursuit and OKN for them. We also use ON-1 and eye movements were recorded under gazing onto the imaginary target, like examiner's nose, for ten seconds, in front of them at the primary position. We analysed whether or not each eye movement is different and alteration of each pupil' s area (pupillary constriction as a near vision) by use of a new version software Image J 2D-VOG PupilShape, which is a progressive one of NIH Image.
Results and Discussion: Both patients possess right ocular dominance and borderline stereopsis about circle evaluation 140 seconds and 200 seconds in the stereotest, respectively. Because CN patients possess stereopsis problems are known (Okada T et al. Brain 1999). There can be a sort of fusion image problem in CN patients, but not central origin. And they never complain 'double vision'. Recessive eye performed rather smooth eye movements and loafed, occasionally, notwithstanding just short period. And OKN of dominant eye stimuli seemed to be similar patterns of both eyes stimuli, but we did not find similar patterns in cases of each eye recording of OKN, unfortunately. Analysing ON-1 data revealed almost synonymous but not the same waveform on each eye movement. As to pupillary constriction (pupil's area) of dominant eyes are almost always smaller than left eye (recessive eye) and both pupils' area are almost always fluctuating in size, as well, by use of Image J 2D-VOG PupilShape. As to CN1 patient born in 1972, pupil's area ranging from 2588 to 4051 pixel, Median 3727.5 in dominant eye, but the area ranging from 3020 to 4838 pixel, Median 4350 in left eye. And as to CN2 patient born in 1981, 3320 to 4126 pixel, Median 3994 in dominant eye, but the area ranging from 3924 to 5145 pixel, Median 4889 in left eye. We also analysed whether or not each eye fixate the imagery target like the examiner's nose at the same time. Our CN patients never complain 'double vision' though, they always change their eye positions and pupils' shape. According to this, our CN patients could never gaze on the target in front of them by use of their pupils' centre. We think they might possess eccentric pupils' centre, so they may be always looking for 'the foveation window' (Jacobs JB and Dell'Osso LF. J Vision 2004) and our CN patients could evoke inversions of OKN. Never has been discussed the relationship amongst ocular dominance, nature of each eye's pupillary constriction and eye movements of CN, and also a sort of fusion image problem for CN. The relationship could make the maze in which we have to deliberate on nature of CN. So we here just mentioned the maze may influence conjugate eye movements and stereopsis for CN. We must have more data for CN patients near future.

P-D-15
VIDEONYSTAGMOGRAPHIC CONTRIBUTIONS TO DIAGNOSIS OF VESTIBULAR DISEASE AFTER MILD HEAD TRAUMA – VESTIBULAR ARGENTINA, BUENOS AIRES, ARGENTINA

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Introduction: Mild head trauma (MHT) is defined as a Glasgow Coma Scale (GCS) score of 13 to 15, post-traumatic amnesia of less than 24 hours and loss of consciousness less than 20 minutes. Several studies of the sequelae of head trauma suggest that psicologic, neurologic and vestibular dysfunctions are some of the most frequently reported complications after mild head injury. Many individuals with balance disorders after MHT are referred to our center and videonystagmography (VNG) is one of the first studies performed in this population. We considered of interest to determine prevalent vestibular symptoms and to evaluate VNG as a fast and accurate diagnostic tool.
Objective: To characterize frequent vestibular symptoms following mild head trauma and its relation with videonystagmographic results. To evaluate videonystagmography as a diagnostic tool for vestibular disorders after mild head trauma.
Methodology: We reviewed the clinical records and videonystagmography reports of 140 patients over 18 years old with balance disorders after head trauma, within six months of onset of symptoms, during the period between January 2012 to January 2014. Seventy four (74) of these subjets suffered MHT for the first time and no previous vestibular or neurologic disease was detected.
Results: Forty-eight (65%) of the 74 patients were more than 40 years old. Vestibular symptoms after mild head trauma included positional vertigo (32%), vertigo of hours (22%), instability (19%), dizziness (18%) and vertigo of seconds-minutes (9%). Videonystagmographic results in patients who suffered positional vertigo was a positive Dix Hallpike (DH+) test in 48% of the cases. When the symptom was vertigo of hours the result was Unilateral Canal Paresis (UCP) upon caloric testing in 29% and Central Spontaneus Nystagmus (CSN) in 29%. The result for instability was UCP in 31% of cases. Most frequent vestibular diagnosis were: 33% Post Traumatic Labyrinthine Failure (PTLF), 21% Nondiagnostic, 17% Benign Paroxysmal Positional Vertigo (BPPV), Otolithic Failure 15% and Central Vestibular Failure (CVF) 13%. VNG finding in PTLF was UCP in 57%, in nondiagnostic patients 47% had Central Positional Nystagmus, in BPPV 100% had DH+ test, in Otolithic Failure 43 % had CSN and in CVF 75% had CSN ($p < 0{,}005$).
Conclusions: Positional vertigo, vertigo of hours and instability are the most common symptoms after MHT. Frequently results in VNG are DH+ test, UCP/CSN and UCP respectively. There is a significant relation between VNG results and vestibular diagnosis, being these variables mutually dependent. However for an accurate descriptive analysis more patients are needed.

P-D-16
NYSTAGMUS IN ENLARGED VESTIBULAR AQUEDUCT, A CASE SERIES. CLEVELAND, OHIO

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Introduction: Enlarged vestibular aqueduct (EVA) is one of the commonly identified congenital temporal bone abnormalities associated with sensorineural hearing loss. Hearing loss may be unilateral or bilateral, and typically presents at birth or in early childhood. Vestibular symptoms have been reported in up to 50% of affected individuals, and may be delayed in onset until adulthood.The details of nystagmus in patients with EVA have not been previously reported.
Objectives: Describe the clinical history, vestibular test findings and nystagmus seen in a case series of patients with enlarged vestibular aqueduct anomaly.
Methods: Chart review, including CT temporal bones, infrared nystagmography with positional and positioning testing, caloric testing, rotary chair and vibration testing.
Results: Clinical history and nystagmus varied among the four patients in this series. All patients were initally presumed to have benign paroxysmal positional vertigo, but repositioning treatments were not effective, prompting referral, further testing and evaluation. In three patients with longstanding vestibular complaints, positional nystagmus was consistently present. One patient had distinct recurrent severe episodes of positional nystagmus. Nystagmus was unidirectional and horizontal. In one case horizontal nystagmus was consistently reproducible with seated head turn to the affected side, and reached 48 d/s.
Conclusions: Nystagmus associated with enlarged vestibular aqueduct is often positional, and can be confused with BPPV. Unexplained vestibular symptoms

in patients with unilateral or bilateral sensorineural hearing loss should prompt diagnostic consideration of EVA.

Poster Presentations E. Posturography

P-E-1
CLINICAL CHARACTERISTICS OF THE PATIENTS WHO CANNOT STAND ON STATOKINESIGRAPHY FOR ONE MINUTE

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Introduction and Objectives: Statokinesigraphy is a tool to evaluate a static equilibrium at upright position. Subjects generally stand on the recording board for one minute with open or closed eyes. Most of patients can accomplish one-minute test but rare patients cannot stand on the recording board. Therefore, we extracted clinical characteristics of patients who cannot accomplish one-minute test.
Materials and Methods: In this retrospective study, we analyzed data of 19 patients who cannot stand on the recording board for one minute with a complaint of disequilibrium at our department of otorhinolaryngology in Kyushu University Hospital from January 2004 to November 2011. Clinical tests included spontaneous nystagmus, the vestibular stimulation (vestibular evoked myogenic potentials and caloric test), the oculomotor stimulation (eye tracking, saccade and optokinetic stimulation) and statokinesigraphy. The relation between the data from statokinesigraphy and clinical test was studied. We complied with the declaration of Helsinki in using the personal medical records of patients.
Results: Seventy percent of patients complained dizziness/unsteadiness but not vertigo. Nineteen patients were divided to two groups: One was consisted of the patients who could not stand with closed eyes, while another was consisted of the patients who could not stand with open nor closed eyes. There were no relation between the statokinesigraphic data and any clinical tests.
Conclusions: Many subjects complained dizziness/ unsteadiness but not vertigo. These results suggest that the correct test may be needed to validate dizziness or unsteadiness.

P-E-2
THE EFFECT OF AUDITION ON BALANCE

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Introduction: Maintaining balance relies on integration of visual, vestibular, and proprioceptive inputs. The auditory system may also participate due to its ability to provide spatial orienting cues with extreme speed and accuracy.
Objectives and Mehods: We measured the ability of external auditory signals to reduce postural sway in a group of subjects with varying levels of imbalance standing in the dark.
Results: The sway of our subjects (center of pressure motion per second) decreased from 7.0 cm/sec in silence to 4.7 cm/sec with the addition of external sound. The amount of improvement depended on baseline imbalance so that the addition of sound allowed subjects to decrease sway by over 40 percent. The improvement due to sound was 54% of the improvement observed in postural sway when visual cues only were provided to subjects standing in silence.
Conclusions: These results support the significant effect of auditory cues to provide balance-related cues and suggest that interventions such as hearing aids or cochlear implants may improve postural stability and reduce falls.

P-E-3
COMPUTERIZED DYNAMIC POSTUROGRAPHY "CONDITION 5 DOWN ONLY" DEFICITS REVISITED; DOES THIS SUGGEST UTRICULAR DISEASE?

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Introduction: Computerized Dynamic Posturography is a well known diagnostic assessment of vestibular function. Sensory Organization test conditions 5 and 6 are used by clinicians to delineate vestibular deficits. Normal performance on these two conditions requires intact vestibular function, as no other sensory information is available for balance maintenance. Conditions 5 and 6 are often treated in a similar fashion in interpretive reports, but no mention is made of these conditions individually. Two studies of aphysiological performance on CDP, utilized an analysis technique which totally ignored condition 5 scores. Dickins et al. in

1992 identified a "type 5" subgroup, and suggested that "further studies should lead to a more clear definition of the significance of this pattern" but to our knowledge, no subsequent studies have been reported in the literature.

Objectives: CDP SOT conditions 5 and 6 are often abnormal in patients with otolithic disease. Returning astronauts exhibit such deficits, and Black et al outlined that this results from disrupted processing of otolith inputs. Condition 5 presents a sensory deprivation while condition 6 presents a sensory conflict that must be coped with. Patients with condition 5 deficits are somehow able to utilize visual cues (even inaccurate ones). Visual vestibular mismatch as outlined by Mallinson is a situation specific discongruency between vestibular cues and other cues (i.e. not necessarily an "absence" of cues), and these symptoms suggest otolithic pathology. We hypothesize that the ability to utilize or discount visual cues is a role of the otoliths. With the advent of VEMP testing to assess these patients, and with our recognition of two different "types" of patients, we hypothesized that a "5 down only" deficit in patients suggested a different kind of otolithic abnormality, and that we might be able to delineate our "patients with vestibular symptoms" from our "patients with vestibular signs" using this particular deficit pattern.

Methods: We have identified six patients referred to our clinic who showed distinct "5 down only" CDP patterns. We correlated their assessment results with 6 patients sequentially referred demonstrating a standard "5, 6, down" abnormality.

Results: The results of the assessments will be compared and correlated. We will discuss differences between the two groups and also the similarities within the "5 down group". In the same way as otolithic patients often present differently, their otolithic assessments also differ from patient to patient.

Conclusion: The "5 down only" CDP abnormality is a valid abnormality suggesting outlining a group of patients who are able to utilize visual cues, even orientationally inaccurate ones, as cues to maintaining balance.

P-E-4
DYNAMIC TESTS OF VISUAL ACUITY AND POSTURAL STABILITY IN PATIENTS WITH CHRONIC DYSEQUILIBRIUM WHILE WALKING: THE INFLUENCE OF VESTIBULOPATHY

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Chronic disequilibrium while walking is a frequent complaint in neurotology clinic. The purpose of our work was to determine the results when tests of dynamic visual acuity and of posturography are used in combination in these patients with or without peripheral vestibulopathy. This is a prospective study in a tertiary center, university hospital. For this we selected 101 patients without current vertigo spells and no central nervous system pathology or dysfunction. At bedside, assessment of spontaneous and head-shake nystagmus and the video head-impulse test was done. Vestibular tests were the caloric test and rotatory chair test. The tests of dynamic function were the Sensory Organization Test and tests of dynamic visual acuity: the gaze stabilization test and dynamic visual acuity test. Normal results were determined according to standard and own studies. In 82.2% of the population some degree of vestibular deficit or dysfunction was detected and registered. In patients with vestibulopathy the amount of asymmetry in eye velocity without visual acuity loss and in logMAR change for ipsi vs. contralesional head movements was significantly lower than the same data in patients without vestibulopathy when rightward vs. leftward head movements were considered. Our findings justify the use of tests of dynamic function as an adjunct to the common tests of vestibular function (caloric test and video head-impulse test) in order to increase our diagnostic yield in patients with chronic disequilibrium. Dynamic tests and vestibular function tests provide complementary information and the former are not completely redundant. They allow a better characterization of the patients when a vestibulopathy is diagnosed while testing.

P-E-5
IS POSTUROGRAPHY ABLE TO IDENTIFY FALLERS IN PATIENTS WITH PARKINSON'S DISEASE?

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ment of Neurology, University Hospital of Santiago de Compostela; [5]Department of Neurology, University Hospital Lucus Augusti; [6]Methodological and Statistical Department. Fundación Ramón Domínguez. University Hospital Lucus Augusti

Introduction: Parkinson's disease (PD) is one of the most prevalent neurodegenerative diseases, and more than half of patients with PD experience falls. Our earlier investigations in postural stability of PD have shown that: a) Patients with PD suffer balance disorders basically because of deficient processing of visual and vestibular inputs compared to healthy age-matched controls. b) In some patients with PD, computerized dynamic posturography (CDP) can detect alterations of balance that are not revealed by routine clinical examination. c) The deterioration of vestibular information processing does not depend on the stage of the disease. d) Patients with PD have reduced stability limits when compared to healthy, age-matched controls. This fact means that they are more likely to fall as a result of their diminished base of support. Research for clinically useful risk factors predicting falls has yielded inconsistent findings so far. Actually the most robust clinical predictor was two or more falls in the previous year. However an ideal intervention should take place before the first fall has happened.
Objectives: The aim of the present study is to validate two different posturography techniques and one modified-timed up and go test (TUG) in discriminating fallers and non-fallers among PD patients.
Methods: 32 patients diagnosed with idiopathic PD were assessed with: Dizziness handicap inventory, Activities-specific balance confidence scale, modified-TUG, sensorial organization test (SOT) and limits of stability (LOS)of CDP,results of free-field body sway analysis with Vertiguard device and number of falls. Receiver operating characteristic (ROC) analyses and multivariate logistic regression were performed in those variables that were observed to be very significant in distinguishing fallers ($p < 0.01$).
Results: Fallers took longer to perform the modified-TUG and required more steps. Also these patients had poorer scores in the subjective tests. On average, fallers performed SOT and LOS significantly worse and Vertiguard device indicated a higher risk of falling. Based on the area under the curve of ROC analyses, the overall accuracy of directional control of LOS and steps in modified-TUG are close to 0.9 (high accuracy). Also assessment with Vertiguard device is more efficient in identifying fallers than the parameters of SOT. Results of the multivariate logistic regression analysis after adjustment for age and gender are summarized in table 1. The outcome in directional control of LOS was the factor that most significantly distinguished fallers in PD patients. Score of condition 5 and vestibular input of SOT, maximum excursion of LOS, risk of falling indicator of Vertiguard and steps of the modified-TUG were also independent risk factors for being a faller.
Conclusions: In our present study, specifically a deficient processing of vestibular information appears to be a key risk factor of falls in PD patients. Also our results indicate that LOS, vestibular input of SOT, mobile posturography and number of steps taken in the modified-TUG are most useful to identify fallers in PD patients. The clinical application of these findings is to identify potential fallers prior to their first fall, so an appropriate intervention may be warranted.

Balance Assessment	p-value	ORa	95% CI
Condition 5 (SOT)	0.036	0.963	0.929-0.998
Composite score (SOT)	0.056	0.942	0.886-1.002
Vestibular input (SOT)	0.034	0.964	0.932-0.997
Movement Velocity (LOS)	0.083	0.286	0.070-1.175
Endpoint excursion (LOS)	0.052	0.925	0.854-1.001
Maximum excursion (LOS)	0.029	0.914	0.843-0.991
Directional control (LOS)	0.006	0.950	0.916-0.985
Vertiguard	0.045	1.122	1.003-1.255
Steps (TUG)	0.036	1.282	1.017-1.618

P-E-6
ENERGY CONSUMPTION OF THE POSTUROGRAPHY SIGNAL. SUITABILITY IN THE ASSESSMENT AND FOLLOW UP OF UNSTEADINESS. *LABORATORIO DE OTONEUROLOGÍA, HOSPITAL BRITÁNICO, **FACULTAD DE INGENIERÍA, UCUDAL, MONTEVIDEO, URUGUAY

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Introduction: The inverted pendulum model has been used to understand the postural control skills, measuring together the amplitude of the displacement of the body's center of pressure (COP) and the sway velocity (SV). It would be a key point for the analysis of pos-

tural responses to achieve a parameter that considers both COP and SV values.
Objective: The goal of this study is to evaluate the use of the energy consumption (EC) of the COP signal in the assessment of the postural control disorders.
Methods: Two populations have been studied. 1–16 elderly patients with unsteadiness related with degenerative aging process divided in two groups: 1A. Patients ($N = 8$) with central vestibular disorders (CVD) and bilateral vestibular hypofunction (BVH). 1B. Patients ($N = 8$) with CVD and normal vestibular responses. They were compared with a control group (CG) of healthy subjects ($N = 9$) of the same age range. 2-Patients (N=8) with CVD also related with aging and that were assessed before and after a vestibular rehabilitation program (VRP). The EC values were compared with their own clinical outcomes, evaluated by bedside examination (BS) and dizziness Handicap Inventory (DHI). COP recording was performed using a force platform with the patient in the standing position with the eyes open. The measurement of EC was analyzed using wavelets, processing the total EC and the discrimination by 3 bands of frequencies (Band 1: 0–0.1 Hz, Band 2: 0.1–0.78 Hz, Band 3: 0.78–25 Hz.). Kruskal Wallis and Mann Whitney tests were used for the statistical analysis.
Results: 1A and 1B patients showed a significantly higher total EC compared with CG ($P = 0.001$). 1A patients had a higher proportion of EC at low frequencies (< 0.1 Hz) ($P = 0.001$), whereas 1B patients (with BVH) had greater EC at high frequencies (> 0.78 Hz) ($P = 0.001$). The measurement of EC performed in the group of patients before and after a VRP (Group 2) had consistent EC values compared with the BE and DHI. These EC values decreased significantly when improving the clinical assessment (BS and DHI) after VRP. On the contrary, total EC did not show changes when BS and DHI were not modified after VRP.
Conclusions: The measurement of the EC of COP may be suitable to achieve a quantitative parameter of instability in elderly patients and the analysis by bands of frequencies allows the discrimination between CVD patients with and without peripheral vestibular information. These findings are discussed using the theory of control systems and the possible implications in the assessment and rehabilitation of the balance disorders.

*This abstract is an invited status report related to the International Classification of Vestibular Disorders and was not reviewed by the scientific committee.

Poster Presentations F. Utricular and Saccular Testing with VEMP

P-F-1
EFFECTIVENESS OF COMBINED RECORDING OF CVEMP AND OVEMP VIA GALVANIC VESTIBULAR STIMULATION

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Introduction: Previously, individual cervical vestibular-evoked myogenic potential (cVEMP) and ocular vestibular-evoked myogenic potential (oVEMP) tests via galvanic vestibular stimulation (GVS) have been widely applied in many studies, whereas recording GVS-cVEMP and GVS-oVEMP tests simultaneously have never been investigated. In order to shorten VEMP test time and reduce patients' discomfort caused by galvanic stimulation, it is valuable to clarify whether the combined test can replace individual cVEMP and oVEMP tests.
Objective: This study compared the characteristic parameters of the cVEMPs and oVEMPs via GVS mode between individual and combined recording patterns in healthy and elderly subjects. Consequently, the effectiveness of combined GVS-cVEMP and GVS-oVEMP tests was assessed.
Methods: 24 healthy and 16 elderly subjects were enrolled in this study. All participants underwent individual cVEMP, individual oVEMP, and combined cVEMP and oVEMP testing via GVS mode in a random order. The response rates and characteristic parameters of cVEMPs and oVEMPs between individual and combined tests, including latencies, intervals, and amplitudes, were measured.
Results: The VEMP parameters, including latencies, intervals, and amplitudes, all demonstrated no significant differences between individual and combined tests ($p > 0.05$, paired t test), either in healthy or elderly subjects. Pearson's correlation analyses also revealed significant positive correlations in all parameters between these two tests ($p < 0.05$).
Conclusion: Combined GVS-cVEMP and GVS-oVEMP tests yielded similar information as to what were obtained in individual tests.

P-F-2
OPTIMAL STIMULATION MODE FOR GALVANIC OCULAR VESTIBULAR-EVOKED MYOGENIC POTENTIALS

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Introduction: Galvanic vestibular stimulation can elicit ocular vestibular-evoked myogenic potentials (oVEMPs) in human beings; however, the optimal stimulus mode has not been determined yet.
Objectives: This study compared the characteristic parameters of oVEMPs under various galvanic stimulations to determine the ideal galvanic stimulus intensity and period of duration for evoking them.
Methods: Twenty healthy volunteers underwent oVEMP tests via bone-conducted vibration (BCV) and galvanic vestibular stimulation (GVS) modes of various intensity (1, 2, 3, 5, and 6 mA at 1.0 ms) and duration periods (0.1, 0.2, 0.5, and 1.0 ms at 5 mA intensity). All subjects were questioned about the painful sensation experience in each test using an 11-point numeric rating scale (NRS-11) and a 100-mm visual analog scale (VAS). The prevalence, nI and pI peak latencies, nI-pI interval, amplitude and pain level of each stimulation mode were compared.
Results: Since more than half of subjects were not able to tolerate the galvanic stimulation at 6 mA/1.0 ms, this level was dropped from further study. Galvanic stimulation at 3 mA/1.0 ms, 5 mA/0.5 ms, or 5 mA/1.0 ms exhibited the highest prevalence (90%–100%). In terms of GVS-induced pain, there was no significant difference among these three stimulation modes. In terms of the GVS-oVEMPs, the group receiving 5 mA/1.0 ms had exhibited a significantly larger nI- pI amplitude than the 3 mA/1.0 ms or 5 mA/0.5 ms group, but the latencies and nI- pI interval did not differ significantly among them. In addition, BCV-oVEMPs had significantly longer latencies and a larger amplitude than the GVS-oVEMPs evoked by 5 mA/1.0 ms, whereas the nI-pI interval was similar between them.
Conclusions: Galvanic stimulation at 5 mA/1 ms yields a higher response rate and larger nI-pI amplitude of oVEMPs relative to less intense stimuli without exceeding the tolerable level of subjective pain. Hence, the preferable stimulation mode for eliciting GVS-oVEMPs is optimally set at an intensity of 5 mA with a duration of 1 ms.

P-F-3
HOW DOES SECONDARY ENDOLYMPHATIC HYDROPS OCCUR AFTER SUDDEN DEAFNESS?

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Introduction: Endolymphatic hydrops has several etiologies, either primary or secondary. As sudden deafness may damage the cochlear and/or vestibular partitions, its clinical features exhibit varying severity of involvement. An inner ear test battery, which comprises audiometry, ocular vestibular-evoked myogenic potential (oVEMP), cervical VEMP (cVEMP), and caloric tests, was designed for comprehensively evaluating inner ear function. It is our premise that in some sudden deafness patients with residual vestibular function secondary hydrops may be induced later.
Objective: This study applied the inner ear test battery in patients who had sudden deafness previously to elucidate how secondary endolymphatic hydrops occurs years after sudden deafness.
Methods: Twenty patients who had experienced recent vertiginous attacks several years after sudden deafness (group A) and 20 patients without rotational vertiginous episode for at least 5 years following sudden deafness (group B) were enrolled. All patients underwent audiometry, caloric test, and oVEMP and cVEMP tests.
Results: The mean interval from initial sudden deafness to vertiginous attack in group A was 8 years, with a mean hearing level of 66 $\pm$ 20 dB, which did not significantly differ from 61 $\pm$ 20 dB in group B. For the vestibular test results, the percentages of abnormal cVEMP, oVEMP, and caloric tests in group A were 65%, 70%, and 25%, respectively. Compared to the respective 70%, 60%, and 75% abnormalities in group B, only the caloric test differed significantly.
Conclusion: Patients with sudden deafness who had abnormal oVEMP/cVEMP responses but retained caloric function may subsequently develop secondary hydrops with a mean interval of 8 years.

P-F-4
TESTING THE VESTIBULAR EVOKED MYOGENIC POTENTIAL (VEMP) TO IDENTIFY SUBCLINICAL NEUROLOGICA ALTERATIONS IN DIFFERENT PHASES OF HTLV-1 INFECTION

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Introduction: HTLV-1 is the causative agent of HTLV-1-Associated Myelopathy/ Tropical Spastic Paraparesis (HAM/TSP), which is a progressive neurologic disorder characterized by leg weakness, diffuse hyperreflexia, clonus, loss of vibration sense, and detrusor insufficiency leading to bladder dysfunction. Of the millions of individuals infected with HTLV-1 worldwide, it is estimated that approximately 4% will develop HAM/TSP during their lifetimes.
Objective: The aim of the present study was, by using VEMP, to follow subclinical neurological alterations in different phases of HTLV-1 infection: asymptomatic, possible HAM/TSP and HAM/TSP.
Methods: The control group consisted of 30 HTLV-I-seronegative subjects. The study group was separated into three subgroups: 1) 18 asymptomatic individuals infected by HTLV-1 (positive control); 2) 25 individuals with possible HAM/TSP; 3) 17 individuals with definite HAM/TSP. VEMP was performed in each participant, repeating the exam each six months during the period of two years.
Results: the alterations observed in VEMP were associated with impairment of the vestibulospinal tract in HTLV1-infected individuals, since normal VEMP was confirmed in the HTLV1-seronegative individuals.Comparing the asymptomatic to the HAM/TSP group using the Log-rank test, significant difference between the groups ($p = 0.02$) was observed. In order to control the type I error, the Bonferroni method was used (significance level $= 0.05/3 = 0.017$).
Conclusion: HAM/TSP pathogenesis is a multivariable phenomenon of immune system activation against the presence of HTLV-1 antigens, leading to an inflammatory process and demyelination of the spinal cord of some HTLV-1-infected individuals. In conclusion, VEMP was shown to be useful in diagnosing and following cervical medullar involvement of HTLV-1-infected subjects and should be undertaken in forthcoming studies.

P-F-5
VESTIBULAR EVOKED MYOGENIC POTENTIAL IN CHILDREN

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Introduction: The Vestibular Evoked Myogenic Potential (VEMP) is used as a complementary test in neurotological examination. It verifies the integrity of vestibular function through a muscular response originated from an acoustic stimulation which activates the saccular macula. It is estimated that vertigo accounts for 1% of outpatient neuropediatric consultations, and is also present in 13% of children referred for audiological evaluation. Normal standards in adults have been established, however, there are few published data on the normal responses in children.
Objective: To establish normal standards for vestibular myogenic responses in children without neurotological complaints.
Methods: This is a descriptive, cross-sectional study. The study group consisted of 30 subjects, 15 females (50%) and 15 males (50%). Results: The age of the subjects ranged between 8 and 13 years, with a mean value of 10.2 ($\pm$ 1.7). P1 curve showed an average latency of 17.26 ($\pm$ 1.78) and a mean amplitude -49.34 ($\pm$ 23.07), and the curve N2 showed an average latency of 24.78 ($\pm$ 2.18) and mean amplitude of 66.23 ($\pm$ 36.18). P1–N2 mean amplitude was 115,6 ($\pm$ 55,7). There were no statistically significant differences when comparing by gender or by laterality.
Conclusion: normal values of myogenic vestibular responses in children between 8 and 13 years without neurotological complaints were established.

P-F-6
DOES POSTERIOR CANAL DEHISCENCE CAUSE AUGMENTATION OF VESTIBULAR EVOKED MYOGENIC POTENTIAL?

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Dehiscence of the bone overlying the superior (anterior) semicircular canal was first described by Mi-

nor et al. (Arch Otolaryngol Head Neck Surg 124: 249–258, 1998). Since then, It has been reported that this condition (superior canal dehiscence syndrome, SCDS) manifests as various vestibular and/or auditory symptoms. One of characteristic findings of SCDS is augmentation of vestibular evoked myogenic potential (VEMP), especially ocular VEMP to air-conducted sound (ACS), a large amplitude and a low threshold. In contrast to SCD, posterior canal dehiscence (PCD) is much rarer. Therefore, characteristic findings of PCD are still unclear. Although it was reported that VEMP was augmented in PCD patients as well, VEMP responses in PCD patients are remained to be studied. We experienced a patient with bilateral PCD and compared her findings with those with SCD. A patient of ours with PCD was a 35-year-old woman. She had episodic vertigo attacks since 10 years ago. Her vertigo was often accompanied by aural fullness in the left ear. Pure-tone audiometry revealed bilateral fluctuating sensorineural hearing loss. Both of oVEMP and cVEMP to ACS were normal in amplitudes and thresholds. On the other hand, in our experiences, all the patients with SCD had augmentation of oVEMP responses to ACS. Pathophysiology of augmentation of oVEMP to ACS in patients with SCD may be reconsidered.

P-F-7
OTOLITHIC ABNORMALITIES AFTER MILD TRAUMATIC BRAIN INJURY

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Mild traumatic brain injury is an increasingly recognized public health risk and a major morbidity in a wide spectrum of age groups. Neurosensory sequelae are the major disorders seen after this type of injury and of these balance disorders are the most common. While many individuals suffer recognizable balance abnormalities, others present with vestibular disorders that are not commonly seen in the non-traumatic population. We examined 100 consecutive individuals with balance disorders secondary to trauma and divided this group up into trauma etiology and time since trauma onset. All individuals underwent comprehensive vestibular testing. Otolith testing included subjective visual vertical both on and off axis as well as vestibular evoked myogenic potentials. Definitive patterns of otolithic disorders were seen in this patient group and these patterns are reported here. Understanding otolithic disorders after head trauma will increase our ability to diagnose and treat this important patient population.

P-F-8
CORRELATING FOAM POSTUROGRAPHY WITH VEMP TEST RESULTS IN PATIENTS WITH MENIERE'S DISEASE

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Introduction: The human balance system consists of multisensory and sensorimotor networks of visual, vestibular, and proprioceptive systems. To maintain postural stability under a variety of environmental situations, these systems must be well integrated. Clinically, posturography is designed to evaluate and record postural balance status, which is often coupled with inner ear test battery to identify sensory input deficits.
Objective: This study adopted foam posturography coupled with inner ear test battery including audiometry, and cervical vestibular-evoked myogenic potential (cVEMP), ocularVEMP (oVEMP) and caloric tests in patients with Meniere's disease to investigate the relations between them.
Methods: Fifty patients with unilateral definite Meniere's disease were enrolled. All patients underwent audiometry, and caloric, oVEMP, and cVEMP tests. In addition, posturography was also performed under 4 conditions: A (firm surface, eyes open), B (firm surface, eyes closed), C (foam pad, eyes open), and D (foam pad, eyes closed). Romberg quotient (RQ) was measured as the value from eyes closed divided by that from eyes open.
Results: No correlation existed between Meniere's stage and RQ measured with foam pad. Mean RQ of the sway area on foam pad in Meniere's patients with abnormal oVEMPs (1.75 ¡Ó 0.95) was significantly larger than 1.20 ¡Ó 0.70 in those with normal oVEMPs. However, neither cVEMP nor caloric tests were associated with RQ on foam pad. Further, the area under the receiver operating characteristic curve of the RQ of sway area on foam pad in discrimination between normal and abnormal oVEMP test was 0.65 (95% CI, 0.51 to 0.79; $p < 0.05$), implying that RQ of the sway area on foam pad may serve as a significant predictor for abnormal oVEMP test.
Conclusion: By removing or reducing both visual and somatosensory inputs from foam posturography, the remaining vestibular cue, represented as RQ of sway area on foam pad, may reflect utricular function.

P-F-9

THE SUBJECTIVE VISUAL VERTICAL IN UPRIGHT POSTURE AND TILTED IS INDEPENDENT OF SEMICIRCULAR CANAL FUNCTION

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The Subjective Visual Vertical (SVV) is mainly dependent on otholitic function and in particular utricular. There is an ipsilesional shift of SVV in patients with acute vestibular neuritis and after surgery for vestibular schwannoma; in both cases during follow-up the SVV is normalizad paralleling the clinical resolution. No significant correlation was found between the deviation of the light bar with the patient in upright or tilted positions (bias test) and the amount of canal paresis. The objective of this study was to determine, in a group of patients with vestibular disorders ($N = 60$) whether the results of the bias test for SVV correlate with the results of the vestibulo-ocular reflex after stimulation of each of the semicircular canals (assessed with the video head-ipulse test) in both ears. We did not found any correlation which confirms that semicircular canal function does not influences SVV perception. We have found that patients consistently undercorrect for body tilt to the ipsilesional side and overcorrect for body tilts to the contralesional side; however a systematic undercorrection was found when results were normalizad to SVV in the upright position.

P-F-10

THE EFFECT OF ELECTRODE POSITIONING AND STIMULUS POSITION ON THE OCULAR VESTIBULAR EVOKED MYOGENIC POTENTIAL TO BONE CONDUCTED VIBRATION (BCV)

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Introduction: The oVEMP is emerging as an additional test of otolith function and current evidence suggests an origin primarily in the contralateral superior vestibular nerve (probably mainly the utricle) for sound and vibration stimulation (Rosengren and Kingma, 2013). It is therefore important in the early stages of development to explore different aspects of the recording parameters to optimise the response obtained for clinical use. Sandhu et al. (2013), during their systematic investigation on the effects of electrode placement using air conducted sound, found variation in the response depending on electrode location.

Objective: The aim of this study was to investigate the effect of electrode positioning for bone conducted vibration and to observe the effect of changing stimulus location on the oVEMP.

Method: Ten otologically normal participants were stimulated by 6 msec bursts of 500 Hz vibration, delivered by a Bruel and Kjaer 480 minishaker (50 stimuli, 11/sec), presented at the midline forhead at the hairline (Fz). Participants were tested supine with an upgaze of 30°. Surface electrodes measured the response from beneath both eyes using three electrode configurations: (i) the standard montage in which the electrodes were positioned vertically above and below each other in the orbital midline (ii) with the active electrode placed more medially between the mid line and inner canthus and (iii) a belly tendon montage with the active electrode placed between the orbital midline and the outer canthus and the reference electrode towards the inner canthus. A further recording was made using the belly tendon montage with the stimulus delivered to the mid chin.

Results: Recordable oVEMP responses were obtained to BCV for all participants using the standard montage. A Wilcoxon Signed-Ranks test indicated that the amplitude of the response using the belly tendon montage (Mdn = 5.80 μv) was significantly larger than using the standard montage (Mdn = 3.30 μv), $p < 0.05$. There was however, no significant difference in n10 or p15 latency between these two configurations, $p > 0.05$. Medial placement of the active electrode gave variable responses significantly different from the standard montage with occasional inversion of response or no response. Using the belly tendon montage with chin stimulation gave the largest response amplitude. This recording configuration however, caused a significant change to the n10 latency compared to the Fz location but did not affect p15 latency.

Conclusion: This study, using bone conducted vibration, shows that the oVEMP response amplitude is sensitive to the position of the active electrode as Sandhu et al. (2013) have found using air conducted stimuli. The response is also affected by stimulus position.

P-F-11

CLINICAL CHARACTERISTICS AND SUPPOSED PATHOPHYSIOLOGY OF IDIOPATHIC OTOLITHIC VERTIGO

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Background: The otolith organs, saccule and utricle, are sensors of linear acceleration. Therefore, it is expected that disorders of the otolith organ could cause episodic abnormal translational or tilting sensation. We have proposed a clinical entity, "idiopathic otolithic vertigo". As vestibular evoked myogenic potential (VEMP) testing has been clinically applied as a test of the otolith organs, VEMP seems to be able to detect dysfunction of the otolith organs in patients who might have idiopathic otolithic vertigo.
Objective: The aims of this study were to clarify clinical characteristics of patients diagnosed as having idiopathic otolithic vertigo and to propose hypothesis concerning pathophysiology of idiopathic otolithic vertigo.
Methods: Patients diagnosed as having idiopathic otolithic vertigo according to our diagnostic criteria were enrolled in this study. Diagnostic criteria of idiopathic otolithic vertigo were as follow. Subjects must have one of the following symptoms; episodic tilting or translational sensation in the roll plane or in the pitch plane. Subjects with the following medical history or signs/symptoms were excluded; a medical history of rotatory vertigo, a medical history of loss of consciousness or severe head trauma, symptoms or signs of central nervous system dysfunctions or proprioceptive dysfunctions, or a definitive diagnosis of a disease known to cause disequilibrium (e.g. Meniere's disease, vestibular migraine, etc.). In these patients, features of their vertigo, findings of clinical testing, and association of symptoms with test findings were studied. Clinical tests included ocular VEMP, cervical VEMP, and stabilometry.
Results: The most prominent feature of test findings was abnormal cVEMP and/or oVEMP. Patients who had abnormal sensation in the roll plane showed tendency of abnormal oVEMP. On the other hand, patients who had abnormal sensation in the pitch plane had tendency of abnormal cVEMP. This tendency was more prominent in patients with up-down sensation than patients with antero-posterior tilting or movement sensation. While majority of patients had episodes of vertigo lasting for several minutes, some had much longer vertigo.
Conclusions: VEMP testing is a key examination for idiopathic otolithic vertigo. Idiopathic otolithic vertigo might be caused by transient ischemia in the otolith organ. However, pathophysiology of idiopathic otolithic vertigo might be diverse.

P-F-12
CLINICAL APPLICATION OF OCULAR VESTIBULAR EVOKED MYOGENIC POTENTIALS (OVEMP) TESTING AND BINOCULAR VISION DYSFUNCTION QUESTIONAIRE. ROCHESTER HILLS, MICHIGAN. UNITED STATES

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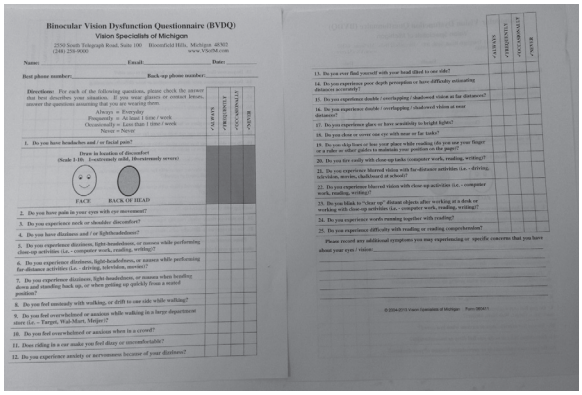
Introduction: Vertical heterophoria (VH) is a binocular vision disorder that can cause dizziness and headache. VH has been thought to be partially based on utricle dysfunction and orbital asymmetry. In our practice Binocular Dysfunction Questionnaire (BVDQ), VEMP and VNG tests are administered to patients with unexplained dizziness.
Objective: This is a preliminary study to look at the clinical usefulness of BVDQ, VEMP, and VNG in nineteen patients. To look at the hypothesis that VH has utricle dysfunction as part of its etiology with correlating OVEMP abnormalities.
Methods: Patients with conductive losses were excluded. VEMP testing was done with 500 Hz tone stimuli. Asymmetry or absent waveforms were considered abnormal. BVDQ were scored: 3 for always, 2 for frequently, 1 for occasionally, and 0 for never.
Results: Saccade, pursuit, or opto-kinetic abnormalities on VNG were suspicious for VH. One patient had normal BVDQ, VEMP and VNG. Two patients had abnormal cervical VEMP (CVEMP) and abnormal VHSQ. Three patients had abnormal OVEMP with normal BVDQ, no orbital asymmetry, and various clinical presentations. Two patients treated successfully with prism for superior oblique palsy, had abnormal BVDQ with normal VEMP and VNG. Eleven of fourteen patients with abnormal OVEMPs had abnormal BVDQ scores. In the eleven patients the average BVDQ score was 32. Two patients with abnormal unilateral OVEMP the BVDQ average was 24. In five patients with bilateral OVEMP abnormalities the average VHSQ was 35. In four patients with bilateral OVEMP abnormalities and CVEMP abnormalities the average VHSQ was 39.

	BVDQ Normal	BVDQ Abnormal
OVEMP Normal	Normal patient, BPPV, Postural Hypotention	Superior Oblique Palsy
OVEMP Abnormal	Utricle dysfunction with orbital symmetry. compensated trauma or virus	Vertical Heterophoria, utricle dysfunction with orbital asymmetry. uncompensated trauma or virus

Conclusions: In conclusion abnormal OVEMP correlated with abnormal BVDQ. This supports the hypothesis of VH having dysfunction of the utricle and or-

bital asymmetry as part of its etiology. OVEMP testing along with BVDQ may helpful to suggest VH. OVEMP testing may help the optometrist to separate VH from superior oblique palsy, which is treated differently with prismatic lenses. Larger studies will need to be performed to evaluate the relationship between OVEMP, BVDQ, and correction of symptoms with prismatic lenses.



P-F-13
TOPOLOGY OF BRAINSTEM LESIONS CAUSING SUBJECTIVE VISUAL VERTICAL TILT

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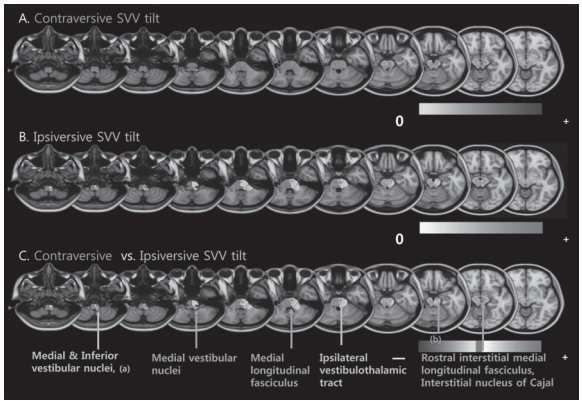
Objectives: We aimed to determine the topology of the anatomical pathway in the brainstem for verticality perception.
Methods: We measured the subjective visual vertical (SVV) in 82 patients with acute unilateral infarction involving the brainstem only. The topology of the brainstem lesions responsible for pathological SVV tilt were determined using MRI-based voxel-wise lesion-behavior mapping, and the probabilistic lesion maps were constructed.
Results: Fifty percent (41/82) of patients with acute unilateral brainstem infarction showed abnormal tilts of the SVV, of which 76% (31/41) patients showed ipsiversive and 24% (10/41) had contraversive tilt. Patients with contraversive SVV tilt showed overlapping of the lesions in the rostral medial vestibular nucleus, medial longitudinal fasiculus, and rostral interstitial medial longitudinal fasciculus and interstitial nucleus of Cajal. In contrast, the lesions producing an ipsiversive SVV tilt and oculomotor disturbances were associated with involvement of the medial and inferior vestibular nuclei in the caudal medulla while those with isolated vertical perceptual changes had injury to the medial side of the medial lemniscus (Figure).
Conclusions: Our data support the evidence that there is a pathway transmitting ipsiversive otolithic signals bypassing the oculomotor system at the medial side of the medial lemniscus called the ipsilateral vestibulothalamic tract (IVTT).



P-F-14
SOUND EVOKED MYOGENIC POTENTIAL AROUND ORBITA IN AWAKED MONKEYS

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Intense brief air-conducted sound and bone-conducted vibration evokes short-latency myogenic potentials around the eyes in humans. These potentials are named ocular vestibular evoked myogenic potentials (oVEMPs), but the origin and pathway of these responses remains unclear. In order to establish the animal model of oVEMPs, we recorded myogenic potentials around the eyes using awake monkeys by evoked air-conducted sound and bone-conducted vibration. Three macaque monkeys were used in the research. A pair of electrodes was attached under the eye and the animals were instructed to gaze the monitor to fix their eye position in the primate chair. When 135 dB SPL air-conducted 500Hz tone-burst was applied, the peak

latencies of the first negative and second positive waves were 10.4 msec and 13.7 msec. When 125 dBFL bone-conducted 500Hz tone-burst vibration was applied, the peak latencies of the first negative and second positive waves were 10.8 msec and 15.0 msec. In two evoked potential there were some characteristics. Firstly, peak latency of the first negative wave did not change when the frequency was changed. Secondary, the threshold of the myogenic potentials at the frequency of 500 or 1000 Hz was lowest among the 4 tested frequencies (500 Hz, 1000 Hz, 2000 Hz and 4000 Hz). Thirdly, the contralateral amplitude to sound stimulation was greater than ipsilateral amplitude. Finally, the amplitude on upgazed position was greater than downgazed position. The characteristics of these potentials were similar to those of oVEMPs in humans, suggesting that the air-conducted sound and bone-conducted vibration evoked myogenic potentials around the eyes in monkeys may be utilized as an animal model of oVEMPs.

P-F-15
OCULAR VESTIBULAR EVOKED MYOGENIC POTENTIALS (OVEMPS): EVALUATION OF THREE DIFFERENT ELECTRODE POSITIONS USING A MINISHAKER

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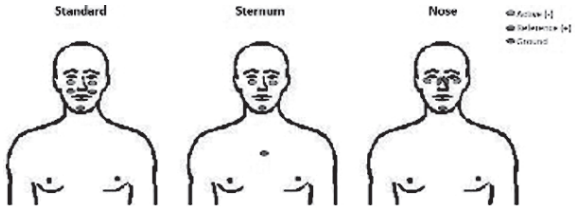
Introduction: The oVEMP test is a recently introduced vestibular technique capable of investigating utricular and superior vestibular nerve function. There is still a lot of speculation and research ongoing on the optimal oVEMP test conditions.
Objectives: In this study, 3 electrode configurations ('standard', 'sternum' and 'nose position') were evaluated in function of the oVEMP response to bone conducted vibration (minishaker) at the Fz position.



Methods: Data from 15 normal hearing subjects (11 females, 4 males; average age = 22,7 years; range between 19 and 27 years) were obtained for the 3 electrode positions. In the 'standard position', the active electrodes were placed approximately 0.5 cm underneath the midline of the eyes. The reference electrodes were placed 1.5 cm below the active electrodes and the ground electrode was mounted on the chin. In the 'sternum position' one reference electrode was placed on the sternum, while leaving the other electrodes in place. A third electrode position was the 'nose position' (Sandhu et al., 2013). In this position the active electrodes were placed more laterally of the eyes, i.e. on the belly of the inferior oblique muscle. The reference electrodes were positioned between the medial canthi and the nostrils and the ground electrode was kept in place on the chin (see image).
Results: A significant effect ($p < 0.001$) of the electrode position was found on the peak to peak amplitude. The largest amplitudes were measured in the nose position (35.04 (19.12) μV; mean (SD)) followed by the sternum position (26.54 (11.95) μV) and finally the standard position (15.40 (6.31) μV). There was no significant effect of the electrode position on the n10 latency. However, there was a significant effect on the p1 latency (left: $p = 0.001$; right: $p < 0.001$), with the shortest p1 latencies found in the nose position. None of the electrode positions revealed significant left-right differences. The normal 95 % prediction intervals for the left-right asymmetry ratio (asymmetry ratio = ((left − right)/(left + right))*100) were (-27, 27) for the nose position, (-38, 38) for the sternum position and (-45, 45) for the standard position.
Conclusion: Largest oVEMP responses were found in the 'nose position'. The normal 95% prediction interval for the left-right asymmetry ratio was clearly lower for the nose position, indicating that abnormalities are easier detected with this configuration. This means that the sensitivity of the oVEMP test increases significantly when applying the 'nose position' as electrode configuration during this test.

Poster Presentations G. Head Impulse

P-G-1
VESTIBULO-OCULAR REFLEX IN VESTIBULAR SCHWANNOMA

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Introduction: Dizziness is a frequent complaint in patients with Vestibular Schwannoma (VS). An abnormal vestibulo-ocular reflex can explain this dizziness in patients with VS. The video Head impulse test offer a chance to describe specifically the VOR findings in patients with VS.
Objective: To describe the vestibulo-ocular reflex findings in a group of patients with vestibular schwannoma.
Methods: Retrospective cohorts study in a tertiary referral Hospital. 51 consecutive patients on which vestibular schwannoma is diagnosed or patients with vestibular schwannoma in a "wait and see" condition. Patients are classified in accordance with the morphology of the VOR: Gain, covert saccade and overt saccade are analyzed both in the affected side and in the healthy side. The relationship between gain and saccades in both sides is evaluated. Indeed, caloric test is performed and compared in patients with vestibular schwannoma.
Results: 50 patients with a vestibular schwannoma are evaluated. (21 men and 29 women). Caloric response was normal in 31/50. According to tumor size, 20 patients suffer a grade I VS, 16 a grade II, 9 a grade III and 5 a grade IV. vHIT was abnormal in 45/50. In the affected side low gain was founded in 27/50, covert saccade as observed in 37/50 and overt saccade was observed in 26/50. In the healthy side, vHIT was abnormal 29/50 with a low gain in 4/50, covert saccade in 7/50 and overt saccade in 23/50. In VS gain in the affected side is not associated with caloric response, but gain in the affected side is associated with gain in the healthy side. Covert and overt saccade in the affected side is associated with gain in the affected side. In the healthy side, covert saccade is not associated with gain in the affected side but overt saccade is associated with low gain in the affected side.
Conclusions: An abnormal VOR is frequent in patients with VS and vHIT is an excellent test to confirm it. Not only the affected side show an alterated VOR but, sometimes, the healthy side and abnormalities in the healthy side are associated with low gain in the affected side.

P-G-2
THE COMPUTERIZED ROTATIONAL HEAD IMPULSE TEST (CRHIT)

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Introduction: The head impulse test (HIT), which uses manually delivered head rotations and direct observation of eye movement has been shown to be a valuable bedside test of unilateral horizontal semicircular canal function. More recently, the video head impulse test (vHIT), which also uses manually delivered head rotations but includes computerized recordings of both head and eye position, has several advantages including precise monitoring of head rotation and quantitative recording of eye movement, which allows detection of covert saccades and computation of unilateral VOR gain.
Objectives: We aimed to assess the ability of the computerized rotational head impulse testing (crHIT), a new test of semicircular canal function, to be used in the evaluation of patients with vestibular disorders.
Methods: crHIT used whole-body, computer-controlled, earth-vertical axis rotation with a peak velocity of 150 deg/sec and a peak acceleration of either 750 deg/sec2 or 1000 deg/sec2. Computerized head and eye movement monitoring was used to estimate unilateral VOR gain using the ratio of velocity, position, or acceleration of the eyes and the head. The horizontal crHIT was evaluated by testing a group of 20 patients with a complaint of dizziness seen at a University Balance Disorders clinic and 22 near age-matched control subjects. Pilot studies have been performed using crHIT to evaluate the vertical semicircular canals using appropriate positioning of the head and eyes during testing.
Results: Results for horizontal testing showed that the crHIT successfully identified most ears with absent ice water caloric responses and compared favorably with caloric responses both in patients with reduced but not absent binaural bithermal caloric responses and in patients with normal binaural bithermal caloric responses. Pilot data for vertical canal testing suggested that the crHIT also can be used to evaluate the vertical semicircular canals.
Conclusions: The new crHIT has the advantages of eliminating neck movement, using a less abrupt move-

ment and thus lowering unpleasant jerk, allowing random magnitude and direction of rotation thus minimizing prediction, avoiding the small position limitations of a head-on-neck rotation, and eliminating the need for a highly trained examiner. A particular advantage of the crHIT is that vertical semicircular canal function can be assessed using the same movement trajectory as that used for assessing the horizontal canals. The crHIT represents a higher technology approach to the well-established head impulse test.

P-G-3
VALUE OF VIDEO-HEAD IMPULSE TEST IN SPINOCEREBELLAR ATAXIA TYPE 3
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Background: Spinocerebellar ataxia type 3 (SCA3), also known as Machado-Joseph disease (MJD), is the most common inherited form of spinocerebellar ataxia. Selective vulnerability of distinct neuronal structures is a major feature of the disease, in which vestibular nuclei is a target to suffer damage. Vestibulo-ocular loss is easily diagnosed at the bedside with the head impulse test. Development of a new video system: the video-Head Impulse Test (v-HIT), measuring eye movements during head displacement, provides objective evidence of semicircular canal function, making dysfunction detection much easier. A head-mounted video camera measuring both eye movements and head motion velocity is equipped with software able to quantify vestibulo-ocular reflex (VOR) gain during brief head turns. v-HIT detects individual horizontal and vertical semicircular canal dysfunction in a quick, noninvasive and practical manner.
Objectives: The objective of this study was to evaluate VOR gain in the different vestibular canals using v-HIT and establish degree of vestibular nuclei lesion.
Methods: We evaluated three patients from a single family with genetically proven MJD, using ICS Head Impulse (GN Otometrics, Denmark), following technical instructions provided by the manufacturer. Case 1. A 54-year-old woman, with 10 years of progressive symptoms comprising: saccadic smooth pursuit, horizontal gaze evoked nystagmus, slurred speech, mild spasticity, limb and truncal ataxia. On clinical examination head impulse test (HIT) showed lateral plane VOR impairment, and altered VOR suppression. Brain MRI showed cerebellar atrophy. Caloric test SPV: 1-7°/sec. Case 2. A 42-year-old woman, younger sister of case 1, with 5 years of mild limb ataxia, slight speech slurring, in whom clinical HIT and VOR suppression were normal. Brain MRI showed mild cerebellar atrophy. Case 3. A 32-year-old man, son of case 1, with mild instability, normal clinical HIT and normal VOR suppression. Brain MRI showed mild cerebellar atrophy.
Results: All patients showed very good tolerance to the method. v-HIT confirmed severe impairment of the lateral semicircular canals in case 1: VOR gain was 0.41 in the right canal and 0.34 in the left canal (Normal value: 0.80) and overt saccades. VOR gain in vertical canals was borderline. Case 2 showed gain of 0.95 in right lateral canal and 0.75 in the left lateral canal (mild impairment), while gains were normal in vertical canals. All gains were normal in patient 3, with values of 0.91 in right, and 0.84 in left lateral canals.
Conclusion: These results suggest that impairment of vestibular nuclei can be progressive and asymmetric. Video Head Impulse Test is a fast, convenient and specific test to detect vestibular deficits in VOR, and is very well tolerated by patients, making it a useful tool both for early detection of vestibular deficits as well as for follow up of SCA3 patients.

P-G-4
VIDEO HEAD IMPULSE AND CALORIC TEST: A COMPARATIVE STUDY OF PERIPHERAL VESTIBULAR PATIENTS
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Background: Caloric ear irrigation produces unilateral stimulation of the peripheral vestibular organ and is the most widely used tool in routine vestibular testing to identify vestibular hypofunction. The exam allows quantitative evaluation of vestibular function through comparison of results between right side and left, but a low non-physiological frequencies. More, this examination is time-consuming and unpleasant for patients who frequently experience nausea and dizziness during the test. The head impulse test (HIT) assesses vestibular function with brisk, passive rotations of the head along the plane of semicircular canal pairs. Recently developed video HIT systems (vHIT) are a useful clinical tool for diagnosing peripheral vestibular deficits. The recordings identify both overt and covert saccades and measure VOR gain. A head-mounted camera registers eye movement and head velocity, and incorporated software quantifies vestibulo-ocular reflex (VOR) gain during brief head turns.

Objectives: The objective of this study was to compare results of quantitative head-impulse testing using video Head Impulse against responses to caloric irrigation, in patients with suspected peripheral vestibular hypofunction. Methods: A retrospective search of the institutional database identified 33 patients (18 females, 14 males) with both caloric test and vHIT evaluation for suspected peripheral vestibular failure between August and November 2013. Caloric testing had been performed using bithermal caloric irrigation (water temperature 30° and 44°, duration of irrigation 30s) and caloric-induced nystagmus recorded by means of videonystagmography using ICS chartr 200 (GN Otometrics, Denmark). Unilateral weakness (UW) was defined as reduced response to more than 24% of asymmetry and responses categorized as normal: 0–24%; mild UW: 25–49%; moderate UW: 50–74% and severe UW: 75–100%. ICS Impulse (GN Otometrics, Denmark) was used to test horizontal semicircular canal function, VOR gain below 0.80 with overt or covert saccades were considered pathological. All vHIT evaluations were conducted by the same operator (FJG) to reduce inter-operator variability.
Results: Of the 33 patients reviewed, 19 (58%) had abnormal vHIT results. Patients were classified into four groups according to caloric test responses: normal response and normal gain 11 patients; mild unilateral canal paresis (25%–49% UW) 9 patients all with normal gain on vHIT; moderate unilateral canal paresis (50%–74% UW) 4 patients only one of which had normal gain on vHIT; and severe unilateral canal paresis (75%–100% UW) 11 patients all with pathological gain on vHIT. Table 3 shows median gain and UW for VOR and caloric tests. For values over 50% UW on caloric tests, both methods were equally useful: gains on vHIT were under 0.80 and, by definition, pathological for caloric tests. Perez and Rama-Lopez found an UW limit of 42.5% for clinical HIT.
Conclusion: Our results show that, as previously described, in cases of over 50% UW both methods detect vestibular hypofunction, but for UWs between 25 to 49%, the caloric test is superior to vHIT. It has been suggested that vHIT should be used to test VOR at high and middle frequencies, and the caloric test to evaluate angular horizontal VOR at low frequencies. We propose vHIT be performed first, and if normal, a caloric test then be conducted. This approach would both save time and allow patients to experience a more comfortable evaluation.

P-G-5
VESTIBULAR OCULAR REFLEX DYNAMICS DURING PASSIVE HEAD-IMPULSES: SLOW PHASE AND QUICK-EYE MOVEMENTS IN HEREDITARY CEREBELLAR ATAXIAS

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Introduction: The vestibular ocular reflex (VOR) dynamic changes occurring in the course of head impulses are poorly understood. VOR function can now be non-invasively and easily assessed with the video head-impulse test (vHIT), allowing the quantification of VOR dynamic parameters (latency, slow phase instantaneous gain, defined as eye velocity to head velocity ratio at a given instant) and the characterization of quick eye movements (QEM) triggered during and/or after the impulses. This provides a unique opportunity to carry out neurophysiological studies on the oculomotor responses generated by head impulses in humans.
Objective and Methods: Our aim was to determine if the involvement of central vestibular pathways caused differential disturbances in VOR dynamic changes during vHIT, which could contribute not only to the differential diagnosis of patients but also to the understanding of VOR control mechanisms. We explored patients diagnosed with spinocerebellar ataxia (SCA) type 3 ($n = 15$), type 1 ($n = 4$) and type 2 ($n = 4$), Friedreich's ataxia (FA) ($n = 9$) and healthy controls ($n = 40$). We calculated the latency, regression (VORr) and instantaneous VOR gain at 40, 60 and 80 ms (VOR40, VOR60 and VOR80) and determined the latency, peak-velocity and occurrence rate of the QEM triggered during (covert saccades) and after (overt saccades) the head-impulse.
Results: VOR latency was prolonged in FA. VORr, VOR40 and VOR60 were significantly lower in FA and SCA3 in comparison to SCA2 and controls ($p < 0.01$ for all comparisons). VOR80 was significantly lower

in SCA3 in comparison with SCA2 and controls ($p < 0.01$ for all comparisons). The VOR instantaneous gain increased from 40 to 80 ms in FA in comparison to controls ($p = 0.01$), and is correlated to VOR latency. Covert saccades were only triggered in SCA3 but with low occurrence rate and peak velocity (11.1 ± 28.5; $77.50 \pm 15.30°$/s). On the contrary, overt saccades were present in all groups, with significantly higher occurrence rate in SCA3 then controls ($p = 0.001$) and higher velocity in FA then SCA2 and controls ($p < 0.01$ for both comparisons).
Conclusions: vHIT testing supplies phenotypic information that discriminates the most common autosomal dominant and recessive ataxias and can serve as a strategy to direct genetic diagnosis.

P-G-6
INFERIOR PEDUNCLE LESION PRESENTING WITH BILATERALLY IMPAIRED VESTIBULAR RESPONSES TO HORIZONTAL AND POSTERIOR HEAD IMPULSES
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Objective: Evaluate and report the clinical pathophysiology of oculomotor changes in a patient presenting with a cerebellar inferior peduncle lesion. Study design: case report. Patient: A 36-year-old man with progressive unsteadiness, particularly when in darkness.
Intervention: Video-oculographic and electrophysiological testing, imaging. Main outcome measures: video head impulse test (vHIT), caloric test, oculomotor tests, cervical and ocular vestibular evoked myogenic potentials (VEMPs), magnetic resonance imaging (MRI).
Results: The vHIT revealed significantly reduced vestibulo-ocular reflex (VOR) gain in both horizontal (0.38 ± 0.07 and 0.29 ± 0.05) and posterior canals (0.49 ± 0.05 and 0.38 ± 0.06) with covert and overt corrective saccades, but normal VOR responses in both anterior canals (0.89 ± 0.08 and 1.04 ± 0.15), for right and left impulses, respectively. With caloric testing there was a right unilateral weakness (56%). The remaining oculomotor tests were normal. oVEMP and cVEMP responses were normal and symmetrical. Brain MRI disclosed a left inferior cerebellar peduncle lesion suggestive of a glioma.
Conclusions: These observations suggest that, given the ampullae innervation, particular, peripheral-unlikely combinations of abnormal vHIT results, may be of topodiagnostic value.

P-G-7
THE VIDEO HEAD IMPULSE TEST
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Outcome objectives: Describe the value of the vHIT test in clinical neurotology. Methods: This study comprises 200 patients with a clinical history of vestibular disturbances who were submitted to a video head impulse test (vHIT) including all six semicircular canals.
Results: Abnormal responses of the anterior and posterior canals were found in several patients, either alone or combined with altered responses in the lateral canals. A unilateral hypoactive response of a posterior canal was found in a patient with a small vestibular schwannoma. The significance of these findings will be discussed. Conclusion: The vHIT tests are an important contribution to neurotological diagnosis.

P-G-8
SINDROME VESTIBULAR BILATERAL: MONITORIZACIÓN MEDIANTE EL REFLEJO VESTIBULO-OCULOMOTOR VIDEOASISTIDO
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Introducción: La exploración instrumentada del reflejo vestíbulo-oculomotor (RVO) es posible llevarla a cabo con el sistema VHIT® (video head impulse test, GN Otometrics, Dinamarca). Es una prueba complementaria útil en la valoración y seguimiento de pacientes afectos de patología vestibular. Esta prueba nos permite analizar la ganancia y las sacadas tras un estímulo a alta velocidad para estudio de los 6 canales semicirculares.
Objetivo: analizar los cambios en el RVO tras procedimientos quirúrgicos y ablativos en pacientes diagnosticados de Enfermedad de Ménière (EM) y su correlación con la evolución clínica.
Material y Métodos y Resultados: Se presentan 2 casos clínicos en los que el estudio del reflejo vestíbulo-oculomotor videoasistido (VHIT) corrobora la sospecha clínica. Caso 1: Mujer diagnosticada de EM en oído derecho sin respuesta a tratamiento médico. En la exploración otoneurológica destaca un nistagmo espontáneo derecho. El estudio del RVO muestra una

ganancia en lado derecho de 0,96 y en lado izquierdo de 0,87 con sacadas encubiertas en el plano lateral. Se realiza una única instilación con gentamicina en oído derecho con una evolución desfavorable. La paciente presenta inestabilidad crónica como consecuencia de un Síndrome vestibular bilateral. Caso 2: Mujer con hipoacusia profunda izquierda y severa derecha como resultado de EM. Como tratamiento paliativo de su hipoacusia se coloca un implante coclear en el oído izquierdo sin incidencias durante el procedimiento quirúrgico. En la exploración preoperatoria el RVO muestra una ganancia de 0,48 en el plano posterior con sacadas overt y covert en el oído derecho y ganancia de 0,85 en el plano posterior del oído izquierdo sin sacadas de refijación. 24h tras la cirugía debuta con un cuadro de vértigo de días de evolución e inestabilidad posterior. Durante el mismo presenta un nistagmo horizontal izquierdo y en el estudio del VHIT al mes de la cirugía se observa una ganancia de 0,36 en el plano posterior del lado derecho con sacadas covert y overt. En el lado izquierdo la ganancia en el plano posterior es de 0,17 con sacadas de refijación covert y overt.

Conclusiones: El estudio del reflejo vestíbulo oculomotor antes de llevar a cabo un procedimiento quirúrgico o ablativo es determinante para advertirnos de posibles complicaciones. En ambos casos el desenlace es un síndrome vestibular bilateral, complicación rara tras estos procedimientos. Es fundamental la evaluación del oído contralateral en este tipo de pacientes.

P-G-9

THE VIDEO HEAD IMPULSE TEST DURING POST-ROTATORY NYSTAGMUS: A PHYSIOLOGIC STUDY

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Objective: To test the effects of a spontaneous nystagmus (SN) on dynamic measures of the vestibuloocular reflex (VOR) in healthy subjects and in patients with unilateral vestibular loss (UVL).

Methods: VOR gain (eye velocity/head velocity) was assessed using head impulses with video-oculography (VOG) during post-rotatory nystagmus after a sustained constant-velocity chair rotation.

Results: When corrected for post-rotatory SN of slow-phase velocities as high as 30 deg/sec VOR gain was unaffectedby the SN. As previously reported there was a linear correlation between head velocity and gain with decreasing gain values at higher velocities and accelerations. This interaction was significantly increased (change of the regression slope), however, by inducing post-rotatory slow phases of nystagmus ($>$ 30 deg/s) in the same direction as the slow phases of the VOR. In addition, nystagmus fast phases were suppressed during the first 80 ms of a head impulse independently of the impulse duration.

Conclusions: Post-rotatory nystagmus at a slow-phase velocity up to 30deg/s does not alter horizontal VOR gain in healthy subjects nor in UVL patients using high speed and high acceleration head impulses. SN faster than 30 deg/s might influence VOR gain measures, however, clinicians should perform head impulses at a specific impulse velocity range (100–200 deg/s), and correct for spontaneous nystagmus in order to get reliable estimates of the gain of the VOR.

P-G-10

AGE EFFECT IN VOR MESURED IN A VIDEO SYSTEM HEAD IMPULSE (SANT CUGAT DEL VALLES. BARCELONA. SPAIN)

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Introduction: The purpose of the Vestibulo-Ocular Refelx (VOR) is to help in stabilizing images in the retina while moving. It is well known that there is a progressive reduction in vestibular function with age and the purpose of this work is to analyze the gain of the VOR across groups of age in normal subjects.

Matherial and Methods: In this study we selected normal subjects. They were family related or companions of patients seen at our department. They all had no history of vestibular impairment, vertigo or dizziness, posture and gait abnormalities, abnormal hearing impairment neither visual problems. Eye movements (gaze stability, saccades and smooth-pursuit) were normal and head and neck mobility was not restricted.

There was no spontaneous nystagmus with or without visual fixation. We have used a video head-impulse test system (vHIT, GN Otometrics, Denmark) for the eavluation of the gain of the VOR.
Results: The number of subjects included was 211. Mean gain of the VOR was 1.06 ± 0.07 and there were no differences according to gender. For all the impulses ($n = 9589$, 4912 rightward and the 4677 leftward) the gain decreases as the velocity of the head thrust increases: mean head velocity was significally faster in subjects younger than 70 years. When gain was evaluated by age and head velocity attained we found that gain is steady until 70 years old in high velocity head thrusts and 90 years old for lower head velocity head thrusts.
Conclusion: The involution of the vestibular system in the semicircular canals, mesured by the gain of the VOR begins at 70 years old for head movements in the velocity range of normal head movements. This must be taken into account in th eevaluatin of elderly patients as it reflects normal aging process.

P-G-11
RESULTS OF VIDEO HEAD IMPULSE TEST AND COMPARISON WITH CALORIC RESULTS IN PATIENTS WITH VESTIBULAR NEURITIS

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Objectives: It is assumed that caloric test probe the canal function in low frequency range and video head impulse test (vHIT) in high frequency range. The aim of the study is to evaluate the results of vHIT test in patients with vestibular neuritis.
Material and Methods: Thirty-eight patients (26 male, 12 female) diagnosed as vestibular neuritis based on caloric test (canal paresis ¡Ã 20%) between July 2013 and January 2014 were included. We analyzed caloric results and by gains, directional asymmetry, overt/covert re-fixation saccades in vHIT test.
Results: Average duration of the symptomwas 19.6 ¡3/3 22 days and caloric weakness was 69¡3/325%. Twenty-two patients (58%) showed canal dysfunction in all three canals. Patients who had dysfunction in superior vestibular nerve territory (superior and lateral SCC) were 5 (13%). Six patients (16%) had only lateral SCC dysfunction. Two patients (5%) showedcanal dysfunctionin lateral and posterior SCC. Two showed no canal dysfunction and 1 showed only posterior canal dysfunction. Correlation between the degree of caloric weakness and directional asymmetry value in lateral canal vHIT test was statistically significant ($r = 0.558$, $p < 0.001$).
Conclusion: vHIT test was a convenient and specific test to probeeach canal dysfunction in vestibular neuritis. Our findings suggest that vestibular neuritis cause vestibular impairment in low and high frequency range and involve superior and inferior vestibular nerve territoriesin various ways. The degree of lateral canal dysfunction by vHIT was significantly correlated with the degree of caloric weakness.

P-G-12
UNILATERAL AND BILATERAL SINGLE POSTERIOR SEMICIRCULAR CANAL DEFICIT IN PATIENTS WITH DIZZINESS.

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Introduction: The detailed assessment of the vestibulo -ocular reflex as with video systems, recently available, is providing insight in some unidentified characteristics of patients with peripheral vestibulopathy. Objective. To identify the frequency of isolated deficiency (unilateral or bilateral) of the vestibulo-ocular reflex evoked after stimulation of the posterior semicircular canal defined by low gain (gPSC). To characterize clinically and on vestibular testing the beforementioned identified patients.
Methods: Prospective observational study of adults from Jun 2012 to Feb 2014 with under normal gPSC with normal anterior and horizontal canal gain. VOR gain was evaluated with the vHIT (Otometrics®), considering as normal gains $\geqslant 0.8$ for horizontal and $\geqslant 0.69$ for verticals. Data were processed in SPSS Stadistics 19.0®.
Results: 363 patients were consequtively evaluated during the study period. 57 (16%) patients (33 male, 24 female) with a mean age 57 ± 15 years old showed abnormal gPSC: the finding was in one side in 46 (81%) and in both in 11 (19%). Most frequent diagnosis was Meniere disease (MD), BPPV (27%), chronic dizziness (9%) and otosclerosis (7%). Not age neither type of finding (unilateral/bilateral) was specifically associated to any diagnosis. Patients with unilateral PSC vestibulopathy are younger than patients with bilateral PSC vestibulopathy (55 vs 68 years; t, $p = 0.03$). In bilateral affected patients gPSC and age are strongly re-

lated (CC: -0.7; RL $p = 0.04$) and gain value is symmetric in both ears (CC: 0.7; RL $p = 0.05$). Unilateral affected patients with vestibulopathy shown lower gPSC (CC: 0.7; t, $p = 0.01$). Anterior and horizontal semicircular canals tend to decrease with age but without statistical significance in our sample, probably because excluding criteria. Hyperextension maneuver was made in 34 patients triggering nystagmus in 18 (37%); among them 61% (11) DN. DN was more common in bilateral affection of gPSC (80% vs 54% of unilateral), although it was not statistically significant in our sample. DN appear in 43% (3) patients with vestibulopathy while in 73% (8) of patients without it (χ^2 $p = 0.2$). Excluding BPPV, this difference decrease to 42,9% and 50% respectively (χ^2 $p = 0.8$).
Conclusions: Abnormal gPSC is present in 16% of vHIT performed, unilaterally in 81% and bilaterally in 19%. Bilateral and symmetric affection of gPSC is common in elderly, independently of the diagnosis. DN could be characteristic of bilateral affection of gPSC although it is necessary further investigation.

P-G-13
THE EFFECTS OF ACUTE ALCOHOL CONSUMPTION ON NEW TESTS OF VESTIBULAR FUNCTION

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Introduction: Alcohol has significant and widespread effects on the central nervous system. As acute alcohol intoxication commonly produces vertigo and imbalance, the effect of alcohol on vestibular function has been the focus of many studies.
Objective: We investigated the effects of acute alcohol intoxication on several recently developed measures of vestibular function: the video head-impulse test (vHIT), dynamic visual acuity (DVA) and cervical and ocular vestibular evoked myogenic potentials (cVEMPs and oVEMPs).
Methods: We recorded vHIT and DVA (in 8 normal volunteers) and VEMPs (in 14 different volunteers) using a repeated measures design to track vestibular function over multiple rounds of alcohol consumption up to a maximum breath alcohol concentration (BrAC) of 1.5?
Results: All tests were normal at baseline. Vestibulo-ocular reflex (VOR) gain measured by the vHIT decreased by 25% by the highest BrAC level tested, while cumulative catch-up saccade amplitude increased from 0.13° to 1.43°. DVA scores increased by 86% indicating a deterioration of acuity, while static visual acuity (SVA) remained unchanged. oVEMP amplitude decreased by 27%, but there was no significant effect on oVEMP latency or cVEMP amplitude or latency.
Conclusions: We found dose-dependent effects of alcohol consumption on all measures of VOR function (VOR gain, catch-up saccade amplitude, DVA and oVEMP amplitude), but no effect on the vestibulocollic reflex (cVEMP) or on SVA. The effects on the oVEMP may have been influenced by the systematic appearance of gaze-evoked nystagmus with increasing intoxication. However, these consistent results across several different tests suggest that alcohol has a selective, detrimental effect of alcohol on the VOR in normal volunteers.

P-G-14
REVISITING THE VESTIBULAR-OCULAR REFLEX IN PARKINSON'S DISEASE
UNIVERSITY OF OTAGO

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Introduction: The VOR is thought to be normal in Parkinson's disease (PD), unlike, for example, Multi-System Atrophy. However, much of the historical data on the VOR gain in PD has been at lower head frequencies. Technological advances in lightweight camera-goggle systems make recording higher velocity VORs feasible outside specialized laboratories. We hypothesized that, despite the existing literature on this subject, there may still exist a subtle alteration of the VOR at higher velocities in PD. If present, even if subtle, this might contribute to postural instability in PD, that with an ageing global population and increasing prevalence of PD, is a major health issue.
Methods: A pilot observational study was conducted under the auspices of a summer student research project. EyeSeeCam goggles and EzeEye software (Munich, Interacoustics) were used to determine VOR angular velocity gain at 60 ms after inititation of passive head impulses during video head-impulse testing (vHIT).
Results: 22 subjects with PD were recruited with (mean, range) age 67.7 (51–83) years, disease duration 6.6 (0.5–25) years, Unified PD Rating Scale 36.8 (12–57) points and total daily L-dopa-equivalent medication dosage of 781 (120–1700) mg. 20 age-matched

normal control subjects were recruited, age 65.8 (47–85) years. No subjects reported a history of vestibular disease, however one control subject was excluded due to vestibular asymmetry (angular velocity gain 0.70 left and 0.98 right). Despite assessing PD subjects immediately prior to when dopaminergic medications were due, neck rigidity did not impact upon the velocity profile of the achieved head impulses, with minimum head velocity of 200deg/s achieved in all PD and control subjects. Mean VOR gain in the control group was 0.954 (Standard Error of Mean 0.022) and in the PD group 0.938 (SEM 0.034). There was no significant difference between the groups. Power analysis (G power 3.1, effect size 0.10, á err prob-0.05) indicates a sample size of $>$ 2000 in each group would be required for a study power of 0.95 to investigate this further.
Conclusion: a high velocity measure of VOR gain by vHIT in PD is similar to age-matched controls, consistent with previous literature.

P-G-15
ASSESSEMENT OF THE VESTIBULOOCULAR REFLEX IN FIGHTER PILOTS WITH VIDEO HEAD IMPULS TEST

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Abstract Objectives/Hypothesis: The vestibular function in pilots has been reported as being different from that of other normal subjects. These results might be explained by adaptations caused by the plasticity of the vestibuloocular reflex (VOR) or by habituation, and flight training might be responsible for the modulation of the vestibular function in pilots. However, in most of these studies only the lateral semicircular canals were assessed by caloric and/or rotatory tests, which test only low frequencies. The aim of this present study was to verify the occurrence of high frequency changes in the vestibular function of the six semicircular canals in active fighter pilots, through the use of the video head impulse test (vHIT) Study Design: Cross-sectional design.
Methods: The subjects participating in this study were divided in three groups, according to their flight experience. For the control group (Group 1) 20 health male subjects serving as soldiers in Brazilian Air Force (FAB), with no experience of in-flight training were randomly selected (ages 20.75 $\pm$ 1.37). For the test subjects 14 fighter pilots registered as active jet pilots in the Brazilian Air Force (FAB) were randomly selected (ages 32.93 $\pm$ 4.39). Group 2 included the pilots with 1000 to 2000 hours of flight experience and Group 3 included pilots with 2001 to 3000 hours of flight experience. All subjects (male volunteers) signed an informed consent form. Medical histories and physical examinations performed in all of the subjects established that all had normal visual, normal vestibular function, and normal neurologic function. The gains of the six semicircular canals by the video head impulse test were investigated. Results: There were significantly low gain values (P $<$ 0,013) only in the left posterior semicircular canal in the control group as compared with the subject groups. However, there were no significant differences in gain values among the two groups of the active pilots.
Conclusion: These results suggest that VOR works well at the high frequencies contained in the natural head movements induced by vHIT and do not suggest adaptations in active jet pilots caused by VOR plasticity.
Table: VOR Gain Reflex of the six canals (Control X Subjects) Canals Control (n = 20) Subjets (n = 14) Values-p* Mean SD Mean SD GLL 0,94 0,05 0,93 0,06 0,890 GRL 0,99 0,06 1,02 0,08 0,215 GLA 0,91 0,05 0,91 0,10 0,979 GLP 0,98 0,08 0,91 0,06 0,013 GRA 0,95 0,09 0,93 0,08 0,543 GRP 0,96 0,09 0,96 0,10 0,821 *Statistical analysis performed of t Student test (P $<$ 0,05)

Poster Presentations H. Vestibular Evoked Responses

P-H-1
ASSESSING INNER EAR DEFICITS AFTER CHRONIC OTITIS MEDIA VIA AN INNER EAR TEST BATTERY

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Introduction: Investigation of the causes of vestibular symptoms in patients with chronic otitis media (COM) faces frustration, mainly because the bithermal caloric test using tap water is generally contraindicated in perforated ears. This study utilized audiometry, and oVEMP and cVEMP tests via bone-conducted vibration stimuli to investigate inner ear deficits after COM.

Objectives: This paper reviewed our experience in assessing inner ear deficits after COM via a battery of tests.
Methods: Each patient underwent a battery of tests comprising otoscopy, audiometry, image study of the temporal bones (Towne's view, Schuller's view, and Stenvers' view.), oVEMP and cVEMP test via bone-conducted vibration stimuli.
Results: Percentages of abnormal cVEMP test, oVEMP test, and BC hearing threshold in 117 COM ears were 65, 62, and 37%, respectively, exhibiting a significantly declining sequence in inner ear function. Furthermore, cVEMP/oVEMP test results were significantly correlated with BC hearing threshold, whereas no correlation existed between the cVEMP and oVEMP test results.
Conclusions: The sequence of inner ear deficits after COM runs from the saccule/utricle to the cochlea and semicircular canals. In addition to BC hearing test, the cVEMP/oVEMP test may serve as a supplementary tool for early detection of inner ear involvement in COM patients.

P-H-2
HEAD-SHAKING NYSTAGMUS IN PATIENTS WITH CEREBELLO-BRAINSTEM INFARCTION

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Introduction: Head-shaking nystagmus (HSN) is a nystagmus which can be evoked after head-shaking stimulation. Vogel first reported HSN and Kamei et al. re-evaluated for useful tool to examine vestibular function. In unilateral peripheral vestibular disorders, the direction of HSN is typically toward contralesional side. The mechanism had not clarified yet. However, it is explained by the theory that asymmetric vestibular input generated by head-shaking stimulation is accumulated in the central velocity storage mechanism and be discharged as contralesional nystagmus after ceases of head-shaking. In general, HSN is observed in patients with peripheral vestibular disorders. However, HSN could be evoked in patients with cerebullo-brainstem disorders. Objectives: We report 3 patients with cerebullo-brainstem infarction and compared the difference of HSN between peripheral and cerebullo-brainstem disorders.
Methods: We enrolled 45 imbalanced patients (3 patients with cerebullo-brainstem infarction and 42 peripheral vestibular disorders). We performed usual neuro-otologic examination, i.e. pure tone audiometry, electronystagmography (ENG)/videonystagmography (VNG), Caloric test, HSN test, and cervical vestibular-evoked myogenic potentials (cVEMP). HSN was evoked by passive head-shaking around the yaw axis between – 45 degree and + 45 degree (30 times, 2 Hz). HSN was monitored by ENG or VNG.
Results: Two patients were right lateral medullary infarction without cerebellar infarction. One patient presented infarction of the right cerebellar uvula, nodule, tonsil, and cerebellar hemisphere (biventer lobule and a part of inferior semilunar lobule). The brainstem did not accompany with infarction. These 3 patients showed HSN toward ipsilesional side. On the other hand, majority of the patients with peripheral vestibular disorders presented HSN toward contralesional side.
Discussion: HSN toward ipsilesional side is characteristics in patients with cerebello-brainstem infarction in this report. And the direction of HSN is opposite to HSN toward contralesional side in peripheral vestibular disorders. We consider the mechanism of HSN in cerebello-brainstem infarction is disinhibition of inhibitory output to central velocity storage mechanism by block of the inferior cerebellar peduncle, cerebellar uvula, or cerebellar nodule. The reason is that central velocity storage mechanism is mediated by the vestibular nuclei, and the cerebellar uvula and nodule project inhibitory output to vestibular nuclei via inferior cerebellar peduncle.
Conclusions: In patients with cerebullo-brainstem impairment, HSN is different from patients with peripheral vestibular disorders.

P-H-3
ABNORMAL CERVICAL VESTIBULAR EVOKED MYOGENIC POTENTIALS IN MULTIPLE SCLEROSIS PATIENTS ARE SUGGESTIVE ALSO OF UPPER CERVICAL SPINAL CORD DYSFUNCTION AND NOT ONLY LOWER BRAINSTEM: A METANALYSIS OF PUBLISHED STUDIES

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Introduction: Vestibular evoked myogenic potentials (VEMPs) are increasingly being used to evaluate

vestibular function from both the peripheral and central nervous system, and has also been applied in patients with Multiple Sclerosis (MS). Recently, there is increasing awareness of the fact that atrophy and structural variability of the upper cervical spinal cord can be seen in early MS, and also there is evidence for early neuronal damage in the cervical spinal cord of patients with primary progressive MS. In the central nervous system, cervical VEMPs (cVEMPs) involve not only the lower brainstem, but also the upper cervical spinal cord. In fact, the accessory nucleus can descend to as low as segment C5. The purpose of this study is to determine if previous publications have appreciated this fact, and also to use the data acquired so far to determine if the cVEMP findings can provide us with insight into upper cervical spinal cord dysfunction.
Methods: A literature search of the PubMed website with the search terms "vestibular evoked myogenic potentials" and "multiple sclerosis" was performed. Reviews were excluded and only original research was considered. Results: A total of 15 papers were recovered using the above criteria,11 papers with cVEMPs alone and 4 papers with both ocular VEMPs (oVEMPs) and cVEMPs. MS patients ranged from 15–70 persons, compared to healthy controls that ranged from 15–35 persons. cVEMPs were abnormal in 31% - 70% of patients. Nine papers (60%) described the findings as being due to lower brainstem injury alone. Where MRI was used (7 papers), all the papers (100%) evaluated only the brainstem area.
Conclusions: A significant majority of studies using cVEMPs in MS failed to appreciate the upper cervical spinal cord aspect. This potentially can deprive us of useful information in determining MS mechanisms.

P-H-4
UTRICULAR LESIONS CONFIRMED BY OVEMP IN THE PATIENTS WITH BPPV

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Introduction: Vestibular evoked myogenic potential (VEMP) studies have provided us with new knowledge regarding otolith dysfunctions in vestibular disorders during the past two decades. Benign paroxysmal positional vertigo (BPPV) is known to be caused by the free-floating otoconia originating from the utricle. Some investigators reported that the patients showed abnormal ocular VEMP (oVEMP) results. Although, this evidence suggested that BPPV resulted from utricular dysfunction, an oVEMP study could not neglect having superior vestibular nerve dysfunction. The aim of this study was to clarify the presence of utricular lesions in patients with BPPV by using oVEMP to compare air-conducted sound (ACS) and galvanic vestibular stimulation (GVS).
Material and Methods: We evaluated 12 patients with BPPV who underwent oVEMP for both ACS and GVS. To measure the oVEMP for ACS, we used tone-burst sounds of 700 Hz were used. The cathode was placed on the mastoid process and the anode on the forehead. GVS was provided at a 4-mA intensity for a duration of 1 ms. Asymmetric ratios (AR) were calculated by previous reported way using the peak-to-peak amplitude of n1 and p1 waves of the oVEMP to both ACS and GVS. When the AR exceeded the normal range, it was considered as an abnormal result.
Results: In all, 8 subjects showed abnormal results of oVEMP to ACS. No abnormal results were shown by any subject of oVEMP to GVS.
Discussion: In accordance with previous reports, our study showed that large number of BPPV cases showed right-to-left difference on oVEMP to ACS; no abnormal results were shown with regard to GVS. Therefore, the abnormal results in ACS were not caused by the superior vestibular nerve but rather, the utricular organ.
Conclusión: This study strongly suggested that patients with BPPV had an abnormality in the utricular organs.

P-H-5
DELINEATING AFFECTED TERRITORY OF ANTERIOR/POSTERIOR INFERIOR CEREBELLAR ARTERY INFARCTION

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Introduction: Recently, ocular vestibular-evoked myogenic potential (oVEMP) and cervical VEMP (cVEMP) tests had been utilized to identify the origin of vestibular schwannoma from the superior or inferior vestibular nerve, discriminate lesions between the upper and lower brainstem, and differentiate lesions between the brainstem and cerebellum. But less attention focused on the posterior/anterior inferior cerebellar artery infarction (PICA/AICA) infarction. This study applied audiometry and caloric, oVEMP and cVEMP tests to map affected territory in patients with PICA/AICA infarction.
Objective: This paper applied audiometry and caloric, oVEMP and cVEMP tests to map affected territory in patients with PICA/AICA infarction.

Methods: Fourteen patients, including 11 with PICA infarction and 3 with AICA infarction, were enrolled in this study during the past 8 years. Each patient underwent audiometry, caloric test, oVEMP test and cVEMP test.
Results: In the PICA group, 8 (36%) of 22 ears had a mean hearing level $>$ 25 dB. All 6 ears (100%) in the AICA group had abnormal hearing, and thus both groups revealed a significant difference. Conversely, significant differences were not observed in vestibular test battery between the PICA and AICA groups. MR imaging demonstrated infarction at the brainstem for 6 patients, while one patient also had cerebellar involvement, indicated by loss of visual suppression on caloric nystagmus. Six patients showed infarction at the cerebellum, and 4 of them had brainstem affliction based on abnormal oVEMP/cVEMP test results.
Conclusion: Although the affected territory in the PICA/AICA infarction could not be meticulously demonstrated by MR imaging, it could be picked up by the results of a vestibular test battery comprising caloric, oVEMP and cVEMP tests.

Poster Presentations I. Vestibular Neurophysiology Morphology and Pathology

P-I-1
SOMATOSENSORY ABNORMALITY IS ONE CAUSE OF CHRONIC DIZZINESS IN DIABETES PATIENTS

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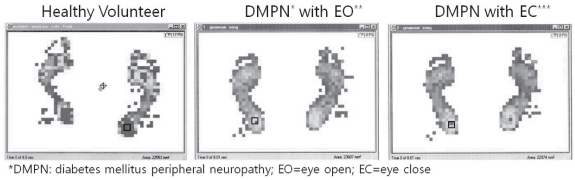
Introduction: Metabolic disorders, including glucose metabolism, have significant impacts on inner ear physiology, even small changes of which may result in balance disorders. The incidence of vertigo (16.6%) was found in type I diabetes mellitus (DM) patients. A significant vestibular functional change was found (60.0%) in a clinical test, compared to the auditory system (10.0%). It is an explanation of dizziness that the diabetes mellitus is a condition that increases the risk of a coronary artery disease, arrhythmia, due to autonomic neuropathy, cerebral infarction, and vertebrobasilar insufficiency. Another possible explanation is that the free-floating deposits in the semicircular canals were significantly higher in type I DM patients compared with normal temporal bones. The last proposed explanation is a dopaminergic change, which is a neurotransmitter in brain. However, these hypotheses were not sufficient for dizziness in DM patients during walking or moving.
Objective and Method: This study was designed as a case-control study from Jan. to Feb. 2014 in a single tertiary hospital under the approval of institutional review board (Incheon, Korea). 12 type I DM patients (55 „b 8.4 y, male/female = 7/5), who were diagnosed according to the International Diabetes Federation definition, and 5 healthy volunteers for the control group were enrolled. All patients did not have any external wound present on their feet and have suffered from chronic dizziness. The patients were divided into two groups, according to current perception threshold (CPT) and pulse wave velocity (PWV). Their foot pressures were measured by Tekscan (F-Scan„?system Tam v4.4, Tekscan Inc., South Boston, MA, USA) with an insole system on a low speed treadmill (Kdd-9100, 1.8 km/h, DAUN co., Seoul, Korea). The foot force (kg), as a representative parameter, was checked at 3 sareas (front, middle, heel) of both feet.
Result: The middle-area foot pressure was not different between the normal control and the CPT and PWV negative group, but was significantly increased in the CPT and PWV positive groups ($p < 0.001$, Mann-Whitney U-test).
Conclusion: The DM patients with chronic dizziness, who had a vascular or peripheral autonomic pathology present, showed foot pressure changes as one of somatosensory inputs for human balance.



*DMPN: diabetes mellitus peripheral neuropathy; EO=eye open; EC=eye close

P-I-2
VISUAL PERCEPTION OF UPRIGHT: HEAD TILT, VISUAL ERRORS AND OCULAR VIEWING

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Here we investigated the visual perception of upright in relation to the ocular viewing, head position and direction of the visual line rotation. The subjective visual vertical (SVV) was measured in 22 healthy subjects while seated upright using a forced-choice paradigm in otherwise complete darkness. The paradigm consisted of two blocks. In each block, the task was to report perceived orientation of a luminous line that moved repeatedly in steps of 2° in either clockwise (CW) or counterclockwise (CCW) direction (up to 160 from earth vertical). The accuracy (i.e., the degree of veracity as reflected by the median upright reports) and precision (i.e., the degree of reproducability as reflected by the trial-to-trial variability) of perceived upright were compared among the following conditions: ocular viewing (left eye, both eyes and right eye), head position (20° left tilt, upright and 20° right tilt) and direction of the visual line movement (CW and CCW). Overall, the accuracy of SVV in the eye viewing conditions were significantly different between the CW and CCW blocks irrespective of the head position ($p < 0.0001$). The accuracy of SVV in the eye viewing conditions were significantly different between the CW and CCW blocks for the upright and right head tilt positions ($p < 0.05$), but not the left head tilt position ($p > 0.05$). Only in the head upright position was the accuracy of SVV significantly different between the right and left eye viewing irrespective of the direction of the visual line rotation ($p < 0.05$). The precision of SVV was different between the head positions for both CW and CCW blocks irrespective of the eye viewing ($p = 0.0005$, $p < 0.0001$). With binocular viewing, the precision of SVV was different between the upright and left head tilt positions for the CW blocks ($p = 0.008$) and between the upright and right head tilt positions for the CCW blocks ($p = 0.01$). With the left eye viewing, the precision of SVV was different between the right and upright head positions in the CCW blocks ($p = 0.003$), and with the right eye viewing, there was no difference between the head positions in either CW or CCW blocks ($P = 0.16$ & 0.21). These results suggest that: 1-the accuracy and precision of the visual perception of upright are affected by both direction of the visual line rotation and head position 2-the effect of eye viewing on the accuracy of upright perception is only apparent in the head upright position 3- the effect of visual line rotation on accuracy of upright perception is masked by the head tilt effect when the head is tilted to the left.

P-I-3
ANATOMICAL AND PHYSIOLOGICAL CHARACTERISATION OF HUMAN VESTIBULAR HAIR CELLS

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Introduction: The majority of studies investigating the development of peripheral vestibular function have focused on animal models. Here we describe anatomical and physiological characteristics of developing human hair cells during a critical period of maturation.
Objectives: We have established a semi-intact preparation of human vestibular organs to investigate the functional development of hair cells and afferent terminals.
Methods: Human tissue was collected according to regulatory requirements of The University of Newcastle Human Research Ethics Committee. Inner ears from electively terminated human fetuses (11 to 18 weeks gestation; WG) were isolated. Tissue was used for either anatomical characterisation or physiological recordings. The vestibular triad including semicircular canal cristae and utricle were excised in ice-cold glycerol-based Ringers' solution. For recordings, tissue was transferred to a recording chamber perfused with oxygenated L15 cell culture medium. Whole-cell patch-clamp recordings using potassium fluoride internal solution were made from embedded hair cells. For anatomical studies, the tissue was fixed using 4% paraformaldehyde, and then later sectioned. A number of different antibodies were used to label hair cells, stereocilia, and afferent fibres.
Results: We have recorded and intracellularly labelled human hair cells that display inward and outward rectifying conductances. Throughout the period examined (11–18 WG), approximately 20% of immature hair cells exhibit sodium conductances. The remaining cells that lacked a specific type I conductance (GK,L), and were classified as type II hair cells, showed a significant increase in maximal conductance (GMAX) between 11–14 WG and 15–18 WG (3.5 ± 0.2 nS versus 11.9 ± 1.5 nS, $p < 0.05$). The earliest expression of the mature type I hair cell conductance, GK,L, was observed at 15 WG. This approximately coincided with our first recordings from calyx afferent terminals (15 WG). Our anatomical results show there are a variety of morphological characteristics (cylindrical versus

amphora shape) of developing human hair cells by 13 WG.

Conclusion: Our data show that while human vestibular hair cells are beginning to show distinctions in morphology by 13 WG, functionally the 11–14 WG age group, are still immature. By 15 WG, hair cells begin to express more mature conductances, including those typically seen either in mature type I or type II human hair cells. In addition, there is a concomitant maturation of calyx afferent terminals contacting putative type I hair cells.

P-I-4

CASE REPORT – INADVERTENT DURAL PUNCTURE CAN BE THE DIRECT CAUSE OF PERIPHERAL VESTIBULAR DAMAGE

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Introduction: Epidural steroid injections can sometimes inadvertently result in dural puncture causing intracranial hypotension. Although rare, a complication of this can be acute vertigo. (Reference) When this occurs, it has been assumed to be of central nervous system origin.

Objectives: We describe a patient presenting with vestibular complaints and measured abnormalities after a documented dural puncture.

Case History: The patient was involved in a minor rear end accident. She was assessed a day or two post accident by her family doctor, because of general aches and pains in the neck and back. She had no complaints of hearing deficit or tinnitus, but suffered lumbar disc and nerve compression which persisted for a year. She was treated with subdural steroid injections and after the third one she developed severe headache and acute vertigo and imbalance. Symptoms settled over the next week. She also developed complaints of visually induced dizziness (or visual vestibular mismatch). She was referred for balance assessment. Videonystagmography (VNG) was normal but Computerized Dynamic Posturography (Equitest) Sensory Organization Testing (SOT) was abnormal. Cervical vestibular evoked myogenic potential assessment (CVEMPS) were normal but OVEMPs were abnormal.

Discussion: This patient suffered a dural puncture after epidural steroid injection, which caused acute vestibular symptoms. It is probable that the accident is not the cause of these abnormalities which arose fourteen months after the accident. However her complaints are of inner ear origin, and not related to central pathology. Her visually induced symptoms are of macular utricular origin. We hypothesize that damage to the inner ear (subsequent to low pressure in the dural compartment) is due either to a mechanical effect of traction on the superior vestibular nerve, or a vascular insult due to traction of vascular loops into the internal auditory canal. Either of these mechanisms can result in end organ damage.

Conclusion: Previous descriptions of this have been noted following direct trauma, but always in close proximity to the accident. Onset of these symptoms over a year post accident means it is probable that the development of these visually induced dizzy symptoms is the result of the lumbar puncture.

P-I-5

VESTIBULAR SYSTEM, A NEW SYNCHRONIZATION PATHWAY OF BIOLOGICAL RHYTHMS?

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All living organisms have endogenous biological timing mechanisms that regulate behavior and physiology. These biological rhythms such as body temperature (Tb) are controlled both by endogenous master clock and synchronized by external factors such as light/dark cycle (LD cycle), physical and social activities. Others parameters such as gravity has also been recently involved. Studies in dogs, monkeys and rodents exposed to hypergravity (centrifugation) show that this stimulation induces rapid fall in Tb that is mediated by the vestibular system. Fuller et al. (2002) also demonstrated that vestibular stimulation is involved by showing that centrifugation at 2G inhibits circadian rhythm of Tb in normal mice while it has no effect in mice without functional otolith system. Instead of stimulating the vestibular system, we have studied how the loss of vestibular information via a chemical lesion influences circadian rhythm of temperature and activity in Long-Evans rats ($n = 18$). All rats exhibited strong circadian rhythms of activity and body temperature ($\tau = 24$ hours) before lesion. Just after lesion, mean Tb dropped drastically by 2.5° and recovered in 4 days following an asymptotic curve but stayed

lower than in sham operated rats (0.12°). Tb circadian rhythm disappeared during 5–7 days following the lesion. The circadian period was usually recovered in all rats during the second week after the lesion. As in Tb, activity dropped during few days and its circadian rhythm was not fully recovered at day 7, probably related to a direct effect on circadian rhythm and motor symptoms of the vestibular syndrome. Sham operated rats don't present alteration of circadian rhythms of Tb and activity. Vestibular loss disrupts circadian rhythm of temperature and activity as observed after vestibular stimulation. These results confirm that the vestibular system play a role on the synchronization of circadian rhythms. Vestibular inputs might be driven by the vestibulo-latero geniculo-supra-chiasmatic neuronal pathways as hypothesized by Horowitz et al., 2005. This study is granted by le conseil regional de Basse-Normandie (projet emergence).

P-I-6

EFFECTS OF AMPLITUDE OF STIMULATION ON THE SENSITIVITY AND SPATIAL-TEMPORAL PROPERTIES OF NON-EYE MOVEMENT CENTRAL VESTIBULAR NEURONS TO TRANSLATION IN MACAQUES

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For neurons that are sensitive to yaw rotation, the sensitivity of vestibular central neurons decreases with increases in peak stimulus velocity (Newlands et al. 2009; Newlands and Wei 2014). This reduction of sensitivity with increasing amplitude of stimulation is well described in sensory systems and is known as amplitude compression. Amplitude compression extends the dynamic range sensory neurons. However, as most studies on the translational sensitivity of central vestibular neurons mainly focused on single peak amplitude, whether amplitude compression exists for central translational responses is currently unknown. While otolith afferents display one-dimensional features (cosine tuning), vestibular central otolith neurons demonstrate 2-D tuning from spatial and temporal convergence of afferent input (STC). For most STC neurons, it is proven that the tuning ratio is frequency dependent (Angelaki et al, 1993), but the amplitude dependence of STC has not been tested. The current studies were undertaken to determine whether the sensitivity of central vestibular neurons responsive to translation in the horizontal plane is influenced by the amplitude of the stimulation and whether the STC properties of these neurons are impacted by amplitude. Translational motion sensitive central vestibular neurons that did not demonstrate eye movement sensitivity were studied. Extracellular recordings of the responses of these neurons in two macaques (1 rhesus, 1 fascicularis) were made during sinusoid horizontal translation at 2 Hz. The animals was translated in 6 different directions in the horizontal plane (spaced 30° apart) with 4 different peak accelerations ($\pm$ 0.025 g, $\pm$ 0.05 g, $\pm$ 0.1 g, and $\pm$ 0.2 g). This protocol allowed calculation of the direction in the horizontal plane which yielded the maximum sensitivity, the sensitivity in the direction of best response (Smax) and the sensitivity orthogonal to the direction of maximum sensitivity (Smin). Data analysis was done off-line. Firstly, the gain and phase of the neuronal response to sinusoidal translations was calculated (details see Newlands et al, 2009). Then, Smax and Smin were computed by fitting eclipse equations described by Angelaki (1991). Additional analysis included determination of the threshold of the responses in both directions and the variability of firing at the best orientation using the technique of Cullen and colleagues (Sadeghi et al. 2007). We found a clear decrease in the gain of the response (Smax) with increasing peak acceleration. Similarly, Smin decreased with increasing peak acceleration, resulting in preservation of the tuning ratio (Smin/Smax) over the amplitude series. Additionally, as the amplitude of the stimulation (the peak acceleration) decreased, the detection threshold increased. These findings suggest that amplitude compression, the phenomenon whereby gain of sensory responses depends on the amplitude of the stimulation, occurs in central vestibular neurons. This amplitude compression results in lower detection thresholds for less intense stimuli and potentially a wider dynamic range for more intense stimuli. Angelaki DE. IEEE Trans Biomed Eng 38:11:1053-60, 1991 Angelaki DE, Bush GA, Perachio AA. J Neurosci 13: 1403–17, 1993 Newlands SD, Lin N, Wei M. J Neurophysiol 102: 1388–97, 2009 Newlands SD, Wei M. J Neurophysiol 109: 2571-84, 2013 Sadeghi SG, Minor LB, Cullen KE. J Neurophysiol 97: 1503-14, 2007

P-I-7

STRETCH REFLEXES IN STERNOCLEIDO-MASTOID MUSCLE EVOKED BY TENDON TAP

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Introduction: The neck muscle motorneurones are innervated by both vestibular and proprioceptive afferents which stabilise the head either on the trunk or in space. Since the majority of body manoeuvres activate both systems simultaneously it is difficult to differentiate their respective properties.
Objectives: The aim of this study was to isolate a neck stretch reflex by tendon tap with the head fixed in space in order to eliminate vestibular activation.
Methods: The subjects were 17 healthy adults and 8 patients with bilateral vestibular failure. Subjects were seated in a semi-reclined position with forehead head restraint. Electromyographic (EMG) activity was recorded bilaterally from sternal (SM) and clavicular (CM) heads of SCM. The tendon of the left SM was tapped using a hand held mechanical device whilst the subject remained relaxed and during isometric neck flexion. In addition forehead skull taps were applied to evoke vestibular responses. Rectified EMG responses were analysed.
Results: Tapping of the left SM tendon evoked EMG responses of a similar latency in the ipsi- and contralateral SCM muscles in both groups when the neck muscle was relaxed ($\sim$32 msec) and isometrically contracted ($\sim$33 msec). There were no latency differences between subject groups or between different levels of muscle contraction. The areas of the EMG responses were significantly larger in healthy subjects than in patients. In contrast, forehead skull taps (vestibular responses) evoked responses in healthy subjects but not patients.
Conclusion: Our data indicate that the tendon tap responses in all subjects were induced via neck muscle stretch afferents and not by activation of vestibular reflexes. The relatively long latencies found would suggest a long loop reflex. Presumably this stretch reflex is the substrate of the cervico-collic reflex which normally interacts with the vestibule-collic reflex for the control of head posture. The weaker stretch reflexes in labyrinthine defective subjects could be an adaptive dis-facilitation to reduce neck muscle induced head oscillations.

P-I-8
VESTIBULAR NEUROMODULATION IN THE BASAL GANGLIA ACTIVITY OF RATS

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The main function of the vestibular system is the reflex control of posture and eye position during body movement. The central vestibular nuclei in the brain stem have a massive neural network in the brain, suggesting that vestibular afferent information can affect brain functions. Several clinical studies have demonstrated that peripheral vestibular activation has a transient therapeutic effect on central pain, post-stroke hemineglect, and phantom limb illusion in human being. Recent clinical trials also reported that vestibular stimulation showed the possibility as therapeutic options for alleviating symptoms of Parkinson's disease. However, there is a little information about underlying possible mechanisms for therapeutic effects of vestibular activation on Parkinson's disease (PD). This study was designed to elucidate basic phenomena and mechanisms for role of vestibular system on change of basal ganglia (BG) neural activity in hemi-Parkinson model of rats. Bilateral deprivation of peripheral vestibular end-organs aggravated apomorphine-induced turning behavior in hemi-Parkinson's rats. On the contrary, electrical stimulation to the ipsi-vestibular nuclei to the lesion significantly decreased the turning movement in hemi-Parkinson's rats. The parafascicular nucleus (PF) of thalamus is an essential structure in the feedback circuits of basal ganglia-thalamo-cortical systems and has anatomical connection with central vestibular nuclei. The electrophysiological recording revealed that short-latency neuronal excitation of PF neuron was noted by vestibular stimulation. Single unit activity of PF neuron was increased with a frequency-dependent modulation in response to electrical stimulation of the vestibular nuclei. Peripheral vestibular inputs also reached major components of the basal ganglia such as striatum and substantia nigra pars reticulata (SNr), a main output center of BG with polysyanptic nature. The short-term stochastic galvanic vestibular stimulation (sGVS) reduced a slow oscillation ($<$ 1 Hz) of spike trains induced by dopamine cell lesion in SNr neurons. Recording the single-unit activity and local field potentials revealed that sGVS leaded to a mild suppression of beta rhythm (13$\sim$35 Hz) power of subthalamic nucleus (STn), a major output of BG and the motor cortex. This rhythm was considered as abnormal neuronal activities caused by PD as well as the decreased correlation between the STn and the mo-

tor cortex. Furthermore, sGVS tended to decrease neuronal activities and irregularity of STn. These results of present study suggest that the alteration of neuronal activities in BG component and PF neurons by vestibular stimulation can be a possible mechanism for vestibular neuromodulation for alleviating symptoms of Parkinson's disease.(Supported by Converging Research Center Program through the Ministry of Science, Korea. No. 2013K000351)

P-I-9

CHOLINERGIC ACTIVITY OF THE PERIPHERAL EFFERENT VESTIBULAR SYSTEM

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Introduction: The function of the mammalian efferent vestibular system (EVS) has remained a mystery for too long. Cellular information regarding the EVS has been hampered by the lack of a suitable model. While some information about the EVS has been collected from isolated mammalian vestibular hair cells, most of our understanding has come from studies of afferent discharge following electrical activation of the EVS. While both these approaches have proved informative, each has a major drawback. Afferent discharge is an indirect measure of cellular activity, and isolation of hair cells results in the unavoidable destruction of the microarchitecture of the vestibular neuroepithelium. Therefore, the contribution of cholinergic transmission in the EVS remains to be determined.
Objectives: Recently, we have developed a semi-intact preparation that preserves the cellular microarchitecture and allows us to record from the three major neuroepithelial components: type I hair cells, type II hair cells, and calyx afferent terminals. Thus, this preparation provides a means of investigating efferent action in the mammalian periphery. We investigated the cholinergic contribution to EVS activity in all three peripheral components. We did this using immunolabelling techniques, and recording the cellular response to exogenously applied acetylcholine (ACh).
Methods: Tissue preparation: A semi-intact preparation of vestibular organs was dissected from the mouse inner ear. The preparation consists of a vestibular triad including the horizontal and anterior cristae and the utricle. This preparation was used for immunofluorescence and whole cell patch clamp recordings. Immunofluorescence: Paraformaldehyde-fixed mouse vestibular organs were cryostat sectioned (20 μM), then incubated with primary (VAChT, ChAT, and calbindin) and secondary (Texas Red, FITC) antibodies. Patch Clamp Electrophysiology: KF and KCl-gluconate internal solutions were used to recording from hair cells and calyx afferent terminals. ACh (300 μM) was applied using a picospritzer to evoke cholinergic responses. Antagonists; strychnine, apamin, and DHBE were used to block alpha-9 receptors, alpha4-beta2, and SK channels respectively.
Results: Emerging evidence from our semi-intact preparation indicates that the EVS has a much more complex and heterogeneous effect than previously thought. During ACh exposure (300 ìM, 100 ms duration), type II hair cells display a biphasic current response; 1) a current carried by the ACh receptor subunit (alpha-9/10), 2) a current carried by calcium-activated potassium channel (SK-type). In some cases, an additional cholinergic response was also detected and was identified as containing alpha4-beta2 acetylcholine receptor subunits. Approximately 25% of type II hair cells did not respond to ACh exposure. Why a minority of type II hair cells did not respond to cholinergic stimulation is unknown. In addition, we have recorded long-lasting ACh-induced responses in calyx afferent terminals and type I hair cells, which suggests the presence of muscarinic receptors.
Conclusion: Combining these electrophysiological results with those obtained from immunohistochemistry, we are building a more comprehensive picture of how EVS functions within the vestibular periphery. Preserving the critical cellular milieu, by using the semi-intact neuroepithelial preparation, we are able to define peripheral cholinergic EVS function in ways that were not possible previously.

P-I-10

AN ENTIRELY NEW APPLICATION OF CALORIC VESTIBULAR STIMULATION: ILLNESS AWARENESS IN SCHIZOPHRENIA

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Introduction: Anosognosia or impaired insight into illness is common among individuals with schizophrenia contributing to medication nonadherence and poor treatment outcomes. Caloric vestibular simulation (CVS) is typically used to assess functioning of the peripheral vestibular organ, specifically, the horizontal

semicircular canal. CVS is transiently effective treatment for anosognosia and hemineglect secondary to right brain hemisphere stroke. There are only a few case reports of insight improvement and mood stabilization with left cold CVS in patients with schizophrenia spectrum or bipolar disorders.

Objective: To determine the effect of iced water caloric irrigation on insight into illness in schizophrenia.

Methods: Subjects with a schizophrenia spectrum disorder and moderate-to-severe insight impairment (¡Ý3 PANSS G12) participated in a double blind, crossover, randomized controlled proof of concept pilot study of the effects of CVS on insight into illness. Subjects sequentially received all experimental conditions–left cold (4¡ãC) CVS, right cold CVS, and sham/body temperature–in a random order. Insight into illness was assessed using the VAGUS, self-report and clinician-rated versions (VAGUS-SR and VAGUS-CR). Positive symptoms were assessed using the SAPS; a 10-point Likert scale was used to assess mood. Assessments were performed pre-CVS, 5 min, and 30 min post-CVS.

Results: Data from 13 subjects (PANSS G12, x = 4.5, SD = 1.0) were analyzed at 30 min post-CVS. VAGUS-SR Insight improvement: Left_cold_CVS > Sham, Cohen's d = 0.09; Right_cold_CVS > Sham, d = −0.31; Left>Right_cold_CVS, d = 0.40; VAGUS-CR Insight improvement: Left_cold_CVS>Sham, d = 0.09; Right_cold_CVS>Sham, d = −0.05; Left>Right _cold_CVS, d = 0.13; Mood improvement: Left_cold_ CVS>Sham, d = 0.88; Right_cold_ CVS>Sham, d = 0.07; and Left>Right_cold_CVS, d = 0.92.

Conclusions: Left cold CVS appears to significantly improve insight into illness and elevate mood in schizophrenia spectrum disorders in a transient fashion. This is the only intervention that has immediate effect and may be of substantial value in the management of the acute phase of psychotic events. The mechanism of effect is thought to be due to the stimulation of inactive right hemisphere circuits via vestibular nuclei projections to the contralateral hemisphere when using left cold CVS. Treatment studies over an extended duration of time are required to determine the procedure's efficacy for improving illness awareness in schizophrenia.

P-I-11
CALCIUM BINDING PROTEINS SUBDIVIDE MEDIAL VESTIBULAR NUCLEUS NEURONS

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Introduction: The medial vestibular nucleus (MVN) integrates multiple inputs, including those from the vestibular apparatus, cerebellum, and visual system. The output of the MVN plays an essential role in the vestibulo-ocular reflex (VOR) as well as other known functions such as vestibular adaption and vestibular compensation. Therefore, understanding how this important nucleus contributes to these important vestibular functions has been a major goal in neuroscience research. While distinct subgroups of neurons within the MVN have been characterized neurochemically or electrophysiologically, few studies have combined the two methodologies to selectively study MVN subgroups.

Objectives: Two neurochemically discrete subpopulations of MVN neurons have been identified by their expression of specific calcium binding proteins (CBPs): calretinin (CR) or parvalbumin (PV). Our objective was to target these two groups for electrophysiological characterisation using transgenic mice expressing enhanced green fluorescent protein (eGFP) conjugated to either CR or PV.

Methods: Electrophysiology: Whole-cell patch clamp technique was used to record from fluorescently labelled eGFP-CR or eGFP-PV neurons in the MVN. Action potential profile, discharge properties, and spontaneous miniature post-synaptic currents were assessed in both populations of neurons. Immunolabelling: Tissue was fixed with 4% paraformaldehyde, sectioned, and processed for immunofluorescence using antibodies against GFP, calretinin, parvalbumin, calbindin, VGAT, and VGluT to determine co-expression levels, density of cerebellar inputs, and the neurotransmitter phenotype of each population.

Results: CR neurons are located in the parvocellular MVN, adjacent to the 4th ventricle. These neurons have a type B action potential profile, consisting of a double afterhyperpolarisation (AHP). They have reduced excitability in response to depolarising current steps compared to control neurons (0.104 Hz/pA, n = 31 vs 0.146 Hz/pA, n = 30, $p < 0.005$), and show only small changes in discharge rate following hyper-

polarizing current steps (0.66 ± 0.22 Hz, $n = 25$ vs 5.98 ± 0.84 Hz, $n = 23$, $p < 0.0005$). Synaptic inputs to CR neurons were both GABAergic and glutamatergic, but very few glycinergic inputs. Consistent with physiological results, immunofluorescent labelling shows many VGAT and VGluT positive terminals apposing CR-expressing neurons. PV neurons are located in the rostro-lateral parvocellular MVN. They also have a type B action potential profile, and the spike width is significantly narrower than control neurons. They are less excitable than surrounding control neurons (0.124 Hz/pA, $n = 39$ vs 0.17 Hz/pA, $n = 42$, $p < 0.05$), but contrast to CR neurons, PV neurons show a modest increase in discharge rate after hyperpolarizing current steps that is no different to control (3.81 ± 0.46, $n = 33$ vs 13.3 ± 4.7, $n = 35$, $p = 0.053$). Inputs to PV neurons were also GABAergic and glutamatergic with few glycinergic inputs.

Conclusions: The combined studies have generated a unique electrophysiological profile for neurons expressing either CR or PV. These different electrophysiological properties suggest distinct and separate roles for these two MVN subgroups. In particular, the fidelity of firing rate, even after hyperpolarization in CR neurons, and known increase in expression after labyrinthectomy suggests an important regulatory role within the MVN.

Poster Presentations J. New Examinations of Vestibular Dysfunction

P-J-1
HYPERVENTILATION AS A METHOD TO IMPROVE THE SENSITIVITY OF HEAD SHAKE NYSTAGMUS TEST IN PERIPHERAL VESTIBULOPATHY.

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Introduction: The Head Shake Nystagmus test (HSN) has received attention in the assessment of the dizzy patient. In unilateral peripheral vestibulopathy, rapid head shaking followed by abrupt cessation, may induce a nystagmus usually to the healthy side. However, the clinical application of HSN is controversial because according the literature it is not sensitive enough (20–30%) to be used as a screening test in vestibular pathology. We hypothesized that the low sensitivity of this test may be explained by the process of central vestibular compensation resulting in a smaller final asymmetry of vestibular input at the level of the brainstem. It has been described that hyperventilation may unmask nystagmus in patients with vestibular pathology because produces relative ischemia in the CNS thus altering central vestibular compensation mechanisms temporarily. Therefore, if one of the factors in the HSN sensibility is the central vestibular compensation, applying a method that can reverse it, as is the hyperventilation, we could improve the final HSN sensibility.

Objectives: To analyze the sensitivity of the hyperventilation test (HT) in unilateral peripheral vestibulopathy. To compare the sensitivity of HSN before and after hyperventilation in unilateral peripheral vestibulopathy.

Materials and Methods: Ten patients with unilateral peripheral vestibular loss (defined as unilateral low gain in the vestibulo-ocular reflex by video Head Impulse Test or Magnetic Scleral Search Coil testing) and ruled out CNS pathology by MRI. Patients were seated upright with video goggles and subjected to three consecutive tests: Head Shake Nystagmus Test 1 (HSN-1): 20–30 cycles of passive head rotation at a rate of about 2 Hz with the head tilted 30 degrees forward (the plane of the horizontal semicircular canal) were performed. The head shaking was abruptly stopped and eyes were immediately examined. Hyperventilation Test (HT): After a waiting time of 30 seconds finished the previous test, patients took an average of one deep breathing every 1 or 2 seconds, during 60 seconds. Head Shake Nystagmus Test 2 (HSN-2): A second HSN is repeated in the same way than the first one, 30 seconds after the hyperventilation. The presence, direction and duration of nystagmus were obtained for each test. Positive test was defined as the presence of at least 3 beats nystagmus. Sensitivities were calculated.

HIPERVENTILATION AS A METHOD TO IMPROVE THE SENSITIVITY OF HEAD SHAKE NYSTAGMUS TEST IN PERIPHERAL VESTIBULOPATHY. DIVISION OF NEUROTOLOGY, UNIVERSITY HELTH NETWORK AND UNIVERSITY OF TORONTO, TORONTO, CANADA

Results: The sensitivity for each test for predicting unilateral vestibular loss may be seen in the Table 1. For HSN-1 sensitivity was 40%, but this improved to a 60% after 60 seconds of hyperventilation (HSN-2). Hyperventilation alone (HT) had a sensitivity of 30%,

but for both tests combined (HIN + HSN-2) it increased to 80%. The direction of nystagmus was contralateral to the side of vestibular loss in 7 cases and biphasic in 1 case. In cases that HSN-1 was positive, nystagmus was prolonged after hyperventilation (HSN-2)

	HSN-1 Positive	HT Positive	HSN-2 Positive	HSN-2 or HT Positive
n	4/10	3/10	6/10	8/10
Sensitivity	40%	30%	60%	80%

Conclusions: Hyperventilation may be used as an easy clinical method to assess patients with dizziness. This may itself predict unilateral vestibular loss and improve the sensitivity for the HSN. Both tests combined may result in an 80% of sensitivity. We suggest apply the HSN after 60 seconds of hyperventilation in the dizzy patient examination. Hyperventilation probably reduces central vestibular compensatory mechanisms allowing unmask nystagmus because a greater asymmetry in peripheral inputs at the level of the vestibular nuclei.

P-J-2
THE CLINICAL UTILITY OF VESTIBULAR EVOKED MYOGENIC POTENTIALS (OCULAR VEMPS AND CERVICAL VEMPS) AND OF THE VIDEO HEAD IMPULSE TEST (VHIT) IN PATIENTS SUFFERING FROM A UNILATERAL VESTIBULAR SCHWANNOMA

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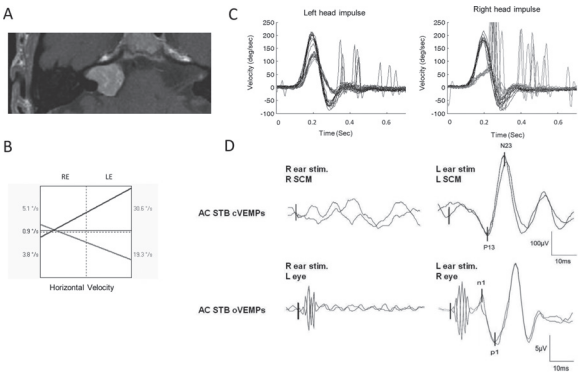
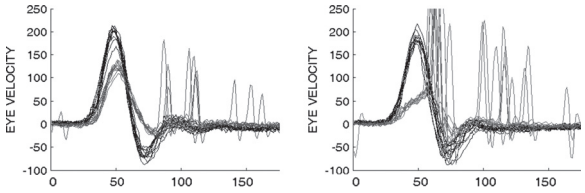
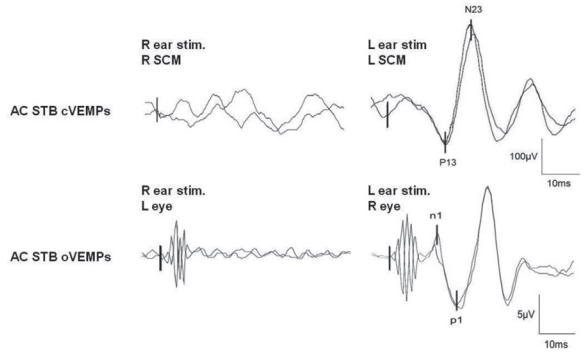
Introduction: vHIT, cervical and ocular VEMPs are three recent and interesting tests to appreciate the function of the superior and inferior vestibular nerves. 63 patients suffering from vestibular schwannoma (VS) were testing using caloric tests, vHIT and VEMPs.
Objectives: To investigate the clinical utility of VEMPs in patients suffering from unilateral VS and to determine the optimal stimulation parameter (air conductive sound, bone conductive vibration) for evaluating the function of the vestibular nerve. To study the interest of video head impulse test (vHIT) compared to caloric test for appreciating the function of the horizontal canal nerve.
Methods: Data were obtained in 63 patients with non-operated VS, and 20 patients operated on VS. Vestibular function was assessed by caloric, vHIT, cervical and ocular VEMP testing. 37/63 patients with conclusive ACS ocular VEMPs responses were studied separately.
Results: In the 63 non-operated VS patients, cVEMPs were abnormal in 65.1% of patients in response to AC STB and in 49.2% of patients to AC clicks. In the 37/63 patients with positive responses from the unaffected side, oVEMPs were abnormal in 75.7% of patients with ACS, in 67.6% with Fz and in 56.8% with mastoid BCV stimulation. In 16% of the patients, VEMPs were the only abnormal test (normal caloric and normal hearing). Among the 26 patients who did not show oVEMP responses on either side with ACS, oVEMPs responses could be obtained with Fz (50%) and with mastoid stimulation (89%). VHIT was always abnormal (gain decrease and catch up saccades) in areflexic patients to caloric test. The reverse was not true: in 9% of our VS patients, vHIT gain was normal whereas caloric test showed a horizontal canal paresis on the side of the VS.



Patient suffering from a right vestibular schwannoma (A) with a 70% canal paresis on the right side to caloric test (B). The VOR gain measured with vHIT was decreased and covert and overt catch-up saccades were detected on the right side (C). Finally, cervical and ocular VEMPs to ACS were abolished on the lesionned side (D).



Conclusions: The VEMP test demonstrated significant clinical value as it yield the only abnormal test results



in some patients suffering from a unilateral vestibular schwannoma. For oVEMPs, we suggest that ACS stimulation should be the initial test. In patients who responded to ACS and who had normal responses, BCV was not required. In patients with abnormal responses on the affected side using ACS, BCV at Fz should be used to confirm abnormal function of the superior vestibular nerve. In patients who exhibited no responses on either side to ACS, BCV was the only approach allowing assessment of the function of the superior vestibular nerve. We favor using Fz stimulation first because it is easier to perform in clinical practice than mastoid stimulation. This work also demonstrated the interest of vHIT. We recommend to use it first before caloric test and to select patients in which caloric tests should be done to better determine the function of the horizontal canal nerve.

P-J-3
OPTOKINETIC-AFTER NYSTAGMUS (OKAN) AS VESTIBULAR TEST

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Clinica Anglo Americana

Objective: To determine the effectiveness of OKAN as vestibular assessment test in terms of sensitivity, specificity and positive and negative predictive values when compared with spontaneous nystagmus, head- shaking nystagmus and caloric test.
Study Design: A retrospective cross-sectional study in a clinic. 274 vestibular evaluations were reviewed. The results of spontaneous nystagmus, head- shaking nystagmus, caloric test and OKAN was obtained. The results were considered normal or pathological. Was considered pathological spontaneous nystagmus without eye fixation if this was more than 2°/sec, head-shaking nystagmus if pathological display five nystagmic beaten after twenty seconds of vigorous head-shaking, Caloric vestibular paresis pathological if there was a major difference or equal to 25%, directional preponderance if there was greater than or equal to 30% difference and OKAN pathological if there was any of these conditions: nystagmic absence bilateral if there was no nystagmus in both directions, no unilateral if there was no nystagmus in one direction, asymmetry if there a difference of 50% in the number of nystagmus in both directions, if you had inverted unilateral change in the direction of the nystagmus in one direction and if you had inverted bilateral change in the direction of the nystagmus in both directions.
Measuring Results: The results of each of the forms of pathological OKAN were compared with spontaneous nystagmus, head-shaking nystagmus and caloric test for sensitivity, specificity and positive and negative predictive values.
Results: The sensitivity, specificity, positive and negative predictive values of OKAN unilateral inverted compared to caloric test were 75%, 79%, 72.9% and 80.8% respectively, compared with head-shaking nystagmus were 65%, 75%, 70% and 70%, and spontaneous nystagmus 86.9%, 72%, 54% and 93.6%. OKAN absent unilateral were compared with caloric test 79.5%, 57.5%, 55.5% and 80.8%, compared with head-shaking nystagmus were 70.2%, 52.3%, 52.3% and 70.2%, and spontaneous nystagmus were 81%, 46.8%, 20.6% and 93.6%. OKAN bilateral absent were compared with caloric test 70%, 54%, 39.6% and 80.8%, compared with head-shaking nystagmus were 54.8 %, 47.8%, 32% and 70.2% and compared with spontaneous nystagmus were 66.7%, 48.3%, 11.3% and 93.6%. Asymmetrical OKAN compared with caloric test were 76.9%, 48.7%, 42.8% and 80.8%, compared with head-shaking nystagmus were 63%, 41.7%, 34% and 70.2%, and spontaneous nystagmus were 78.5%, 42.7%, 15.7% and 93.6%. As for bilateral inverted OKAN size does not allow for an analysis.
Conclusion: The unilateral inverted OKAN has the best results when compared with caloric test, head-shaking nystagmus and spontaneous nystagmus, having better sensitivity with spontaneous nystagmus. We believe that OKAN could be more useful in monitoring vestibular compensation.

P-J-4
DYNAMIC STABILITY DURING GAIT IN PATIENTS WITH SENSORY AND CEREBELLAR DEFICITS

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Introduction: Human bipedal gait requires the continuous integration of sensory feedback in order to maintain a stable pattern of walking. Sensory input serves as stimulus for reflexive movements organized at the spinal cord level. In addition, sensory information has a vital role in modulating the output of higher central motor centers. We systematically investigated the influence of disturbed sensory or cerebellar control on the dynamic stability of gait.
Methods: According to the Dynamic Pattern Theory, we used temporal and spatial gait variability as control variables for describing the stability of the walking subjects. These measures were analyzed over the speed spectrum ranging from slow speed ($\sim$ 0.5 m/s), preferred speed ($\sim$1.0 m/s) to maximally fast speed ($\sim$1.7 m/s). Areas of lowest gait variability were regarded as most stable walking patterns. Patients with cerebellar ataxia (CA; $n = 41$), downbeat nystagmus syndrome (DBN), bilateral vestibulopathy (BVP; $n = 41$), sensory neuropathy (PNP; $n = 11$), and visual impairment (VIS; $n = 10$) are included.
Results: We found that spatial and temporal gait variability is dependent on the current walking speed in patients with sensory deficits (BVP, PNP, VIS) and patients with cerebellar disorders (CA, DBN). The highest amount of variability occurs during slow walking; in CA variability is also increased during fast walking. At preferred walking, variability measures are minimal. Moreover, the amount of gait variability during slow and fast walking is associated with a higher risk of falls in patients with CA. Pharmacotherapeutic interventions, e.g. the administration of 4-aminopyridine, reduce gait variability and improve the subjective balance confidence in patients with cerebellar deficits (CA, DBN).

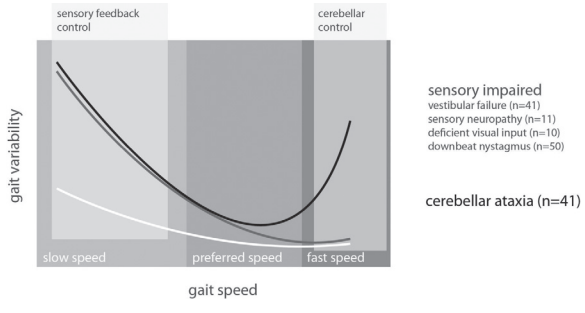

Fig. 1. Speed dependency of gait variability.

Conclusion: Patients with sensory deficits show the highest dynamic stability at preferred and fast walking modes. A reduction of walking speed results in a decrease of dynamic stability; this might explain why patients with sensory deficits select near to normal walking speeds in order to maintain dynamic equilibrium at self-selected pace. Patients with cerebellar deficits show a deep and tight association of self-selected walking speeds with the lowest gait variability levels. Dynamic stability measurements are important to understand the walking patterns of patients with dizziness and vertigo. Speed-related factors should be considered in these patients. Future studies are necessary to better understand the relationship between dynamic stability and the occurrence of falls.

P-J-5
TOWARDS A VESTIBULAR 'TRICORDER': SMART PHONE AND TABLET 'APPS' FOR VESTIBULAR MODELLING AND TESTING

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Introduction: Smart phones and tablet devices offer unique opportunities to model the function of the vestibular system because they contain 3D inertial sensors for rotation (gyroscopes) and linear acceleration/tilt (accelerometers) that function like the semicircular canals and otoliths of the inner ear respectively (a 'bionic labyrinth'). Inertial Measurement Units with these sensors were previously available for research but at a cost of several thousand dollars. Smart phones and tablets also incorporate the high resolution displays required to show reflexive vestibular responses (eye movements) and a touch interface to make settings, import data files, network devices, record and analyse responses, etc. These compact and affordable devices also contain video cameras, Bluetooth wireless connections, and analog/digital converters for audio input and output. The massive international app distribution systems like iTunes, user-friendly interfaces, and significant device availability and penetration (with over 600 million iOS devices and 900 million android devices in use) also offer new opportunities.
Objectives: In this project our general aim is to take advantage of the proliferation of current technology in the form of smart phones and tablets by developing the apps and associated hardware to assemble a basic neuro-otology testing kit or vestibular 'Tricorder'. This will provide the tools and experience to test and analyse balance problems quickly and simply, at the bed-

side (or anywhere in the real world), as well as modelling tools to assist in the interpretation and comparison of results.

Methods: The first free app, which we have called aVOR (the angular Vestibulo-Ocular Reflex), demonstrates the stimulation of the balance sensors of the inner ear by rotation (angular velocity) and models the reflexive eye movement responses that serve to stabilize gaze (http://itunes.apple.com/app/avor/id497245573). The aVOR app allows manipulation of the functional state of the semicircular canals, the influence of cerebellar function, the type of visual fixation, saccade characteristics, the presence of canalithiasis, etc. The user can interactively explore the consequences of these settings by moving the virtual subject's head (the device) and observing the displayed eye movement responses. A quiz mode introduces unknown settings.

Results: The aVOR app has been downloaded $\sim$ 20,000 times, from more than 100 countries and in 9 languages. Significant positive feedback from around the world has reinforced the potential of mobile apps to benefit patients, students, researchers and clinicians.

Conclusions: We now have a number of other prototype apps at various stages of development including: 'VOR': for modelling complex angular and linear vestibulo-ocular reflex interactions; 'ImprovEyes': for eye movement recording and measurement; 'LocoMate': for gait, locomotion and movement analysis; 'OtoPortential': for cVEMP and oVEMP assessment of otolith function; 'BalanceRite': for posturography and balance rehabilitation; 'BinocuLevel' a bucketless test of the subjective visual vertical, and 'DynaVision' to assess dynamic visual acuity. This presentation will demonstrate some of these apps to stimulate suggestions, discussion and feedback.

P-J-6

THE TRANSLATION OF THE VERTIGO SYMPTOM SCALE INTO AFRIKAANS: A SOUTH AFRICAN VALIDATION STUDY

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University of Cape Town

Introduction: Diagnosis and management of dizziness is challenging and at times frustrating. The subjective nature of the complaints, difficulty patients have describing them and the broad range of causes, from vestibular to psychological; all form the complexity that is the dizzy patient. The identification of vertigo, and its association with vestibular disorder, may direct professionals in their choice of investigation, management and subsequent referrals. The corner-stone of diagnosis is the history. However, anamnesis may be problematic, particularly in settings where there are linguistic and cultural differences between the health care professional and patient, a scenario common in a diverse country such as South Africa. Pragmatic measures such as questionnaires add to the completeness of the case history, open areas for further probing during the clinical encounter, and focus the patient's thoughts prior to the consultation. When translating materials into another language the results should be validated, however, literature shows that the quality and validation of translations is often variable.

Objective: The aim of this study was to validate a translation of the Vertigo Symptom Scale (VSS) into Afrikaans, the most commonly spoken language in the Western Cape of South Africa; and to assess the translation's ability to differentiate between patients with and without complaints of vertigo.

Methods: A Delphi consensus procedure was used to refine a translation of the VSS. One panel of bilingual health care professionals and one of mother-tongue Afrikaans speakers sought consensus on aspects of the translation including grammar, use of language and vocabulary equivalence. In addition they generated a list of words used to capture the essence of vertigo. In the validation study, 72 Afrikaans- speaking participants with and without vertigo completed the Afrikaans Vertigo Symptom Scale (AVSS) and congruence between their diagnosis and results on the AVSS established.

Results: Two independently translated versions were similar and merged, and no discrepancies were detected using the forward-backward method of translation. Two rounds of Delphi consensus were required, which proved time and cost-effective. The pilot study revealed formatting issues which were addressed to

make the appearance more user-friendly. A list of words suggesting vertigo was agreed upon and can be implemented in clinical practice. The VSS' two subscales evaluate the experience of vertigo (VER) and symptoms of anxiety and psychological problems (AA). Cronbach's alpha performed on the AVSS indicated good internal consistency on the VER subscale (a = 0.8822) and AA (a = 0.9248). Further analysis revealed the control group had lower scores on both subscales than the patient group, suggesting the VER is reliably able to differentiate between groups. The vertiginous group, as expected, had relatively high mean scores on the AA (mean 26.89). ROC curves established cut-off scores to establish cases and non-cases. Overall the AVSS showed good sensitivity and specificity on both subscales and as a whole.

Conclusion: Various methods to evaluate translation of instruments exist. This study highlights the use of the Delphi technique and the success and robustness of the final version of the AVSS. The importance of appropriate materials for use in diverse populations; and use of formal technique to validate their translation, is highlighted.

P-J-7
MTBI IN VETERANS IS ASSOCIATED WITH REDUCED VESTIBULAR FUNCTION AND IMPAIRED CEREBRAL BLOOD FLOW REGULATION

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Recent data has demonstrated that veterans returning from Iraq and Afghanistan have increased incidence of mild traumatic brain injury (mTBI) as well as impaired vestibular function. The objective of this work is to determine if reduced vestibular function is associated with impaired cerebral autoregulation. To asses vestibular function we measured ocular torsion, rotation of the eye within the socket during roll tilt. This vestibular ocular reflex provides us an index of otolith function. To assess cerebral autoregulation we had veterans perform three sit to stand maneuvers while measuring beat-by-beat blood pressure, cerebral flow velocity in the middle (MCA) and anterior cerebral artery (ACA) and end tidal CO2. 11 Veterans completed both vestibular and cerebral autoregulation assessments. Ocular torsion ranged from 0.03 to 0.32 deg torsion per deg head tilt (Mean 0.14). Ocular torsion was correlated to autoregulatory index (ARI) in the MCA ($R = 0.339$, $P = 0.058$) and the ACA ($R = 0.461$, $P = 0.018$), with lower ocular torsion having reduced ARI. Defining low ocular torsion using a mean split, we found significantly lower ARI values in both MCA (Low 3.1 ± 0.4 vs High 4.6 ± 0.4, $P = 0.012$) and ACA (2.7 ± 0.4 vs 5.2 ± 0.3, $P = 0.000$). Further examining mTBI in these groups, we found that in the group with low ocular torsion, mTBI patients had lower MCA ARIs (2.5 ± 0.7 vs 3.7 ± 0.4) and ACA ARIs (1.5 ± 0.6 vs 3.8 ± 0.4), although these values did not reach significance. In contrast in the group with high ocular torsion, there was no difference in ARI values between those with and without mTBI. These data suggest that individuals with reduced otolith function have impaired autonomic function resulting in impaired cerebral blood flow regulation that is worsened by having a history of mTBI. Future work is needed to verify these findings in a larger group and to examine how impaired cerebral blood flow regulation may contribute to the cognitive impairment associated with mTBI.

P-J-8
EFFECTS OF DUAL (COGNITIVE) TASKING ON FREE WALKING IN PATIENTS WITH A PERIPHERAL VESTIBULAR DISORDER

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[1]Ear Institute UCL/Department of Neuro-otology, National Hospital for Neurology and Neurosurgery;
[2]Centre of Human and Aerospace Physiological Sciences, King's College London

Introduction: Patients with vestibular disorders experience unsteadiness while walking which exposes them to high risk of falls. Gait studies in vestibular disorder have been carried out in indoor laboratories, which fail to expose patients to challenges they may encounter in everyday life. Outdoor environments are more challenging because they expose the patient to unpredictable changes in their surroundings which increases the attentional demands and need to flexibly shift concentration between more than one tasks while walking. Previous studies suggest that the presence of an underlying vestibular pathology increases the attentional demand required to control postural & dynamic balance. The addition of a cognitive task when performing a balance task results in a greater reliance on available cognitive resources and the need to divide attention between the two tasks. Studies that have examined

the effect of cognitive tasks on balance performance in vestibular disorders have mainly assessed posture, while studies assessing dynamic balance-cognitive interactions are very limited.
Objective: To determine how patients diagnosed with a peripheral vestibular disorder navigate in an outdoor environment and to examine the effect of adding a secondary cognitive task on dynamic balance.
Method: Twenty-one people with a peripheral unilateral vestibular disorders and 21 healthy age-matched controls performed the Timed-Up & Go (TUG) and Functional Gait Assessment (FGA) under four different conditions; a)single task and b)dual task with a motor, numeracy & literacy cognitive task. Walking velocity and Medio-lateral(ML), Antero-posterior(AP)& Vertical(V) accelerations of the head, neck and trunk were measured using three tri-axial accelerometers while walking with & without simultaneous performance of a cognitive tasks in four different urban environments(busy, quiet, cobbled pathway, street crossing). Validated questionnaires were used to assess the patients' symptoms & functional abilities. All participants had a cognitive evaluation using the Behavioural Assessment of Dys-executive Syndrome test battery (BADs).
Result: TUG & FGA scores were significantly worse in the patient compared to the control group ($p < 0.01$). The addition of a cognitive numeracy or literacy task adversely affected the FGA score in both groups ($p < 0.01$). The outdoor walking environment affected walking speed in the patients group with a significantly slower speed in busy and cobble segments ($p < 0.01$). Walking velocity was significantly reduced in the patients group compared to controls in all walking segments under single & dual task conditions ($p < 0.01$). Trunk acceleration was significantly reduced in the patients group and under dual tasking in both groups in the ML, AP & V directions ($p < 0.05$). Head acceleration in the ML & AP direction did not differ significantly between groups or with the addition of cognitive tasks. The average score of cognitive tasks during outdoor walking was significantly lower in the patients group ($p < 0.01$).
Conclusion: Patients with peripheral vestibular disorders may have increased risk of fall and injuries. Thus, they adopt conservative gait strategies with a reduced walking speed and acceleration at various body segments to maintain balance especially in challenging environments. When dual tasking, the attentional demand to maintain dynamic balance is increased in both groups leaving limited resources to cognitive tasks, though patients' group perform worse.

Poster Presentations K. Central and Peripheral Disorders

P-K-1
CENTRAL ACUTE VESTIBULAR SYNDROME BY VASCULAR CAUSE

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Introduction: Acute vestibular syndrome is characterized by acute, spontaneous and sustained vertigo and is accompanied by nausea, vomiting, and instability, and nystagmus, intolerance to movement lasting 24 hours or more. The main cause is vestibular neuritis; however, similar signs and symptoms occur in cerebellar stroke, called pseudo-vestibular neuritis.
Objective: To determine the frequency of stroke that appears as acute vestibular syndrome, clinical pattern and vascular territory.
Material and Methods: From 2006 to 2012, 124 patients with diagnosis of acute vestibular syndrome were identified. From them, 41 presented diagnosis of stroke, 32/41 territory of the posterior inferior cerebellar artery (PICA), 8/41 anterior inferior cerebellar artery (AICA) and 1/41 superior cerebellar artery (SCA).
Results: Infarction on the territory of the posterior inferior cerebellar artery: 1. All patients presented provoked nystagmus; unilateral 14/32 pts (all presented a single direction toward the side of the lesion); bilateral 18/32 (all presented normal head impulse test); 17/32 patients had ocular tilt reaction; asymmetric eye smooth pursuit 27/32 pts; modification in visual suppression of the vestibulo-ocular reflex (VOR) 25/32 pts; ataxia score 1 3/32 patients; ataxia score 2 9/32 pts; ataxia score 3 20/32. Territory of the anterior inferior cerebellar artery 1. Neuro-otological findings: spontaneous, horizontal nystagmus beating toward the non-injured side: 3/8 pts; provoked bilateral eye nystagmus (Bruns nystagmus) 5/8 pts; OTR 4/8 pts; head impulse test 6/8 pts; slow asymmetric eye tracking 5/8 pts. 2. Pattern of audio vestibular dysfunction: cochleovestibular involvement 5/8 pts; isolated vestibular involvement 1/8 pts; isolated cochlear involvement 1/8 pts; no cochleovestibular involvement 1/8 pts; prodromal cochleovestibular symptoms that preceded the stroke 3/8 pts.
Conclusion: fá The most common stroke in acute vestibular syndrome is that of the PICA. fá To differentiate pseudo-vestibular neuritis from vestibular neu-

ritis, head impulse test was key. fá Cochleovestibular dysfunction is a significant sign for the diagnosis of AICA infarction and more important prodromal symptoms are present in around 40% of the cases.

P-K-2
A CASE OF SUDDEN VERTIGO AND FACIAL PALSY DUE TO DIFFUSE LARGE B CELL LYMPHOMA

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An 35-year-old man presented with left facial palsy and vertigo. The patient was diagnosed diffuse large B cell lymphoma in cecum. left ear drum had granulation and bulged out. MRI scan showed diffuse soft tissue enhancement in left internal auditory canal, cranial nerve V and VII.Lymphoma involvement of IAC and cranial nerve V and VII was suspected. Clinical diagnosis was lymphoma involvement of internal auditory canal or acute otitis media with complication. antibiotic and steroid treatment was done with close observation.

P-K-3
ISOLATED INFERIOR CEREBELLAR PEDUNCULAR LESION CAUSES A DISTINCT VESTIBULAR SYNDROME

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Introduction: The inferior cerebellar peduncle (ICP) connects the medulla oblongata with the cerebellum. The ICP contains various fibers to and from the cerebellum, which are mainly concerned with integrating the proprioceptive sensory inputs with the vestibular function such as balance.
Objectives: To elucidate full clinical features of unilateral ICP lesion in humans, we analyzed clinical and laboratory findings of patients with isolated unilateral ICP lesion.
Materials and Methods: We had recruited 4 patients with isolated unilateral ICP lesion (three with cerebral infarction and one with multiple sclerosis) at the Dizziness Clinic of Pusan National University Hospital from November 2011 to April 2013. All patients received bedside neurological and neuro-otological evaluation including horizontal head impulse tests, prism cross-cover test for ocular alignment, and assessment of balance. Laboratory tests included measurements of the subjective visual vertical (SVV) and ocular torsion, bithermal caloric tests, and pure tone audiometry.
Results: All patients presented with acute vertigo and imbalance mimicking peripheral vestibular disorders. Three patients showed spontaneous horizontal nystagmus which was all ipsilesional. All patients showed contralesional SVV tilt and ocular torsion, and one of them also had contralesional skew deviation. Three patients fell or veered to the lesion side with mild to severe postural instability. Head impulse, bithermal caloric tests, and pure tone audiometry were normal in all the patients.
Conclusions: Unilateral ICP lesion presents with acute vestibular syndrome mimicking peripheral vestibular disorders. However, directional dissociation between ocular-tilt reaction and body lateropulsion in the absence of positive head impulse or caloric paresis may be a sign distinguishing lesions involving unilateral ICP from those affecting other vestibular structures.

P-K-4
APOGEOTROPIC CENTRAL POSITIONAL NYSTAGMUS: CHARACTERISTICS AND MECHANISMS

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Objective: This study aimed to determine the characteristics and mechanisms of apogeotropic central positional nystagmus (apogeotropic CPN) in comparison to apogeotropic nystagmus from cupulolithiatic horizontal canal benign paroxysmal positional vertigo (apogeotropic BPPV).
Methods: Twenty seven patients with apogeotropic CPN and 20 patients with apogeotropic BPPV underwent recording of spontaneous nystagmus while sitting and supine and position-triggered apogeotropic nystagmus in the ear-down position. We measured the gravitation-induced nystagmus (GIN) by subtracting the intensity of spontaneous nystagmus while supine

from that of apogeotropic nystagmus in the ear-down position to either side.
Results: The intensity of spontaneous nystagmus was similar between the sitting and supine positions in the apogeotropic CPN group, but greater in the supine position in the apogeotropic BPPV group. In both groups, the apogeotropic nystagmus was greater when it was in the direction of the spontaneous nystagmus while supine. The intensity of GIN was symmetrical between the sides in the apogeotropic CPN group, but markedly asymmetrical in the apogeotropic BPPV group. In apogeotropic CPN from unilateral circumscribed lesions, the lesions were mostly overlapped in the nodulus, uvula, and tonsil. Even though apogeotropic CPN is more intense in the direction of spontaneous horizontal nystagmus while supine, the gravitation-induced nystagmus is symmetrical even in patients with unilateral lesions.
Conclusion: Apogeotropic CPN appears to result from linear summation of spontaneous nystagmus while supine and gravitation-induced nystagmus.

P-K-5
MISDIAGNOSIS OF CEREBELLAR HEMORRHAGE-FREQUENCY OF 'PSEUDO-GASTROENTERITIS' CLINICAL PRESENTATIONS TO THE EMERGENCY DEPARTMENT
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Objective: To determine the frequency of gastroenteritis-like presentations and delayed or missed diagnoses among patients with spontaneous cerebellar hemorrhage.
Background: Early-stage cerebellar hemorrhage can present with nausea or vomiting absent other neurological symptoms or signs, potentially leading to an incorrect diagnosis of gastroenteritis and delayed treatment of this serious condition. Little is known about the risk of such 'pseudo-gastroenteritis' presentations.
Methods: Ambispective, case-control analysis of atraumatic, primary cerebellar hemorrhages derived from a systematic search of surgical pathology and autopsy databases at two large urban, academic medical centers from 1984–2006. The free-text search strategy included relevant terms such as "cerebellar" and "hemorrhage" or "hematoma". Hospital visit and clinical symptom data were abstracted from electronic and paper medical records for included patients. Delayed or missed diagnoses were defined as those at least one previous visit for relevant clinical symptoms in the 7 days prior to the correct diagnosis being confirmed.
Results: Among 254 records captured by our search filter, we identified 35 cases of pathologically-proven primary cerebellar hemorrhage. Patients had a mean age of 54 and the most common identified risk factors for hemorrhage were hypertension (66%) and vascular anomaly (20%). Initial symptoms of cerebellar hemorrhage were headache (77%), nausea/vomiting (63%), altered mental status (57%), ataxia/imbalance (42%), and dizziness/vertigo (30%). Four patients (11%) were misdiagnosed initially–three with "gastroenteritis" (emergency department) and one with "hypertension" (primary care). Misdiagnosed patients were more likely to present with nausea/vomiting (100% vs. 58%, $p = 0.10$) and normal mental state (100% vs. 35%, $p = 0.01$). Although patients deteriorated clinically after the initial misdiagnosis, and potentially lethal diagnosis and treatment strategies were instituted as a result of misdiagnosis, none of the misdiagnosed patients died or suffered major permanent harms due to diagnostic delay.
Conclusions: Patients with cerebellar hemorrhages can present with relatively unimpressive clinical findings without obvious neurological manifestations. Such individuals are sometimes misdiagnosed with gastroenteritis or other benign disorders initially, particularly when their symptoms are mild, nonspecific, and mimic more common disorders. Targeted bedside neurologic examinations might decrease the risk of misdiagnosis. Future studies should seek to validate and extend these findings in larger patient samples.

P-K-6
VERTIGO SYNDROME TRIGGERED CAVERNOUS ANGIOMA OF MIDDLE CEREBELLAR PEDUNLE. ASUNCION-PARAGUAY. 2014. CASE PRESENTATION
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Introduction: Cavernous angiomas are vascular malformations most often hidden from angiography, and

constitute from 5 to 13% of all cerebral vascular malformations. They may be single or multiple and sporadic or family regarding the presentation. Most are asymptomatic and when it described symptoms, the most common symptoms are the vertiginous crises, headache and focal neurological symptoms. The diagnostic test of choice is MRI for its ability to characterize the hemorrhagic lesion in its various stages, and/or the sequence is more sensitive gradient echo T2 empowerment. Objective: To describe a case of vertigo syndrome due to cerebellar peduncle cavernoma.

Case: Presentation 42 Man with no personal or family history of disease relevance. Came to the emergency vertigo 22 days of evolution that were accentuated in the a week before consultation, accompanied by constant vomiting and ataxia over the past 24 hours, without auditory symptoms and facial peripheral palsy and dysgeusia palsy, nystagmus evoked gaze, remaining afebrile. Suspecting a central vertiginous syndrome proceeds to cranial CT scan, which shows a lesion at the origin of the right middle cerebellar peduncle on the floor of the fourth ventricle. MRI confirmed the diagnosis of a cavernoma without signs of recent bleeding. These findings suggest, as a first diagnostic possibility, the presence of cavernous angioma located in the right middle cerebellar peduncle causing the clinical situation.

Discussion: The cavernous angiomas are vascular hamartomatous lesions, non-encapsulated and well demarcated, formed by sinusoidal vascular spaces without brain parenchyma between them. As usually are asymptomatic, their frequency is not well known. Our case is unique, sporadic lesion, without alterations in MRI studies performed to parents and the sister of the patient. His manifestation depend primarily on their location; supratentorial are usually presented as seizures, whereas infratentorial usually appear as focal, such as cranial nerve impairment, ataxia sensitivity and neurological deficits. MRI is the best imaging technique for the diagnosis and evaluation of cavernous angiomas (with high sensitivity at different stages) and its characteristic "popcorn" look as seen in our case.

Conclusion: In this case we show that with a careful medical history and examination otoneurological, differential diagnoses that may go unnoticed, and the possibility of vascular malformations in the vertiginous syndromes as a cause can be presented.

Keywords: cavernous angiomas, vascular malformations, brain stem, vertiginous syndrome.

P-K-7

PREDICTORS OF CEREBROVASCULAR CAUSES IN THE EMERGENCY DEPARTMENT PATIENTS WITH DIZZINESS: APPLICATION OF THE ABCD2 SCORE

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Objectives: Dizziness is a common presenting complaint in the emergency department(ED) that had various pathologic causes. Most of dizziness can be caused by benign origin but identifying cerebrovascular causes among ED patients with dizziness is a diagnostic challenge. We evaluated predictors of cerebrovascular causes and whether ABCD2 score would identify cerebrovascular events among ED patients with dizziness.

Methods: We analyzed 180 patients ($\geqslant$ 20 years old) with dizziness in ED, Presbyterian medical center (Single-centre prospective observational study) for 2 months. Type of dizziness, associated symptoms, past medical history, ABCD2 score (0–7), neuro-otologic examination, diagnosis were recorded.

Results: The incidence of dizziness is 3.6% (192/5374). After excluding 12 patients, 180 patients (54% female, mean 59 years) met our eligibility criteria and were included in the final analysis. Cerebrovascular causes of dizziness were found in 10% (18/180): 3 vertebrobasilar insuffiency, 9 cerebellar infarction, 1 right MCA infarction, 1 right MCA giant aneurysm, 1 lateral medullary infarction, 1 posterior limb of internal capsule infarction, 1 intracerebral hemorrhage of cerebellum. Patients with cerebrovascular cause had more hypertension, diabetes mellitus, imbalance abnormal neuro-otologic findings, ABCD2 score and.

Conclusions: Several clinical factors (hypertension, diabets, abnormal neuro-otologic findings ABCD2 scores) favored a diagnosis of central neurological causes of dizziness. ABCD2 score is a simple and easily applied tool for distinguishing cerebrovascular from noncerebrovascular causes of dizziness in ED.

P-K-8
USEFULNESS OF DHI AND MSQ IN VARIOUS VESTIBULAR DISORDERS: ARE THEY DISEASE SPECIFIC?
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Background and Objective: Dizziness handicap inventory (DHI) and Motion Sensitivity Quotient (MSQ) are used for quantifying self-perceived handicapping effects by the various vestibular diseases. These questionnaires could be used for assessing the patient's functional, emotional and physical handicap induced by disease and subjective motion sensitivity. The aim of this study is to compare DHI and MSQ among 5 different diseases such as BPPV (Benign paroxysmal positional vertigo), Meniere's disease, migraine associated vertigo, vestibular neuritis and psychogenic dizziness to see whether these questionnares are specific to any diseases.
Materials and Method: 100 patients diagnosed as 5 vestibular diseases were enrolled to this study from 2009 through 2013. DHI and MSQ questionnares were written at first visit by the patients. We also divided two groups according to the severity of DHI and MSQ score. The mild group was that DHI scores were less than 30 and MSQ scores less than 10, respectively. The moderate to severe handicap group was that DHI scores were between 31 to 100, and MSQ were more than 10, respectively.
Result: Total score of DHI, score of subgroups of DHI and MSQ scores were not different between any diseases. In addition, even though we divided into two groups according to the severity of scores, there was no difference between diseases, neither. However, there was tendency that the patients with migraine associated dizziness were higher in MSQ score than other disease groups.
Conclusión: The DHI and MSQ score were not specific to any diseases. Any vestibular disease could induce similar functional, emotional disability regardless of disease.

P-K-9
RECENT ONSET DISEQUILIBRIUM MIMICKING ACUTE VESTIBULOPATHY IN EARLY MULTIPLE SCLEROSIS
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The evaluation of patients complaining of disequilibrium needs adequate interplay of the clinical characteristics after a detailed medical history and specific vestibular testing coupled with orientated ancillary methods of neurological function and imaging. The medical history should focus on some clinical issues of symptoms the most relevant of which are the following: their duration (recent onset or chronic), the existence of identifiable vestibular antecedents (acute vestibulopathy, Meniere's disease, etc), of risk factors for dizziness (neurological, cardiovascular, visual, etc) and, whether there a disorder during gait or this is only perceived by the patient. A proper bedside vestibular examination is the key step for the selection of following tests. All this has provided increasing awareness of puzzling clinical cases of which most frequently a peripheral vestibulopathy is considered, in accordance with the pattern in their initial symptoms and signs but concludes as a central lesion after complete examination and work up; this is more frequent in stroke, but less for Multiple Sclerosis and vestibular schwannoma. We present a case in where the clinical symptoms and vestibular evaluation found some incongruities.

Poster Presentations L. Cochlear-Vestibular Testing

P-L-1
PILOT STUDY ON THE IMPACT UNILATERAL COCHLEAR IMPLANT (CI) HAS ON VESTIBULAR FUNCTION
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Introduction: Cochlear implant will allow sound and spoken voice to be perceived but the bilateral loss of vestibular function may generate severe disability in patients whose hair cells are damaged by ototoxic drugs, infections, Ménière disease or surgical trauma during cochlear implantation. It is necessary to know the impact cochlear implantation has on vestibular function in order to provide adequate information about the risks so that candidates may receive presurgical advice.
Objective: To do research on the changes in vestibular function before and after implantation in patients who suffer from different pathologies that caused bilateral deafness.

Methods: 9 patients were studied: 3 children between the ages of 5 and 9 (average 7 y.o.), three adolescents (average 15 y.o.) and two adults ages 40 and 67 y.o. 5 of them were women and 4 were men. Patients were evaluated immediately after implantation and 24 hours after it using Video Head Impulse Test (Otometricts) considering Gain of the VOR in the Horizontal Plane.
Results: Despite the simplicity of the technique, two 5 and 7 y.o. patients presented unreliable results and had to be excluded. The rest of the patients presented reliable results which showed that there was no significant variation in the Gain of the VOR in the Horizontal Plane before and after the surgery. Two patients showed normal Gains in both ears before and after CI. Four patients showed distinctly lowered bilateral Gains before and after CI. One patient showed lowered Gains in the non-implanted ear.
Conclusions: vHIT is a simple and useful test that makes it possible to quickly evaluate vestibular function, even in children. Nevertheless, the results from two young patients in our population were not reliable. vHIT made it possible to prove the presence of bilateral (in most cases) and unilateral vestibular failure (non-implanted ear in 1 case). CI did not modify previous Gains in any of the cases.

P-L-2
ROLE OF ELECTROCOCHLEOGRAPHY IN SUPERIOR CANAL DEHISCENCE SYNDROMES

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Objectives: SP/AP of electrocochleography (ECoG) is elevated not only in Meniere's disease has been reported to be increased in SCD syndrome and was consistently normalized after canal occlusion in a small cohort of patients with SCD. In this study, To understand the presenting auditory symptoms and to examine the relationship between the auditory manifestations and audiometric parameters including ECoG in superior canal dehiscence (SCD) syndrome.
Methods: Thirteen symptomatic SCD patients (1 bilateral) confirmed by temporal bone computed tomography (TBCT) and vestibular evoked myogenic potentials (VEMP) were recruited. Presenting symptoms and results of audiologic tests (audiometry, VEMP, EcoG)) were reviewed. The SCD size was measured on a reformatted image in the plane of the SC. Relationship between presenting symptoms and the bone-conduction thresholds (BC) and air-bone gap (ABG) on pure-tone audiometry (PTA) was evaluated. Audiometric parameters were also compared before and after plugging surgery in 5 patients.
Results: All 13 patients (14 ears) presented with typical auditory symptoms with or without vestibular symptom and sign. Auditory symptoms included tinnitus (93%), earfullness (79%), autophony (79%), hearing loss (43%) and hyperacusis (7%). Two patients exhibited sudden deafness at initial visit. All patients showed an ABG at 250 Hz in PTA. Nine of total 12 ears (75%) except two patients with sudden deaf demonstrated negative bone conduction thresholds at 250 Hz. Thresholds in cVEMP were lower on the affected side compared to the healthy side by 15 to 20 dB and the lowest value was 13 dB. The mean SP/AP ratio was elevated (> 0.4) in 11 of 12 tested ears and significantly higher than that among unaffected ears (0.51 versus 0.23, $p < 0.01$). A SCD size was not correlated with BC, ABG in PTA, VEMP threshold and SP/AP ratio in EcoG. Of 12 patients, 5 who underwent surgical repair experienced resolution of autophony and/or hyperacusis postoperatively and scores of VEMP, EcoG were normalized.
Conclusion: Auditory symptoms are common in SCD syndrome patients. These symptoms do not show any relationship to the presence of negative BC on PTA. No definite conclusion could be drawn regarding the association between symptoms or size with result of audiologic test. Surgical repair of the SCD results in resolution of auditory symptoms and result of test in most patients.

P-L-3
HYPEREXCITABILITY OF THE PRIMARY AUDITORY CORTEX IN PATIENTS WITH UNILATERAL HEARING LOSS AND TINNITUS. CONDUCTED AT EPFL, LAUSANNE, SWITZERLAND

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Introduction: Tinnitus, the most common hearing disorder, is characterized by the persistent hearing of ringing or other phantom sounds. In most cases, tinnitus occurs as a consequence of hearing loss which may be

the result of cochlear or vestibular disorders. Animal studies show that hearing loss leads to decreased neuronal inhibition in the primary auditory cortex (A1), and the resulting hyper-excitability of cortical neurons may generate the tinnitus perception (Engineer et al., Nature, 2011). Recent developments by our group in human functional MRI imaging now make it possible to image AI in human patients, non-invasively and with high-spatial resolution (Da Costa et al. 2011). Here, we test for A1 abnormalities in human patients suffering from tinnitus.

Objectives: To test the hypothesis that neural disinhibition and hyperexcitability occur in the primary auditory cortex (A1) in human patients with unilateral hearing loss and tinnitus.

Methods: Here we measure the blood oxygenation level dependent signal (BOLD functional MRI) using high-resolution fMRI at 7 Telsa within the auditory cortex of tinnitus patients and normal controls. Six patients with unilateral hearing loss and tinnitus were scanned, and five normal-hearing control subjects. Patients had chronic subjective non-pulsatile tinnitus associated with moderate to severe unilateral sensorineural hearing loss (SHL) with at least PTA>40dB on three consecutive frequencies between 1 and 4 KHz; SHL of cochlear or retrocochlear origin; tinnitus duration $<$ 6 months; age-adjusted normal hearing in the unaffected ear. The goal of the study is to test for aberrant responses to sound at the cortical level. Hence, the recruitment of patients with unilateral hearing loss allows us to deliver sound via the unimpaired ear, bypassing any abnormal responsiveness at the peripheral level.

Results: As in the cochlea, neurons of the primary auditory cortex are arranged in a tonotopic pattern – with neurons responsive to high frequencies on one end and to low frequencies on the other end. Identification of this tonotopic map with functional MRI allows the identification of primary auditory cortex (A1) in each individual (both left and right brain hemispheres). Our first finding is that orderly tonotopic maps were seen in all patients similar to control subjects, suggesting that unilateral hearing loss with tinnitus does not result in gross distortions of cortical tonotopic organization. Second, we find a tendency for larger response amplitudes (% BOLD signal change in response to sound) in response to low-to-middle frequency sounds in patients compared to controls. This result is similar to that previously observed in animal studies and was most apparent in those patients with the strongest tinnitus severity according to self-report (Tinnitus Handicap Inventory)

Conclusions: These preliminary results suggest that unilateral hearing loss with tinnitus is associated with hyper-excitability in human primary auditory cortex, similar to animal models. These results suggest that reduction of cortical excitability may be important to the development of treatments to cure tinnitus.

Poster Presentations M. Inner Ear Morphology, Imaging

P-M-1
PREVALENCE OF SUPERIOR SEMICIRCULAR CANAL DEHISCENCE AND OVERLYING BONE THICKNESS IN COMPUTED TOMOGRAPHY

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Objectives: Computed tomography (CT) has been used to confirm the diagnosis of superior semicircular canal dehiscence syndrome (SCDS). A consecutive series of temporal bone CT (TBCT) scans was reviewed to define the prevalence of SCDS in the temporal bone and to measure the thickness of bone overlying the superior semicircular canal.

Study Design: Retrospective CT review. Setting: Tertiary referral center.

Patients and Methods: TBCT scans (2000 ears, 1000 individuals) performed for hearing loss, otorrhea, and other otological symptoms from January 2006 to December 2008 at a tertiary referral hospital were retrospectively reviewed after approval of the institutional review board. Cases were excluded when otitis media or a tumor invaded the petrous apex or bony labyrinth. The determination of a dehiscent superior semicircular canal on CT view was by consensus. Furthermore, for the control study, additional multidetector-row CTs of 50 subjects were checked and the thickness of bone overlying the superior semicircular canal (SSC) was measured.

Results: Dehiscent-appearing SSCs were seen in 30 of 2000 ears (1.5%) on the TBCT scans. Most SSC dehiscence (SSCD) was located at the middle cranial fossa floor ($n = 22$), and others were in contact with the superior petrosal sinus ($n = 8$). The thickness of bone overlying the SSCs of the control group was measured at 1.02¡3⁄30.42 mm (mean¡3⁄3SD). The thickness of one side was proportional to that of the other side ($r = 0.62$; $p < 0.0001$).

Conclusion: The prevalence of SCDS was 1.5% in a large number of TBCTs. If a patient complains of clinical symptoms indicating SCDS, such as ear fullness, tinnitus, or Tullio's phenomenon, active tests including TBCT are necessary for a definite diagnosis.

P-M-2
RADIOLOGICAL PREVALENCE OF SUPERIOR AND POSTERIOR SEMICIRCULAR CANAL DEHISCENCE IN CHILDREN

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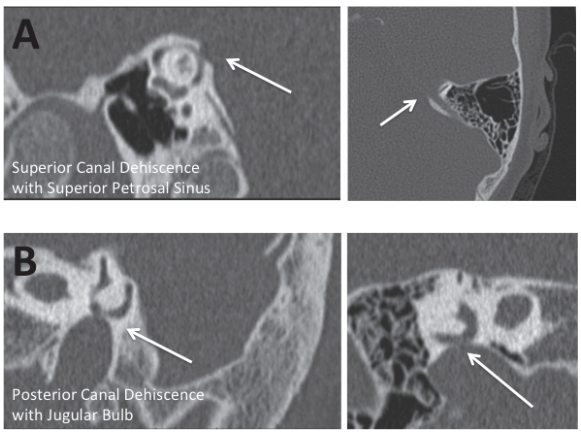
Introduction: The prevalence of canal dehiscence in the pediatric population is important for understanding the etiology of semicircular canal dehiscence syndrome and the clinical considerations for the children involved.
Methods: Retrospective analysis of all CT scans of the temporal bone in patients under the age of 18 years during a 5 year period (2007 to 2012). Images were reformatted in the plane of the semicircular canals and assessed by two independent reviewers with a third for disagreement. Detailed chart review was performed for those subjects found to have dehiscence.
Results: 649 temporal bones were assessed from 334 patients. The prevalence rate of superior canal dehiscence (SCD) was 1.7% (3.3% of individuals). Posterior canal dehiscence (PCD) was present in 1.2% (2.1% of individuals). There were no cases of bilateral SCD, and one case of bilateral PCD. Age under 3 years was associated with a higher prevalence of thinning but not dehiscence. Congenital inner ear malformation was not related to a higher probability of dehiscence. The superior petrosal sinus was anatomically associated with the SCD in three cases (27.3%). Retrospective chart review highlighted possible vestibular symptoms in three of the 11 patients with SCD (27.3%) of whom one also had bilateral PCD. The other seven patients with PCD did not have any vestibular symptoms recorded.
Conclusion: This forms the largest pediatric study of canal dehiscence to date. The prevalence rate was significantly lower than previous reports, where the true rate may have been overestimated by imaging limitations and study design. The identified association with overlying venous structures may reflect the etiological process involved. The presence of canal dehiscence in children supports the hypothesis of a congenital predisposition for development of canal dehiscence syndrome.



Poster Presentations N. Vestibular Loss

P-N-1
VISUAL DEPENDENCE AND DIZZINESS AFTER VESTIBULAR NEURITIS IMPERIAL COLLEGE LONDON

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Symptomatic recovery after acute vestibular neuritis (VN) is variable, with around 50% of patients reporting long term vestibular symptoms; hence, it is essential to identify factors related to poor clinical outcome. Here we investigated whether excessive reliance on visual input for spatial orientation (visual dependence) was associated with long term vestibular symptoms following acute VN. Twenty-eight patients with VN and 25 normal control subjects were included. Patients were enrolled at least 6 months after acute illness. Recovery status was not a criterion for study entry, allowing recruitment of patients with a full range of persistent symptoms. We measured visual dependence with a laptop-based Rod-and-Disk Test and severity of symptoms with the Dizziness Handicap Inventory (DHI). The third of patients showing the worst clinical

outcomes (mean DHI score 36–80) had significantly greater visual dependence than normal subjects (6.35° error vs. 3.39° respectively, $p = 0.03$). Asymptomatic patients and those with minor residual symptoms did not differ from controls. Visual dependence was associated with high levels of persistent vestibular symptoms after acute VN. Continued over-reliance on visual information for spatial orientation may be one mechanism that impedes recovery.

P-N-2
BALANCE IS IMPAIRED IN CHILDREN WITH UNILATERAL DEAFNESS

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Purpose: Maintaining balance relies on the integration of visual, somatosensory and vestibular inputs with appropriate estimation of head and body position in space. It is well known that children with bilateral profound deafness frequently have impaired vestibular function which leads to poor balance. Our goal was to determine if children with unilateral deafness demonstrated similar impairments in balance function.
Methods: Balance was assessed in 24 children (13 unilateral deafness and 11 normal hearing) using the Bruininks-Oseretsky Test of Motor Proficiency(BOT2) in a "real-world" virtual-environment at the Challenging Environmental Assessment lab. Light-emitting markers measured angular movements of the head and trunk and center of pressure was measured using forceplates lining the floor. Postural control during BOT2 Task 1 (tandem stance with eyes open) was quantified and compared.
Results: Balance ability as measured by the BOT2 score was significantly worse in children with unilateral deafness compared to normal hearing controls ($P = 0.015$). Children with unilateral deafness also demonstrated significant differences in the manner in which they moved their head during balance related tasks. Specifically they reached their maximum head pitch angle ($P = 0.022$) and maximum head roll angle ($P = 0.030$) significantly faster than normal hearing controls.
Conclusion: Children with unilateral deafness show poorer balance skills than normal hearing controls. Head control is of major importance for maintaining balance and children with unilateral deafness display rapid maximal displacement of their heads, limiting their stability. This may point to deficits not only in the hearing but also the vestibular portion of the inner ear.

P-N-3
CLINICAL CHARACTERISTICS OF THE PATIENTS WITH PERILYMPHATIC FISTULA

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Introduction: The perilymphatic fistula (PLF) is characterized by an impaired balance and fluctuating hearing. Though the pathogenesis of PLF may be categorized as either congenital or acquired, most of that is acquired. PLF, however, is difficult to diagnose because the history of patients is similar to that of patients with Meniere's disease. In the previous studies, the power of clinical tests has been discussed to diagnose the PLF correctly.
Objectives: The aim of this study is to draw the characteristics of the patients with perilymphatic fistula.
Materials and Methods: We recruited forty-nine subjects with a diagnosis as suspected perilymphatic fistula. They were referred to our department in Kyushu University Hospital from January 2007 to August 2013. These patients were divided to three groups: operated patients with true fistula (group I), operated patients missing fistula (group II) and patients who did not want to be operated (group III). Their history was checked in detail. The vestibuloauditory function was clinically tested by a caloric test, vestibular evoked myogenic potential, statokinesigraphy and pure-tone auditometry.
Results: Half of patients were diagnosed as perilymphatic fistula over six months after onset. The triggers were trauma, barotrauma, nose-blowing and ear operation, but that was unknown in 49% of patients. Eighty-four percent of patients had an impaired equilibrium including vertigo, dizziness and their combination. The fistula phenomenon was checked in 39 patients and 64% of those showed positive reaction. Over half of patients had a remaining caloric response and one-third of patients had a high Romberg's quotient in statokinesigraphy.
Conclusions: These results suggest that the check of fistula phenomenon may be very important in the clinical tests.

P-N-4
ACUTE PERIPHERAL VESTIBULAR ASYMMETRY – A NEW DISEASE ENTITY?
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Introduction: Acute vestibular syndrome (AVS) is characterized by the rapid onset of vertigo, nausea, vomiting, gait unsteadiness and nystagmus lasting days to weeks.
Objectives: We report the patients mimicking vestibular neuritis without central lesion and diagnose the cases as "acute peripheral vestibular asymmetry."
Methods: We retrospectively reviewed the patients who were diagnosed with vestibular neuritis between 2010 and 2013. Among them, five patients showed different findings compared to vestibular neuritis without central lesion. We analyzed the patients' clinical features, clinical course, and vestibular testing.
Results: All patients showed spontaneous nystagmus continuing for a few days. However, head impulse test did not reveal a corrective saccade detected in vestibular neuritis. Magnetic resonance imaging (MRI) of the brain showed no abnormal lesion. The bithermal caloric test revealed directional preponderance without canal paresis. The slow harmonic test of rotary chair revealed unilateral high gain and phase within normal range, but the significant asymmetric response was found.
Conclusion: We described the cases as "acute peripheral vestibular asymmetry," which defines negative head impulse test and normal caloric response with spontaneous nystagmus. Our report offers useful information regarding the peripheral lesion underlying AVS.

P-N-5
CIRCADIAN RHYTHMS EXPLORATION IN PATIENTS WITH BILATERAL VESTIBULAR LOSS
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Objective: The vestibular system encoding head rotation velocity, linear acceleration and gravity level has recently been highlighted as a potential non-photic time cue for the circadian system when stimulated by centrifugation or after vestibular loss in rodent. However, it is still unknown in what extend it might interact with circadian rhythms in humans. This study explored the sleep/wake cycle and circadian rhythms in 9 people suffering from Bilateral Vestibular Loss (BVL). 9 matched control subjects has been recruited but did not complete the study yet.
Method: The sleep/wake cycle was recorded during 15 days at home by actigraphy. Temperature, grip strength and salivary cortisol concentration were then measured each 3 hours from 06:00 am to 09:00 pm. Core temperature was also recorded continuously with an ingestible pill during a 24 hours period. Circadian parameters were estimated by the COSINOR method and compared with an RM ANOVA.
Results: Sleep parameters indicated poor sleep efficiency in BVL patients (77.7 $\pm$ 10.04%) with 1:04 $\pm$ 00:34 of nocturnal wake and a total sleep time of 6:00 $\pm$ 1:20. Circadian temperature values recorded at 06:00 am (36.60 $\pm$ 0.35°C) were significantly lower ($p < 0{,}001$) than those recorded during all other test sessions. The temperature peak to peak amplitude and mesor were respectively of 0.85 $\pm$ 0.22°C and 36.97 $\pm$ 0.14°C, with an estimated acrophase at 04:48 pm $\pm$ 2:19. Salivary cortisol concentration was significantly higher at 6:00 am (254.4 $\pm$ 211.8 ng.ml-1) than at the other sample hours ($p < 0.002$). Handgrip strength did not present significant circadian rhythm.
Conclusion: BVL patients seem to present marked circadian rhythms of temperature with a slightly anticipated peak. Important inter-individual variations compared with classical recorded values of temperature and salivary cortisol coupled with the poor sleep quality suggest a circadian disturbance linked to the BVL. Measurements obtained in the paired-aged control group are necessary to confirm this hypothesis.

P-N-6
THE IMPORTANCE OF VESTIBULAR INFORMATION FOR MOTOR LEARNING – USING OPTIMAL CONTROL THEORY TO EXPLAIN GAZE SHIFT BEHAVIOUR IN BILATERAL VESTIBULOPATHY
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Introduction and objectives: Vestibular information is well known to be important for gaze stabilization via on-line feedback control. Here, we assessed its impor-

tance for feedforward motor learning, i.e., the ability to choose optimal movement parameters that minimize variability during active eye-head gaze shifts.
Methods: We used an optimal control model with which we had shown that healthy subjects adjust motor commands to minimize endpoint variability also when movements are experimentally altered by an increase in the head moment of inertia. We now increased the head inertia in five patients with chronic complete bilateral vestibular loss (aged 45.4 $\pm$ 7.1 years, mean $\pm$ SD) as well as in ten healthy controls (aged 39.7 $\pm$ 6.3 years) while they performed large (75° and 80°) horizontal gaze shifts towards briefly flashed targets in darkness and, using the model, compared their gaze shift parameters to the expected optimal movements with increased head inertia.
Results: We found that – in contrast to healthy subjects – vestibular-loss patients could not optimize any gaze shift parameter with increased inertia. Their gaze shifts were highly variable and suboptimal.
Conclusions: We conclude that vestibulopathy leads to gaze variability not only due to deficient online gaze control but also a failure in motor learning due to missing error signals. The fact that vestibular information is relevant for motor learning suggests that patients with incomplete vestibulopathy should be advised to actively move their heads whenever appropriate so that error signals can be used to shape the motor command and optimize gaze shifts trial-by-trial.

P-N-7
OUTCOME OF SURGERY IN PATIENTS WITH EQUILIBRIUM DISORDER INDUCED BY PERILYMPHATIC FISTULA
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Introduction: The perilymphatic fistula (PLF) is an abnormal communication between the inner ear and middle ear. As the results after the rupture of oval or round window membrane, PLF is characterized by an impaired balance and fluctuating hearing. When symptoms are sustained, operation is selected to vanish them. General evidences show that balance is likely to recover after surgery and that the hearing level is likely to recover in early phase but not in late phase.
Objectives: The aim of the present study is to validate the postoperative outcome of the equilibrium and hearing.
Materials and Methods: We recruited forty-nine subjects with a diagnosis as suspected perilymphatic fistula. They were referred to our department in Kyushu University Hospital from January 2007 to August 2013. Twenty-two patients had a surgery in our hospital, while twenty-seven patients did not want to be operated. Surgery was done as below: 1. Lateral tympanotomy with preserved chorda tympani, 2. Seeing both windows for thirty minutes, 3. Covering both windows with fascia removed temporal muscle. The history and the clinical course after surgery were collected in detail from the patients.
Results: The fistula was found during operation in over eighty percent of patients. Half of fistula was found in the oval window and another half was in the round window. The impaired equilibrium disappeared after surgery in approximately ninety percent of patients.
Conclusions: These results suggest that an operation may be very useful to control the abnormal vestibular symptom.

Poster Presentations O. BPPV

P-O-1
BALANCE AFTER CANALITH REPOSITIONING MANEUVER IN BPPV
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Introduction: During bouts of BPPV most patients complain disequilibrium and unstable gait, demonstrable by posturography or other balance tests, and improve after canalith repositioning maneuver (CRM). Motion sickness a common vestibular symptom, found in about 50% of the migraneurs, has not been investigated in BPV patients and might impact on residual dizziness and recovery.
Objective: To examine the subjective complaints, balance and gait performance before and after Epley maneuver and to determine the factors on recovery.
Methods: Balance was investigated in 57 posterior semicircular canal BPPV patients before and after Epley maneuver. The perception of vertigo was estimated with Visual Analogue Scale (VAS), gait performance with Dynamic Gait Index (DGI). Balance performance was assessed with the modified Clinical Test of Sensory Integration and Balance (mCTSIB). All patients were reassessed 1 week after and Epley maneuver was

repeated if the positioning test was still positive. If the patient complained about residual dizziness after 1 week, Brandt-Daroff habituation exercises were recommended as a home program. When remission was confirmed the patients called after 1 month to repeat all tests

Results: All patients VAS scores were improved 1 month after Epley maneuver. Recurrence occured in 14 patients. Thirty patients reported residual dizziness. The balance performance was abnormal before Epley maneuver in foam stance conditions and improved after Epley maneuver. The most difficult stance, on foam with eyes closed and head extended, was abnormal in up to 50% patients. DGI scores of patients improved without statistical difference. Migraineurs had more severe complaints of imbalance and motion sickness.

Conclusion: Subjective complaints, balance and gait abilities improved in all patients. The recurrence rate, residual dizziness and motion sickness complaints were higher in migraineurs. The migraineurs also had a worse performance on mCTSIB than non-migraineurs before as well as after Epley maneuver. Brandt-Daroff exercise didn't prevent recurrence and residual dizziness.

P-O-2
BENIGN PAROXYSMAL POSITIONAL VERTIGO: IMPAIRMENT AND ACTIVITY LIMITATION LEVELS AS SEQUELS IN PATIENTS REFERRED TO VESTIBULAR REHABILITATION

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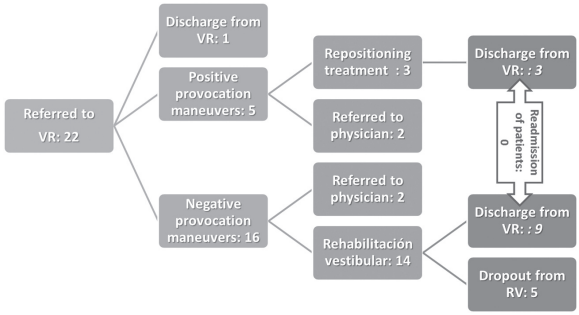
Background: Benign paroxysmal positional vertigo (BPPV) is the most common cause of vertigo. Repositioning treatment is an effective therapy in 90% of cases, being Brandt- DaroffĄLs exercises or modified Epley procedure used when these maneuvers fail. These approaches in general improve dramatically the condition, though register as sequels: in 66% of cases residual dizziness and in 8–14% of cases imbalance. While residual dizziness disappears within 3 months without specific treatment, imbalance is the motive described for derivation to vestibular rehabilitation for the BPPV after the repositioning treatment In our setting, BPPV after repositioning treatment is usually referred to vestibular rehabilitation (VR).

Purpose: To describe health condition and evolution of patients referred to VR after repositioning treatment.

Methods: Descriptive investigation of 22 consecutive BPPV after repositioning treatment outpatients, CABA residents, during 2013. After medical intervention, they were examined by physical therapist who evaluated the impairment and activity limitation levels. After that, he/she decided the physical therapy approach: admission to VR, repositioning treatment, referred to physician, discharge from VR. Statistics: meanĄ}SD, paired t-test, $f¿ < 0.05$.

Results: Of the 22 patients, 63% were women, aged 58.8Ą}13.5 years, 81.8% occupationally active, 27.3% history of neuro-otologic disorders, 40% medicated with anti-vertigo or anxiolytic drugs, 13.6% had previously done VR. Time of evolution was 6.68Ą}7.5 months, 31.8% had less than 3 months of evolution. The circuit that the patients followed was the following one:



– Health condition (ICF): All patients presented a positive neuro-otologic sign: Impairment level: positional vertigo 63.6%, dizziness 45.5%, Fukuda 40.9%, vestibular dysfunction pattern (mCTSIB) 36.4%, instability/autonomic/nystagmus 31.8%, Babinski Weil 27.3%. Imbalance 18.2%. Activity limitation level: Dizziness Handicap Inventory (DHI) 33.7, with moderate physical predominance (11.4, moderate). Functional Gait Assessment 24.7, without risk of falling. – Patients referred to physician: 2 cases for atypical response to provocation maneuver, 2 cases for neurological central signs. – Patients with positive provocation maneuvers: 3 compatible cases with posterior canal canalithiasis were treated and resolved with the appropriate repositioning maneuver. Readmissions: 0 case. – Patients admitted to VR: 14. They did 6.4Ą}3.4 habituation/gaze stabilization/balance training sessions; 5 dropout from RV. 100% had total remission of impairments, DHI had a mean decline of 18.25 points ($p = 0.009$). 50% of these patients had less than 3 months of evolution. Readmissions: 0.

Conclusions: The imbalance was not the main found sequel, but it was the positional vertigo and dizziness

with moderate activity limitation. These sequels were a positive development although this could not be attributed to our intervention because patients were referred to VR within the times in which spontaneous remission was expected. As BPPV after repositioning treatment, we received patients with possible involvement of the central nervous system and others who were an unresolved or new episode of BPPV.

P-O-3
FOUR TYPES OF HORIZONTAL CANAL POSITIONAL VERTIGO AND EFFICACY OF THE CLASSIFICATION

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Introduction: Benign paroxysmal positional vertigo (BPPV) is well known as posterior semicircular canal type showing rotatory nystagmus on the Dix-Hallpike maneuver. On the contrary, direction-changing positional nystagmus (DCPN) is also well reported as the horizontal canal type BPPV recently. But the nystagmus of this type is thought to be a relatively new disease concept and the enough consensus of its pathophysiology and treatment is not obtained necessarily. Ichijo classified horizontal canal positional vertigo into three types. Each had DCPN without evidence of neurologic disease. Nystagmus patterns were classified into these three types: 1) persistent apogeotropic type (nystagmus lasts more than one minute and the nystagmus in the supine position ceases when the head is turned to the affected ear by 20–40 degrees where is called "neutral position"), 2) persistent geotropic type (nystagmus lasts more than one minute and has also "neutral position"), 3) transient geotropic type (nystagmus decays and stops within 30 seconds). Besides, we added a case of transient apogeotropic type (nystagmus decays and stops within 30 seconds) and reclassified it into four types.
Objectives: The purpose of this study was to describe the details of four types of DCPN and discuss each pathophysiological mechanism and treatment. Methods: We conducted retrospective case study in 50 patients (26 males, 24 females; mean age, 66.4 years; range, 30–94 years) with DCPN. Positional nystagmus was examined using an infrared camera (installed in goggles) or Frenzel glasses.
Results: We could classify 50 patients into four types. 1) Persistent apogeotropic type 11 patients (6 males, 5 females) showed this type DCPN. Pathophysiology of this type was thought to be cupulolithiasis or "heavy cupula" in the unilateral horizontal semicircular canal (HSCC). By rolling (yaw rotation), 3 cases of this type changed to transient geotropic type and barbecue rotation (Lempert maneuver) and forced prolonged position (FPP) were effective. 2) Persistent geotropic type 10 patients (4 males, 6 females) showed this type DCPN. Pathophysiology of this type was thought to be controversial "light cupula" due to the specific gravity of the endolymph in the unilateral HSCC. Prognosis of this type was good without any canalith repositioning maneuver. 3) Transient apogeotropic type 5 patients (2 males, 3 females) showed this type DCPN. Pathophysiology of this type was thought to be canalolithiasis with the debris within the anterior part of the unilateral HSCC. In our cases, however, a transformation from apogeotropic DCPN into geotropic DCPN was not observed before nystagmus completely disappeared. We speculate that the free floating otoconia was located in the ampulla region on the utricle (vestibular) side. Therefore, rolling (yaw rotation) and FPP are considered to be an effective maneuver. 4) Transient geotropic type 24 patients (14 males, 10 females) showed this type DCPN. Pathophysiology of this type was thought to be canalolithiasis with the debris within the posterior part of the unilateral HSCC. This type had a majority among the four type and barbecue rotation (Lempert maneuver) and FPP were effective.
Conclusions: Horizontal canal type BPPV shows various types of DCPN and each have different pathophysiology and different treatment. Our classification may be extremely significant for considering their pathophysiology which remains to be fully elucidated.

P-O-4
THE EFFICACY OF MODIFIED DIX-HALLPIKE TEST (SHOULDER ON THE PILLOW TEST) IN PATIENTS WITH POSTERIOR CANAL BPPV

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Introduction: Dix-Hallpike test (DH test) is a definite diagnostic maneuver used to confirm posterior canal BPPV. However, the patient needs to endure the dizziest moment while going through this maneuver, head hanging in the air for 30 seconds only supported by the

hands of an examiner. This frightening experience often leads to a poor cooperation from the patient part, while the examiner suffers an arm pain and backache from holding onto the patient's head. Another drawback of this maneuver is that the maneuver cannot be done on beds with a headboard, making the examination difficult for confined patients.

Objectives: The authors designed a modified Dix-Hallpike test (shoulder on the pillow test) that can be conducted with a head on the bed, and evaluated its usefulness in this study.

Method: Patients with suspicious BPPV from a detailed history taking were enrolled in this study. The first group went through a standard DH test first, then the modified DH test; the second group, in reverse order. Each patient was assigned to a group by a randomized single blind manner. Two tests were conducted in 5-minute interval, and the patient rated level of discomfort, pain, and anxiety in 0 to 10 scales after each test. The diagnostic outcome of BPPV and the subjective rating were statistically analyzed. Only data of definite vertical canal BPPV was used in the analysis.

Results: During the study period of year of 2013, February 7th to March 14th, the total number of patients included in the study was 55. The male patients were 13, female, 42; the average age was 54.1¡3/3314.0 (16yrs∼78yrs). The number of "A group" patients, which went through a standard test first then the modified test, was 26, and the "B group", in reverse order, was 29. 20 patients from the study were diagnosed as vertical canal BPPV, 19 were posterior canal BPPV, and 1 was anterior canal BPPV. The side of the lesion was the right side, 5, and the left side, 15. Out of 20 patients who were diagnosed as vertical canal BPPV, 19 showed a positive result during a modified DH test, and 17, during a standard DH test. The effectiveness of two tests was not statistically different by the McNemar test. Analysis of the survey showed that although the patients felt less discomfort, pain, and anxiety during the modified DH test, it was not statistically significant from the standard test.

Conclusion: The modified DH test may reduce discomfort, pain, and anxiety of the examinee while showing a same diagnostic rate of a standard DH test. Because modified DH test can be conducted regardless of any bed type, it may be useful in the situation where standard DH test cannot be conducted.

P-O-5

DIAGNOSIS OF BENIGN PAROXYSMAL POSITIONAL VERTIGO BY HISTORY TAKING

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Introduction: Patients with benign paroxysmal positional vertigo (BPPV) usually have typical history. They usually complain of vertigo that lasting a few seconds to a minute. It usually occurs in the morning after awaking and provoked by typical positional change such as head turning, sitting, and lying down.

Objectives: However, some patients may describe their vertigo in a rather atypical way, so there is no absolute reliability of a diagnosis based on history taking. To evaluate the reliability of a diagnosis based on history taking, we performed prospective studies.

Methods: We obtained structured history from all the patients with BPPV. Total of 408 patients were diagnosed as having BPPV. The diagnosis was based on typical findings of vertigo and nystagmus by Dix-Hallpike maneuver and head turning in supine position.

Results: Duration of vertigo was more than 10 minutes in 22% of patients. Position-precipitating factors were not spontaneously reported by 37%. 16% of patients complained non-spinning vertigo. 38% of patients could not tell the side to which the spell occurs. In 83 cases (20%), it was impossible to diagnose BPPV based upon a typical history.

Conclusions: We conclude that non-paroxysmal, non-positional vertigo dose not rule out BPPV. The provocation test is mandatory in those complaining of dizziness regardless of history since BPPV can be quickly diagnosed by provocation test and easily treated.

P-O-6

BPPV. COULD THYROID HYPOFUNTION TRIGGER IT? ASUNCION-PARAGUAY. 2014. EXPERIENCE

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Introduction: In 1921, Barany was the first to link to otolithic BPPV pathology. Today it is considered the most common cause of vertigo. It is most prevalent among 50 to 60 years. Its etiology is often unknown, The symptoms are caused frequently by canalolitiasis. Usually on the Posterior Semicircular Channel and less frequently in the lateral channel and rarely in the

superior semicircular channel. Occasionally it may be associated with previous vestibulopathies or cephalic trauma. Hypothyroidism characterized by decreased thyroid function, has incidence of 1 in 1,501 newborns in Paraguay. Both entities are common and thyroid hypofunction is an endemic disease in Paraguay due to lack of iodine in the salt (Mediterranean countries), we decide to find the relationship between both entities.
Objective: *Describe the relationship or not thyroid hypofunction with Benign Paroxysmal Positional Vertigo.
Material and method: A descriptive, observational study of transverse, retrospective. Inclusion criteria and patients attended at ENT consultation, between 2012 and 2013, diagnosed with BPPV without concomitant disease, a thyroid profile that was requested. Exclusion: incomplete medical records.
Main results: The study included a total of 100 patients of whom 79 (79%) were female and 21 (21%) for male. The age was between 50 and 70 years with 48 patients (48%). The main symptoms reported were: 99 patients (99 %) Had vertigo, followed by tinnitus present in 7 patients (7%). The posterior semicircular canal is most often affected with 96 patients (96%), 60 of which were on the right side (62.5%). Thyroid profiles yielded the following results: normal profile in 73 patients (73%) and altered in 27 patients (27%) (elevated TSH and T3, T4 low). Regarding improvement, 95 patients (95%) are asymptomatic after reposition maneuvers. The rest of the patients required more than one session.
Conclusions: Benign Paroxysmal Positional Vertigo is a very frequent reason for consultation. The history and the maneuvers are critical for diagnosis. PSC is most affected and is confirmed with Dix and Hallpike maneuver. LSC (McClure maneuver) and SSC are very infrequent. Large number of patients diagnosed with BPPV only presented altered thyroid profile, this may be a condition to be considered in the etiological to this entity.

Keywords: Benign Paroxysmal Positional Vertigo, Hypothyroidism.

P-O-7
EFFECTIVENESS OF REPEATED CRP ON THE TREATMENT OF POSTERIOR OR LATERAL CANAL CANALOLITHIASIS MIRAE ENT CLINIC SEOUL SOUTH KOREA

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CRPs(Epley and BBQ rotation maneuver) for the posterior or lateral canal canalolithiasis are effective treatment. However, guidelines about numbers of the procedures in each visit are lacking. The authors performed this study to confirm the effectiveness of repeated CRP in a visit on the treatment result of canalolithiasis by comparing with the result of single cycle CRP. We analyzed the numbers of visit to get CRP in the patients with posterior or lateral canal canalolithiasis from August 2001 to October 2013. CRPs were done in single cycle in a visit from 2001 to 2005 (group A) and repeatedly until the nystagmus was converted negatively from 2006 to 2013 (group B). In every follow up, the same manner of procedure was applied respectively in the two groups if there was residual nystamus. Among the total 1224 patients, there were 392 male and 832 female patients, and 870 posterior canal and 354 lateral canal involvements. Group A was 451 and group B was 773. The numbers of visit to get CRP were compared in the two groups of each canal by log rank test in Kaplan Meier survival curve function. In lateral canal canalolithiasis patients, repeated CRP was more effective than single cycle CRP ($p = 0.001$). In posterior canal canalolithiasis patients, the difference between the two groups was not statistically significant ($p = 0.074$). Repeated CRP in a visit is more effective treatment than single cycle CRP in lateral canal canalolithiasis while it is not in posterior canal canalolithiasis.

P-O-8
RISK FACTORS FOR REPEATED CANALITH REPOSITIONING PROCEDURES TO RESOLVE THE POSITIONAL VERTIGO IN PATIENTS WITH BPPV

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Background and Objectives: Benign paroxysmal positional vertigo (BPPV) can be treated successfully with canalith repositioning procedure (CRP) according to the subtypes. The aim of this study is to evaluate the clinical factors affecting the treatment outcomes of CRP performed on a daily basis.
Methods: Two hundred and nineteen patients were diagnosed to BPPV and underwent CRP from March 2011 to February 2012. Diagnosis of BPPV was confirmed with the nystagmus during provocative (Dix-Hallpike and head roll) tests. All patients were treated with an appropriate CRP at diagnosis and followed up

on a daily basis. If the patients show positive provocative test at follow-up, CRPs were repeated daily until symptom and nystagmus disappeared. The total number of maneuvers needed was analyzed and any risk factors (hypertension, diabetes, headache, otitis media, Meniere's disease, involved canals, duration of symptom) for repeated maneuvers were identified.
Results: Posterior canal BPPV was the most common (134, 61%) and their mean number of CRP was 1.7. Horizontal canal canalolithiasis was the second most common (48, 22%) and needed 1.6 CRPs. Horizontal canal cupulolithiasis (24, 11%) needed 2.8 CRPs and multiple canal BPPV needed 5.8 CRPs, which were significantly higher compared to posterior canal BPPV ($p < 0.05$). Superior canal BPPV was rare (4, 2%) and needed 1.8 CRPs. Mean number of CRPs (2.7) in the patients who had duration of symptom longer than 1 month was higher than that (1.8) of those who had within a week ($p = 0.002$). The patients who had history of Meniere's disease needed 2.3 CRPs, which was higher than that (2.0) without Meniere's disease.
Conclusion: BPPV could be treated successfully with appropriate CRP. The involved SCC, duration of symptom and history of Meniere's disease were risk factors for repeated CRP needed.

P-O-9
DIFFERENCE IN LEVEL OF RESPONSE TO MANOEUVRES BETWEEN IDIOPATHIC AND SECONDARY BENIGN PAROXYSMAL POSITIONAL VERTIGO (BPPV)

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Background: BPPV is the most frequent pathology assisted in our balance center. It is caused by the movement of misplaced calcium carbonate crystals (otoconia) in the semicircular canals of the inner ear, which stimulate abnormally the cupula receptors. The most common cause of BPPV is idiopathic. However secondary BPPVs are those cases with objective evidence of inner ear or brain disease.
Patients and Methods: 2390 medical records were reviewed for a four-year period (June 2008–July 2012). A total of 715 patients with posterior SCC BPPV (positive Dix-Hallpike manoeuvre) were found. All other subtypes of BPPV (horizontal SCC BPPV $n = 255$; anterior SCC BPPV $n = 51$) were excluded. We used Epley's canalith repositioning treatment (CRT) because of physician familiarity with this procedure. A patient was considered cured when was free of symptoms from the last CRT and Dix-Hallpike manoeuvre was negative during the next medical appointment 7 days later.
Patients and Methods: 2390 medical records were reviewed for a four-year period (June 2008–July 2012). A total of 715 patients with posterior SCC BPPV (positive Dix-Hallpike manoeuvre) were found. All other subtypes of BPPV (horizontal SCC BPPV $n = 255$; anterior SCC BPPV $n = 51$) were excluded. We used Epley's canalith repositioning treatment (CRT) because of physician familiarity with this procedure. The patients were adviced to stay upright during the next 48 hours after the treatment. A patient was considered cured when was free of symptoms from the last CRT and Dix-Hallpike manoeuvre was negative during the next medical appointment 7 days later.
Statistical analysis: We used t Student test. Results: From a total of 715 patients with posterior SCC BPPV, in 195 of them (120 females and 75 males) we found a clear cause of BPPV and 520 of them were idiopathic cases (365:155 F:M). We included migraine cases in the idiopathic group because of the high prevalence of both pathologies. 60 years old (23–87) was the mean age for the secondary BPPV group and 65 years old (29–81) for the idiopathic BPPVs. The difference wasn't statistically significant ($p > 0{,}05$). The average of CRT required for the resolution of the problem was 1,64 for the idiopathic group with 50% of success during the first manoeuvre and 2,57 for the secondary group with 10% of success in the first manoeuvre. The difference was statistically significant ($p = 0{,}0083$).
Conclusions: – Secondary causes of BPPV are frequent and they should always be investigated in every typical BPPV patient. – Secondary BPPV required more number of CRT than idiopathic cases: 2.57 vs. 1.64 ($p = 0.0083$ test t de Student) – We found a significative female preponderance (2,1: 1 F:M) in both groups; but even more significative for the idiopathic cases (2,35:1) than for secondary BPPVs (1,6:1).

P-O-10
ANTERIOR CANAL BENIGN PAROXYSMAL VERTIGO IN PRACTICE: WHERE DOES IT COME FROM AND WHERE DOES IT GO?

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Introduction: Anterior canal benign paroxysmal positional vertigo (AC-BPPV) unlike Posterior canal BPPV (PC-BPPV) has a wide range of prevalence. This variability in frequency is poorly understood, since PC-BPPV is largely stable. From the geometry of the ear, it would seem likely that AC-BPPV might arise as a complication of the Epley maneuver. The most important differential differential diagnosis of AC-BPPV is central positional vertigo.
Objectives: To investigate the frequency and origin of the AC-BPPV. To evaluate how probable is the theory that the AC-BPPV results from the Epley Maneuver.
Methods: Study Design: Retrospective chart review. Setting: Secondary referral center. Patients: We identified 1075 BPPV patients including 66 (6.1%) with AC-BPPV. Sixty of the AC-BPPV patients were followed up after a canalith repositioning procedure.
Interventions: Medical records of all AC-BPPV patients were reviewed. Vestibular examinations included all positional tests and head hanging test. Cranial magnetic resonance imaging and a neurological exam were routinely performed to rule out CNS disease (pseudo AC-BPPV). Patients with positional vertigo exhibiting brief positional down-beating nystagmus in positional tests (Dix-Hallpike and head-hanging position) were initially diagnosed with AC-BPPV. The diagnosis was confirmed by resolution of vertigo and nystagmus after canalith repositioning procedure(CRP). The canalith repositioning procedure previously described by the authors to treat AC-BPPV [1] was performed after the initial diagnosis. "De novo" AC-BPPV was defined as patients without history of vertigo. "Canal switch" were patients that remained symptomatic after CRP for other canals and the typical positional downbeat nystagmus was identified. "Non-related" were those cases with AC-BPPV and a history of BPPV without temporal relationship.
Results: Of all AC-BPPV, De novo cases occurred in 25 (37.8%), and non-related in 18 (27.2%). Canal conversion from others canals to anterior canal semicircular was observed in 23 (34.8%). All but 1 occured after the Epley Maneuver. Of all 60 patients initially diagnosed with AC-BPPV treated with CRP and followed up, 41 (68.3%) resolved after 1 to 3 maneuvers, 19 (31.6%) switched to others canals (to posterior canal BPPV in 18 and to horizontal canal in 1) at a follow-up visit. In 2 (3.3%) of 60 patients a "double canal switch" (posterior to anterior to posterior) occurred.
Conclusions: Canal conversion from other canals to anterior semicircular canals explains about 1/3 of all case of AC-BPPV. Similarly, a canal switch after AC-BPPV treatment is frequent. De novo AC-BPPV is a rare condition, but the frequency of AC-BPPV increases substantially if a BPPV history is present. These features should be considered to differentiate between central and peripheral downbeat nystagmus and vertigo.

P-O-11
THE AFFECTED SIDE OF HORIZONTAL CANAL BPPV AND THE LATERALITY ON PURE TONE AUDIOGRAM

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Introduction: Benign paroxysmal positional vertigo (BPPV) is the disease developing vertigo by taking a certain head position, and the clinicopathological condition is associated with the otolith detached from the utricle. It is understood that the cupulolithiasis is caused by the otolith attaching to the cupula of the semicircular canal, and as the canalolithiasis is caused by the otolith moving in the semicircular canal. BPPV associated with horizontal semicircular canal is considered as horizontal canal BPPV (HC-BPPV) recently. Generally these hearing threshold levels are mostly normal or symmetrical, so we couldn't see the laterality on pure tone audiogram. However, we sometimes encounter HC-BPPV with unilateral sensorineural hearing loss and the laterality on the audiogram. Here we report the cases of HC-BPPV which had already had unilateral hearing disturbance diagnosed in our hospital and discuss the pathophysiology of HC-BPPV.
Methods: We examined 35 patients (16 males and 19 females) who came to our department with vertigo, diagnosed as HC-BPPV cases at the time of the first visit, and were able to perform the pure tone audiometry at the same time between October 2005 and December 2013. We categorized the cases into four groups depending on the direction of nystagmus (apogeotropic and geotropic direction-changing positional nystagmus) and the duration (persistent type which lasts over 1 minute and transient type which is around 30 seconds). We observed the nystagmus by using Frenzel's glasses. In the cases of transient type we decided the affected side was that to which the stronger nystagmus (right lateral or left lateral position) beat and in the ones of persistent type we decided the affected side was that to which the "neutral position" (where the positional nytagmus stopped) was deviated. When the

audiogram threshold level (bone conduction) elevated more than 20dB of one or more frequencies of the five (250, 500, 1 k, 2 k, 4 kHz) between both ears, we judged that as the laterality on the audiogram and regarded the side in which the threshold elevated as the affected side of the audiogram.

Results: We could classify all the HC-BPPV cases with the laterality on the audiogram into three groups. In each group, we also defined them as the "ipsi-lateral case" when the affected side judged by nystagmus and the one by audiogram were the same. When they were different, we defined as the "contra-lateral case". (1) There was no laterality on the audiogram in all cases of the transient direction-changing apogeotropic type. (2) All the four cases of transient direction-changing geotropic type (canalolithiasis) with the laterality on the audiogram were the ipsi-lateral case. (3) Among three cases of persistent direction-changing apogeotropic type ("heavy cupula") with the laterality on the audiogram, one was the ipsi-lateral case and the other two were the contra-lateral case. (4) Among two cases of persistent direction-changing geotropic type ("light cupula") with the laterality on the audiogram, one was the ipsi-lateral case and the other one was the contra-lateral case.

Conclusion: In the transient geotropic type (canalolithiasis), all cases were the ipsi-lateral case. On the contrary in the "heavy or light cupula" type, some cases were the ipsi-lateral case and the others were the contra-lateral case. This outcome was thought to be derived from the different pathophysiological cause existing between canalolithiasis and cupular lesion.

Poster Presentations P. Whiplash Injuries, Neck Disorders

P-P-1
A BALANCE TEST FOR CHRONIC PERILYMPH FISTULA

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Introduction: Perilymph fistula (PLF) has been a contentious topic in otolaryngology and vestibular medicine for over fifty years. The main criticisms have been a lack of reliable symptoms and diagnostic tests, operative traps for distinguishing perilymph from local anaesthetic, and the proof of benefit after repair. In the 1990s it became an emotional issue in otolaryngology with believers and non-believers, causing John Shea to proclaim that descriptions of "spontaneous" perilymph fistulas were a threat to the very credibility of the specialty and that "no characteristic signs, symptoms or diagnostic tests exist ..." This is not true. In the PLF literature there is a variety of loose terminology describing the vestibular symptoms. PLF patients display a unique unilateral balance abnormality (latero pulsion). In 1990, as suggested by Dr David Zee, the author simplified Singleton's "eyes-closed turning" test to the "side-ways stepping test" as an indicator of a possible PLF.

Methods: Over 24 years the author has explored the ears of 25 patients for PLF and a fistula was found in 21. All complained of poor balance and had reproducible unilateral instability on the test. Most had motion intolerance, persisting nausea and subtle cognitive problems. In 13 there was a trauma history (head injury, whiplash, surgery); 7 denied having trauma but in 3 it was eventually uncovered.

Results: All ears were explored via a tympanotomy under general anaesthesia. Most fistulas were at the fissula antefenestram of the oval window. Postoperatively all patients with a confirmed fistula regained normal balance and their motion intolerance and nausea ceased.

Conclusions: Chronic PLF is one of the most disabling vestibular conditions which is potentially curable, and a rare example of an unstable peripheral abnormality. Nearly always there is a history of trauma, but it can be forgotten or even concealed by the patient. It has long been assumed that the symptoms of a PLF are attributable to endolymphatic hydrops but their demonstrable unilateral balance instability suggests that they are due to otolith organ disfunction. A recently treated case (with video-documentation) will be presented, including confirmation of perilymph by the cochlin tomoprotein (CTP)assay by Professor Ikezono.

P-P-2
DISTURBED CERVICAL PROPRIOCEPTION AFFECTS SPATIAL ORIENTATION

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Introduction: Proprioception is together with vestibular and visual information crucial for postural control. Cervical proprioception has a special importance as a reference of head movements in relation to the trunk.

Consequently, cervical pain conditions have been considered to cause dizziness under certain circumstances. Induced cervical pain and muscular tension have been reported to affect head orientation and to affect postural control. The impact of cervical proprioception on spatial orientation would provide additional knowledge about its special role for postural control.

Objectives: To assess if disturbed cervical proprioception, by means of vibration on ventral and dorsal cervical muscles, affects spatial orientation, measured with stepping-test.

Methods: Sixteen healthy volunteers (8 women, 8 men, 19–34 years) performed a stepping-test during 35 seconds (median-time for 50 steps, tested in 10 volunteers, not involved in the study). Stepping-test was, after instruction and a first familiarization, performed with 'no vibration', with 'vibration' unilaterally on ventral and dorsal cervical muscles. Stepping-test was performed three times for each test condition, with a 'wash-out' stepping-test between each test condition. Spatial displacement was recorded with the 3-D Zebris® for the anterior-posterior direction, the medial-lateral direction and for rotation along the own longitudinal axis. Non-parametric statistics was used, p-values < 0.05 was considered significant.

Results: Significant displacement was found for 10/12 conditions (12=four 'vibrated' locations in three cardinal planes) during the first stepping-test<IMAGE01>. During the second stepping-test significance was found for 3/12 conditions and during the third stepping-test significance was found for 2/12 conditions. The un-vibrated stepping-test changed throughout the test set-up with increased, compensatory displacements (stepping-test 1, 2, 3) (anterior-posterior direction, $p = 0.087$; medial-lateral direction, $p = 0.008$ and longitudinal rotation $p = 0.04$).

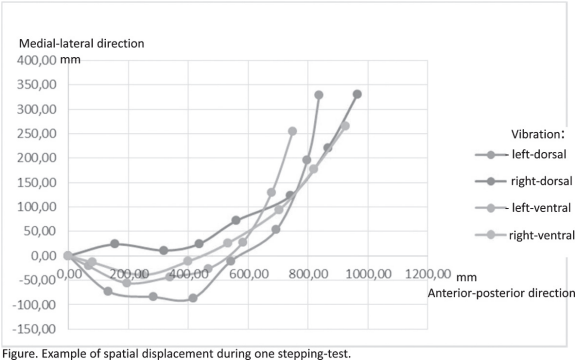

Figure. Example of spatial displacement during one stepping-test.

Conclusions: Disturbed cervical proprioception affects spatial orientation with distinct displacement changes for the first stepping-test during vibration. These spatial displacement changes during vibration decreased throughout the test with a compensatory increased displacement in the un-vibrated state. Cervical proprioception thus impacts on spatial orientation in a complex way.

P-P-3
CHRONIC DIZZINESS FOLLOWING MINOR HEAD TRAUMA AND WHIPLASH

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Introduction: Dizziness and vertigo are common symptoms of minor head trauma or whiplash. Although these symptoms improve within a few weeks in many patients, in some the symptoms may last much longer. Further, the patients following minor trauma often suffer from other symptoms such as hearing loss, tinnitus, olfactory dysfunction, taste disorder, or visual disturbance. This suggests that some dizziness after trauma is due to nonlabyrinthine causes that may be related to central nervous system disorder.

Objectives: The aim of this study is to examine vestibular, hearing, smell and taste function in order to clarify the process that the post-traumatic dizziness arises.

Subjects: We investigated 254 patients (115 males and 139 females, ages ranging from 16 to 76 years, with an average 44.2 years) who had chronic dizziness following minor head trauma and whiplash without any abnormal finding in head CT or in MRI.

Methods: We evaluated the vestibular, hearing, smell and taste function of the 254 patients with spontaneous and gaze nystagmus test, stabilometer test, caloric test (76 cases), standard pure tone audiometry, smell test (intravenous olfaction test, odor-identification card test for Japanese), and taste test (electrogustometry, filter-paper disk assay using taste solutions). Accordingly, we investigated the relation between the body sway and the other sensory functions.

Results: Durations of the symptom after the trauma ranged from 3months -15 years with a mean 2 years. Of 254 patients 231 were injured by traffic accidents, 11 by fall, and 12 by the others. We found the larger sway area than usual in 60? of the patients in stabilometer test both with eyes open and with eyes closed, The patients who had disturbance of consciousness just after trauma showed larger body sway than the patients without that. Spontaneous or gaze nystagmus

were recognized in 36 cases (14.2%), and most of them were direction-fixed horizontal or horizontorotary. Canal paresis was seen in 28 cases. We found a significant correlation between the smell identification and the body sway area. However, there was no correlation between the body sway and the hearing threshold, the laterality of the hearing, the taste function and the smell threshold.

Conclusion: From the result of nystagmus and caloric test, we supposed that approximately 20% of our patients had dizziness of vestibular origin. The results that there was significant correlation between the body sway and the smell identification suggested that chronic dizziness might be related to cognitive disorder caused by minor trauma.

Poster Presentations Q. Hydrops-Meniere

P-Q-1
IMPROVEMENT IN THE HEARING PARAMETERS OF PATIENTS SUFFERING MENIERE'S SYNDROME WHEN TREATED WITH BETAHISTINE (NOVERTIN) WHEN USED AS A MONOTHERAPY. FOUR YEARS EXPERIENCE. CENTRAL HOSPITAL OF THE INSTITUTO DE PREVISIÓN SOCIAL. ASUNCIÓN-PARAGUAY

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Introduction: Meniere's Syndrome is characterized by spontaneous recurrent vertigo attacks, fluctuating loss of hearing, tinnitus and the sensation of external ear pressure. It is believed that the physical pathological cause is due to the endolymphatic hydrops generated by the excess production of endolymph or its reduced absorption. Consequently the increased endolymphatic pressure produces the periodic rupture of the membrane that separates the endolymph from the perilymphatic space producing the typical symptomatic crisis of Meniere's Syndrome. It is known that betahistine is a weak agonist-H1 and antagonist-H3. In addition, trials on animals show that this substance increases the blood flow in the internal ear. It is possible that this reduces the pressure on the internal ear and, hence, achieving an equilibrium between the production and reabsorption of the endolymph. This study also proved a direct relation between the medicine dosage and the blood flow in the internal ear. There are also trials that claim that the effects of betahistine increases with time and that the prophylaxis with high dosage can reduce the hydrops and the endolymphatic pressure. There are trials that confirm the efficiency of betahistine to control the vertigo and the tinnitus, but not that of the hearing impairment, reason why we decided to carry-out this trial.

Objetive: To demonstrate hearing improvement of patients suffering Meniere's Syndrome when treated with betahistine (Novertin), as a monodrug, over lengthy treatments.

Material and Method: Descriptive, observational, transversal and prospective study. Inclusion Criteria: patients diagnosed with definitely Meniere's Syndrome, without associated morbidity as from the year 2010. Exclusion Criteria: patients recently diagnosed (less than 6 months) with Meniere's Syndrome, that had an associated pathology, been treated with other medicines, irregular treatment and/or quitting it.

Findings: The trials were carried out on 7 patients, of which 4 (57%) were female and 3 (43%) male. Age classification was: Between 31 and 50 years old, 2 patients (28.5%). From 51 to 70 years old , 3 (43%) and 2 (28.5%) older than 70 years The principal symptoms: vertigo crisis and fluctuating hearing impairment 3 (43%) right ear and 4 (57%) left ear) in all 7 (100%); Left ear tinnitus in 4 (57%) cases. In relation to the findings of the first listening test: 3 (43%) had presented a moderate hearing impairment of the right ear and 1 (14%) with the left ear; 3 (43%) had presented severe hearing impairment of the left ear. A control was made on the 2nd anniversary of the uninterrupted treatment achieving the following findings: 4 (57%) patients improved the moderate hearing impairment to a slight impairment, 2 (28.5%) the improvement went from severe to moderate and 1 (14.5%) from severe impairment to slight-moderate. As to the improvement quantifiable in decibels of 500, 1000 and 2000 Hz, 2 patients showed an improvement of 10 db (28.5%), there was a 20 db improvement in 3 patients (43%) and the remaining 2 showed a 30 db (28.5%).

Conclusion: The above description shows the efficiency of the Betahistine (NOVERTIN) as a monotherapy treatment for the improvement of hearing impairment of patients suffering Meniere's syndrome. The monitoring of these patients will continue until they present a stable improvement curve, so therefore, to determine the level of improvement they attained. Key words: Meniere's syndrome, Betahistine and hearing impairment.

P-Q-2
DIAGNOSIS AND MANAGEMENT OF DROP ATTACKS IN MENIERE'S DISEASE

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Introduction: In 1936, Tumarkin first described sudden falling spells in patients with a peripheral vestibular or cochleo-vestibular syndrome. These drop attacks occurred without loss of consciousness and were independent of the more typical episodes of vertigo. Tumarkin speculated that these falls resulted from a mechanical deformation of the otolith organs (an 'otolithic catastrophe').
Objectives: We herein report a retrospective study of 12 patients with drop attacks in MeniÃ¨re's disease with the aim to describe the drop attacks and their management.
Methods: The criterion for inclusion in this series included both the occurrence of at least one sudden falls (without loss of consciousness or associated neurological symptoms) and a definite MeniÃ¨re's disease (according to the criteria of the American society).
Results. Twelve patients had sudden falls in a unilateral ($n = 11$) or bilateral ($n = 1$) MeniÃ¨re's disease. The total number of falls varied from 1 to 20. The falls occurred either in a standing or a sitting position, including one patient when driving her car. Although the falls were sudden, 3 patients noted a brief illusion of movement just before the fall. In 2, the illusion was a linear displacement or tilt of the environnement and in 1, it was more a rotatory component. Most of the falls were lateralized to one side (either the side or the opposite side of the MeniÃ¨re's disease), but some occurred forwards, rarely backwards. Interestingly, 7 patients could complained of vertigo or dizziness after the fall, including one patient whose fall occurred in the waiting room, hopefully without traumatism. This latter patient had the feeling to have been pushed forwards to the ground, and complained, immediately after the fall, of an illusion of movement that lasted for approximately 2 to 3 hours and was mainly in the vertical plane. Indeed, videonystagmoscopy, a few minutes after the fall, revealed an essentially downbeating nystagmus with a slight rotatory component beating to the side of the hearing loss. However, this nystagmus fluctuate and could spontaneously change to a slight but more conventional horizonto-rotatory component beating away from the side of the hearing loss. The falls could be complicated either by severe head trauma ($n = 1$) or various fractures (nose, wrist...) ($n = 4$). Although the follow up was insufficient in 2 patients, it was favorable in the 10 others, spontaneously ($n = 4$), after chemical labyrinthectomy ($n = 5$) or vestibular neurotomy ($n = 1$).
Conclusions: Sudden fall in Meniere's disease is an impressive phenomenon with a high risk of traumatism. This risk is an argument for chemical labyrinthectomy, alternatively vestibular neurotomy, although spontaneous remission is possible. From a physiopathological point of view, the occurrence of vertigo or dizziness after the fall would suggest that the mechanism initially limited to the otolith system could spread to the semicircular system.

P-Q-3
VESTIBULAR EVOKED MYOGENIC POTENTIAL IN MENIERE DISEASE

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Introduction: Menière's disease most often affects the cochlea and saccule. Some studies have shown the value of the vestibular evoked myogenic potentials (VEMP) in assessing saccular function.
The objective of this study is to correlate the findings of VEMP to the other audiological findings in subjects with established diagnosis for unilateral Menière's Disease.
Material and Methods: Adults of both genders with Menière diagnosis were selected to undergo VEMP. The subjects were compared to responses by ear.
Results: From 18 evaluated subjects, 11 were women. The main change observed was prolonged P13 latency and the second significant change was prolonged P13 and N23. The degree of hearing loss affected VEMP response.
Conclusion: VEMP was confirmed to be an important test to assess Menière's Disease, considering the degree of hearing loss.

P-Q-4
NUMERICAL INVESTIGATIONS OF THE EFFECTS OF ENDOLYMPHATIC HYDROPS ON THE VOR RESPONSE

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[5]University of Sydney

Background: Tests of the eye movement response to high acceleration yaw head rotation using the video head impulse test (vHIT) show that around the time of the attack some patients with Meniere's Disease (MD) show an enhanced gain of the horizontal vestibulo-ocular reflex (VOR). This may be due to endolymphatic hydrops causing enlarged duct and ampulla volumes, as shown by recent high resolution MRI scans of the labyrinths of MD patients. The present study sought to establish if a recent approach to modelling endolymph flow could predict such an enhanced VOR response due to hydrops with this high acceleration stimulus.
Hypothesis: The smallest lumen in the membranous labyrinth (ML) is found in the slender parts of the semicircular canals. These regions can therefore be regarded as the bottleneck for endolymph motion. A pathologic expansion (hydrops) of the ML hence decreases the hydrodynamic flow resistance and allows for higher endolymph flow velocities during a given head maneuver. This yields larger cupula deflections and thereby causes an increased VOR gain.
Additionally, the fluid dynamics of the utriculus is sensitive to an increase in utricular cross-section. Vortical flows in the "inflated" fluid chambers will carry more inertial mass and will therefore react more slowly to head motions.
Methods: A computational mesh is created on the basis of morphological data for the membranous labyrinth of human horizontal semicircular canals (hSCC) and serves as the reference configuration in the context of this work. Since the exact shape of an inflated hSCC cannot be measured easily *in vivo*, we estimated the inflation of our reference mesh by some *ad hoc* stretching factors. These artificially created morphologies preserve geometrical constraints (e.g. expansion constricted due to the ML positioned at the outermost radius of the bony labyrinth and due to the available expansion space in the perilymph) and model a realistic, pathologic situation to our best knowledge.
We solve the Navier-Stokes equations for the endolymph in the numerical model of the hSCC with the Finite Volume Method (FVM) in a moving reference frame (observer moving with the head during motion) using the OpenFOAM software environment. The frame acceleration corresponds to head motion records from vHIT tests on MD patients, and is included in the equation set as a volumetric force on the fluid. Additionally, we implemented a cupula model to apply restoring forces on the endolymph. The cupula displacement due to the endolymph flow is assumed to be proportional to the VOR-induced eye velocity.
The empirical data came from patients with MD meeting the AAO-HNS criteria. Head velocity and eye velocity were recorded at high speed using the prototype Impulse system and the head velocity was the time series input to the model.
Results: Our numerical simulations show a VOR gain that is of same order of magnitude as the MD patients' eye response from vHIT recordings.
Discussion and conclusions: The numerical results support our hypothesis that an inflation of the endolymphatic lumen can lead to the increased VOR observed in MD patients. Since the individual ML geometries of the hSCC were not measured, we had to rely on prototype ML morphologies and on *ad hoc* estimates for their stretching factors. This may explain why the predictions from the numerical model do not match the vHIT experiments exactly.

P-Q-5
CLINICAL COURSE OF ACUTE LOW TONE SENSORINEURAL HEARING LOSS ACCORDING TO THE SEVERITY OF HEARING LOSS AND SP/AP RATIO ON ECOG

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Introduction: Clinical course of acute low tone sensorineural hearing loss (ALTHL) without vertigo is not the same as idiopathic sensorineural hearing loss. Higher treatment response and recurrent rate were reported. And it may progress to Meniere's disease. It is due to different pathogenesis between these two diseases. In this study, clinical course of ALTHL were evaluated according to the severity of hearing loss and SP/AP ratio in relation to recovery and recurrence rate and progression to Meniere's disease.
Methods: Fifty-nine patients diagnosed at the university hospital with ALTHL without subjective vertigo

were studied retrospectively. ALTHL was defined as 10 or more decibel hearing loss in 250 and 500 Hz but not in three contiguous frequencies within three days. Mean follow up period was over 21 months. According to the severity of hearing loss, mild (10∼30dB loss in low tone (250 and 500 Hz) and moderate-to- severe (> 30dB loss in low tone) groups were divided. Forty-six patients performed ECoG at their initial visit. SP/AP ratio over 0.34 was considered abnormal. All patients received high dose steroid therapy.

Results: Complete hearing recovery rates within 2 weeks were 83% in mild hearing loss group and 53% in moderate to severe hearing loss group (in total 61%). Complete recovery rates within 6 months were 92% in mild group and 72% in moderate to severe group (in total, 78%). In addition, regardless of hearing level, the patients with abnormal SP/AP ratio showed poorer treatment response (14/20, 60%) than normal SP/AP ratio (23/26, 88.5%) ($p < 0.05$). But, ECoG value was not associated with the severity of hearing loss or the rate of recurrence ($p > 0.05$).

Conclusion: Acute low tone sensorineural hearing loss without vertigo showed treatment response in 61% of patients. Mild hearing loss tended to have higher response rate than moderate to severe hearing loss. Acute low tone hearing loss with high SP/AP ratio showed relatively high resistance to early steroid therapy.

P-Q-6
THE PREVALENCE AND CLINICAL SIGNIFICANCE OF SPONTANEOUS LOW-FREQUENCY AIR-BONE GAPS IN MENIERE'S DISEASE

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Introduction: Previous studies have reported spontaneous low-frequency air-bone gaps (LFABG) in approximately 30% of patients with Meniere's disease or Cogan syndrome; the common pathological finding among these is the dilatation of the endolymphatic space (endolymphatic hydrops). However, there have been few reports on the incidence and prevalence of LFABG in Meniere's disease, and no report has described the clinical significance of LFABG in those patients.

Objectives: In this study, we sought to investigate the prevalence and clinical significance of spontaneously developed LFABG in Meniere's disease patients.

Methods: The prevalence of LFABG in this population was calculated, and the following parameters were analyzed: 1) changes in hearing thresholds after the resolution of LFABG; 2) correlation between LFABG and electrocochleography (ECoG) results; 3) changes in the number of vertigo spells after the resolution of LFABG; 4) correlation between LFABG and canal paresis (CP) values in caloric testing; and 5) the difference in the prognoses of patients with and without LFABG.

Results: The prevalence of LFABG was 13.9%. Patients' hearing thresholds were significantly decreased after the resolution of LFABG (from 49.4 ¡3/3 16.8 to 38.3 ¡3/3 19.3, $P = 0.044$), while the summating potential and action potential ratio in ECoG tended to increase as LFABG increased (R2 = 0.09, $P = 0.03$). The mean number of vertigo spells was significantly reduced after the resolution of LFABG (from 2.9 to 0.5, $P < 0.0001$), but CP did not correlate with LFABG. The prognosis was not different for patients with and without LFABG.

Conclusion: The number of vertigo spells and hearing thresholds were significantly higher during the period of LFABG development. Although the prognostic importance of LFABG was not significant, it likely reflects the aggravation of the endolymphatic hydrops in the cochlear and vestibular compartments and may be useful for evaluating and treating patients with Meniere's disease.

P-Q-7
NONINVASIVE EVALUATION OF THE EFFECT OF ENDOLYMPHATIC SAC DECOMPRESSION IN MENIERE'S DISEASE USING MRI

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Abstract Objective: To evaluate the effect of endolymphatic sac decompression (ESD) for the treatment of M¨|ni¨¨re's disease by applying to noninvasive intratympanic gadolinium (Gd) perfusion through the eustachian tube and three-dimensional fluid-attenuated inversion recovery magnetic resonance imaging (3D-FLAIR MRI).

Methods: This was a prospective study. 3D-FLAIR MRI was performed with a 3 Tesla unit 24 h after intratympanic administration of Gd through the eustachian tube in five patients with intractable M¨|ni¨¨ re's disease before and 3 months after ESD, moreover, a 2-year fellow-up on the effect of ESD was reported.

Results: Gd was present in the perilymph of the inner ear in all the patients, which clearly displayed

the endolymphatic space on 3D-FLAIR MRI with a visible borderline between the perilymph and the endolymph. According to the normal value of endolymphatic space, four of 5 patients had a ratio of more than 26% in the cochlea, moreover, three of 5 patients had a ratio of more than 41% in the vestibule preoperatively. All the patients had a ratio of less than 26% in the cochlea and 41% in the vestibule postoperatively. ESD was effective in reducing the incidence and severity of vertigo attacks with significant improvement in 60 percent of patients.
Conclusions: Noninvasive evaluation of the effect of ESD in M¨|ni¨¨re's disease using MRI is firstly indicated.

P-Q-8
CLINICAL UTILITY OF VEMP AND ECOHG TO DIFFERENTIATE VESTIBULAR MIGRAINE FROM MENIERE'S DISEASE
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Introduction: Vestibular migraine (VM) is an emerging diagnosis for a syndrome of vertigo in patients with headache and migraine characteristics. However, establishing the diagnosis and differentiate both Meniere's Disease (MD) and VM remains challenging.
Objectives: Detect vestibular findings to help in the diagnose of VM and MD. Methods. Unilateral definite MD patients ($n = 53$), VM patients ($n = 49$) by the diagnosis criteria elicited by the consensus document of the Barany Society and the International Headache Society, cVEMP testing used Air conducted 500-Hz tone bursts and EcohG testing used clicks. Outcome parameters were cVEMP peak-to-peak amplitudes, P1 and N1 latencies, cVEMP tresholds and SP/AP ratio in both ears.
Results: Both MD and VM groups showed reduced ipsilateral cVEMP comparing to the non affected ear ($P < 0.05$), but no significant differences were observed between both cohorts. No significant differences were found in the cVEMPs thresholds or the latency between MD and VM. A significant increased SP/AP ratio ($p < 0{,}001$) was observed in the affected ear in MD comparing to those in VM.
Conclusions: Using the VEMP technique, VM and MD behaved similarly, which provides evidence of possible peripheral vestibular abnormalities in VM. Nevertheless EcohG demonstrated endolymphatic hydrops in most patients with MD, with normal SP/AP ratio in the majority of VM patients.

P-Q-9
THE USE OF ELECTROCOCHLEOGRAPHY TO MONITOR THE RESPONSE OF A SPANISH POPULATION OF MENIERE'S DISEASE PATIENTS TO INTRATYMPANIC STEROIDS
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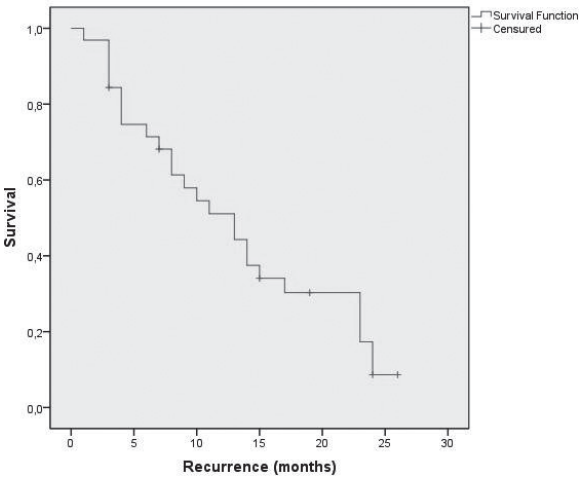
Introduction: The use of intratympanic (IT) corticoid injections for Ménière's disease (MD). has become popular due to the lack of reported adverse effects, but the mechanism of action is not well established. The published results vary among different authors, and no consensus concerning the variations between protocols has been reached. It is well established that endolymphatic hydrops (EH) is a histological marker of MD.Functional testing, like the use of electrocochleography (EcohG), has been used to identify EH.
Objective: This study aimed to evaluate the changes in EcohG measurements during IT dexamethasone therapy.



Methods: This study included 62 patients with unilateral MD refractory to medical therapy for at least 1 year. Each patient was treated with a ?xed protocol of three consecutive weekly injections of a commercial 4 mg/ml dexamethasone preparation. EcohG measurements were performed 1 month before and 1 and 12 months after IT steroid therapy. The SP/AP ratio was measured before and after the IT treatment. A Kaplan–

Meier analysis was used to evaluate the control of vertigo over a 2-year period.
Results: Complete vertigo control (class A) was achieved in 26 patients (41.9%) at the 12-month follow-up and 12 patients (19.3%) at the 24-month follow-up.
A significant reduction ($p < 0.01$) in the SP/AP ratio after the IT steroid treatment was observed in the first month determination, but no significant differences were found when the initial and 12 months determination were compared.
Conclusions: IT dexamethasone provides an alternative for patients with MD. A transitory reduction of the endolymphatic hydrops is detected by the EcohG 1 month after the treatment. The hydrops levels returned to their initial values in the one year EcoHG follow up.

P-Q-10
THE VIDEO HEAD IMPULSE TEST VERSUS THE CALORIC TEST IN MÉNIÈRE'S DISEASE SUGGESTS A NEW WAY OF LOOKING AT THE MECHANISM
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Introduction: The caloric test has been the mainstay screening test for vestibular patients for about a century. However, the recent development of practical and effective video Head Impulse Testing (vHIT) has now presented the field with an alternative to the caloric.
Objectives: In this retrospective study, we compare the results obtained by caloric testing to the results obtained by the vHIT in 22 patients with confirmed Ménière's disease.
Methods: 22 patients with Meniere's Disease (AAO-HNS criteria) were tested by both standard bithermal caloric testing and by the video head impulse test, with 12 patients having both tests on the same day.<$p <$ ear.
Discussion and Conclusions: Previously, this dissociation between caloric and rotational test results has been interpreted as the Ménière's differentially affecting the low frequency semicircular canal responses, leaving the high frequency responses less affected. However, another possibility exists. Recent studies have examined the changes in the membranous labyrinth due to hydrops using high resolution MRI of patients with known Ménière's disease . These imaging studies show that hydropic swelling of the membranous labyrinth is present and visible in Ménière's disease . That evidence has led us to a new hypothesis about the cause of the different results for calorics as opposed to rotational stimulation in MD patients. We propose that this dissociation actually indicates that the caloric test weakness is due more to the hydropic expansion of the membranous duct, rather than to a selective loss of low frequency function. In other words, the non-physiological fluid drive generated by a thermal variation across the temporal bone is dissipated as the duct expands, allowing local convective flow within each arm of the semicircular canal, which, in turn reduces the density difference across the cupula. The normal human membranous labyrinth only occupies approximately 5% of the volume of the bony canal, unlike animal models such as cat and guinea pig where the respective ratios are closer to 60% to 70%. Consequently, it is possible that the duct size can increase to a level at which local convective flow replaces laminar flow within the duct. A fluid dynamics model by Grieser et al, of the response of an enlarged semicircular canal to a standard high velocity head impulse, shows increased duct size leads to increased vortical flow and closely approximates the eye velocity response identified in some Meniere's patients. </$p >$

P-Q-11
VOR CHANGES AFTER INTRATYMPANIC GENTAMICIN FOR MÉNIÈRE'S DISEASE
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Objectives: To assess angular vestibular-ocular reflex (VOR) changes after treatment with intratympanic gentamicin for unilateral Ménière's disease (MD), and evaluate its impact on short-term follow-up.
Material and Methods: Prospective study of 31 consecutive patients submitted to gentamicin intratympanic treatment for intractable unilateral MD. The gain of the VOR and the presence of compensatory saccades elicited by rapid head impulses before and after intratympanic treatment were measured using video Head Impulse Test (vHIT).
Results: The study subjects mean age was of 59,2 years (range 37–80 years). The right ear was affected in 18 (58%) and the left ear in 13 (42%) patients. Functional level scale (FLS) distribution was 35,5% (FLS3), 32,2% (FLS4) and 32,2% (FLS5). Mean follow-up was 15,7 months. In 9 patients at least a second in-

jection was needed. Gain of the VOR after stimulation of the semicircular (SCC) in the treated ear was significantly reduced when all the subjects are considered and for all the SCC (Paired samples t test, $p = 0.005$ (superior), $p = 0{,}000$ (horizontal), $p = 0.000$ (posterior)). Gain averages after treatment were 0,61 (superior), 0,69 (horizontal), 0,47 (posterior). A VOR gain superior to 0,80 after treatment was associated with the need for a second gentamicin injection (Chi-square; $p = 0{,}003$) Gains asymmetry between symptomatic and asymptomatic ear (GASM) were also studied and were increased after treatment: Horizontal (Pre:3,5; Post:18,5; $p = 0.000$); Superior (Pre:3,3; Post:18,2; $p = 0.011$); Posterior (Pre:2,1; Post:23,9; $p = 0.003$). The rate of vestibular function reduction (100-reduction) was 47,9%, 26,0% and 35,8% for the superior, horizontal and posterior SCC, respectively. According to the ROC curve we see that the amount of change in GASM must be higher than 7, in order to predict the avoidance of a second procedure. (AUC horizontal SCC = 0,861), and the amount of vestibular function reduction in the pathologic ear in patients with a controlled disease is higher that 17,8% (AUC horizontal SCC = 0,843),

Conclusions: Intratympanic treatment of MD with gentamicin produces significant variations in VOR results, which can be truthfully evaluated with the vHIT. The observed changes seem to successful foresee short-term control of vertigo attacks.

P-Q-12
SIMULTANEOUS COCHLEOSACCULOTOMY AND COCHLEAR IMPLANT SURGERY IN CASES OF INTRACTABLE MENIERE'S DISEASE; AACHEN, GERMANY

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Introduction: Chemical or surgical labyrinth ablation are used in the treatment of intractable Meniere's disease, if medical therapy fails. Because deafness is a potential side effect of these procedures, the level of speech understanding has to be considered before indicating treatment. Cochlear implantation in Meniere patients was reported in one case of intractable unilateral disease subsequent to labyrinthectomy and in another five cases of bilateral Meniere's syndrome uptil now. To provide relief of vertigo in combination with restoring the hearing we performed cochlear implantation and cochleosacculotomy simultaneously.

Methods: 5 patients in the age of 45–73 years with intractable Meniere's disease according to the AAO-HNS guideline (1995) were treated with simultaneous cochleosacculotomy and cochlear implantation between 6/2013 and 12/2013. All the ipsilateral ears had minimal residual hearing with hearing aids. N=2 patients had contralateral hearing impairment and had worn hearing aids, $n = 3$ had contralateral normal hearing. No ipsilateral hearing deterioration was observed as a complication of previous treatment. All patients were ipsilateral non-responders to previous endolymphatic shunt surgery. Cochleosacculotomy and CI were performed via posterior tympanotomy.

Results: No complications were recorded postoperatively. Observation interval is 4–11 months. All patients are free of vestibular symptoms postoperatively. The mean DHI score is 4. Caloric responses, HIT, cVEMP and oVEMP are negative ipsilaterally, subjective visual vertical is asymmetrical. Bimodal application of hearing aid and CI is used by every patient. 3 months results of speech understanding in quiet and noise are in the upper quartile of non-adult CI patients with other indications. Patient's speech recognition of monosyllables in quiet is $> 50\%$, speech recognition in noise is improved 4.3 dB (SN ratio). Binaural orientation is reported by all of the 5 patients. 11 months postoperatively patients are free of symptoms and speech recognition is $> 75\%$ in quiet.

Conclusions: Patients with untractable uni- and bilateral Meniere's disease or Meniere's syndrome can be effectively treated and rehabilitated to binaural hearing and speech recognition in noise by means of simultaneous cochleosacculotomy and cochlear implantation.

Poster Presentations R. Acoustic Neuromas/ Otoneurosurgery

P-R-1
BILATERAL ACOUSTIC NEUROMA: PATHOLOGY TO CONSIDER. ASUNCION – PARAGUAY. 2014. REPORT OF A CASE

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Introduction: The Acoustic neuroma, injury caused slow growth in Schwann cells of the vestibular nerve, which usually manifest with cochlear and vestibular symptoms. Is the most common tumors of the cranial nerves, constituting 70% of primary CNS located in the cerebellopontine angle. We distinguish two types:

unilateral: presented as sporadic solitary tumors in advanced stages of life, no transmission to the offspring; bilateral, hereditary, associated with neurofibromatosis type II, trasmitiéndose as autosomal dominant high penetrance, so we are interested in presenting this case, appeared at an early age.
Objective: To describe clinical manifestation of bilateral acoustic neuroma.
Clinical presentation: Male patient, 22 years, urban origin, who comes in for progressive hearing loss 2 years of evolution to left ear and right ear in three months, with acute onset of tinnitus in the left ear, which is added at the last dizziness month so she consults. Physical examination: normal otoscopy, romberg drive on the left, march Unterberger – Fukuda tendency to fall to the left, ataxic gait, cerebellar assessment preserved, impaired eye tracking sinusoid tracking absent spontaneous nystagmus, gaze evoked nystagmus, Dix - Hallpike negative head impulse test positive bilaterally. Alteration of cranial nerves V and VII is evident. She underwent the following studies: Audiometry: moderate to severe sensorineural hearing loss in the right ear of 60 to 70 db more pronounced at frequencies of 1000–4000 Hz. Anacusia in left ear. Logo audiometry: Right ear at 70 db does not discriminate. Tympanometry: Right Ear High Reflection Curve 5/4 present low curve left ear reflexes absent. Caloric test videonystagmography: bilateral vestibular arreflexia. Estdudio imaging: MRI with gadolinium images suggestive of bilateral acoustic neuromas location, the right of about 2.8 cm and the left 3.5 cm in diameter with signs of extrinsic compression of the brainstem. Evaluation of surgical treatment for neurosurgery.
Discussion: I based on the present case, diagnosed by careful examination otoneurological, symptoms derivatives VIII pair are often the first to appear: hearing loss, tinnitus and balance disorder which is consistent with our case. Regarding distribution by age and sex, often shows between 40 and 50 years, with a male/female 6/4 ratio, this case occurred at age 22. Audiometry shows hearing loss perception in 93% of cases. Tinnitus is usually the first symptom conuntamente hearing loss, unilateral or asymmetric, in high frequency along with a deterioration of speech discrimination, disproportionate to the loss of pure tones. In our case presented as alterations audiological right and left anacusia sensorineural hearing loss. The test indicates vestibular areflexia or hyporeflexia accused in our case bilateral vestibular arreflexia.
Conclusion: The absence of a clear relationship between symptoms, tumor size and time precluding early diagnosis. Intracanalicular small tumors can be missed, so MRI with gadolinium, are of choice.

Key Words: bilateral acoustic neuroma, schwann cells

P-R-2
VIDEO HEAD IMPULSE TESTING IN COMPARISON TO CALORIC TESTING IN PRE-SURGICAL VESTIBULAR SCHWANNOMA UNIVERSITY OF OTAGO, DUNEDIN, NEW ZEALAND

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University of Otago

The presurgical management of vestibular schwannoma (VS) is typically a 'watch and wait' approach with MRI and clinical monitoring. Quantitative vestibular testing is not routinely available in many centres, and can be utilized less than audiometry in VS, yet vestibular symptoms are common in untreated VS. Video head impulse testing (vHIT) has 'ease of testing' advantages over caloric testing, but requires validation in specific conditions. We compare vHIT to bithermal calorics in a cohort of pre-surgical unilateral VS, along with MRI dimensions and vestibular handicap in an observational study. EyeSeeCam goggles and EzeEye software (Munich, Interacoustics) were used to determine peak slow slow phase velocities of standard bithermal caloric irrigations (Aquastar, Difra), and the VOR angular velocity gain at 60ms during video head impulse testing (vHIT). VS size was assessed by measuring dimensions in the anteroposterior, transverse and longitudinal axes using T1 weighted gandolinium enhanced 1.5 Tesla MR (GE, Milwaukee). The Jacobsen Dizziness Handicap inventory (DHI) was employed as a vestibular symptom score and statistical analysis was done with SPSS 17. Forty-two subjects with unilateral VS were invited to participate, 5 declined due to explicit concerns about having caloric irrigations, 5 due to other reasons, and 1 was excluded due to congenital nystagmus. Thirty-one subjects were assessed (mean age 62, range 34 to 81 years, 13 female). The mean ipsilesional and contralesional vHIT gains at 60ms were 0.84 and 0.92, (2-tailed T test, $p = 0.033$). The mean canal paresis by Jongkees was 0.39 (SD $= 0.30$). 21/31 subjects had an abnormal canal paresis by Jongkees (> 0.25), and of these the ipsilesional vHIT gain was < 0.74 in 14/21. Of the 10 subjects with no significant canal paresis, 1 had an ipsilesional vHIT gain < 0.74. Significant correlations

were found for ipsilesional vHIT gain and canal paresis (Pearson coefficient $r = -0.83$, $p < 0.01$) and to tumour size ($r = 0.62$, $p < 0.001$). Mean DHI score was 19.30 (SD = 17.34), no significant correlation was found for the DHI score with vestibular function or MRI measures. Conclusions: vHIT correlates well with conventional bithermal caloric testing in presurgical unilateral VS, but was less sensitive in this cohort. Despite this, vHIT may have a role in clinical scenarios where caloric testing is not available. A longitudinal study is required to investigate vHIT changes in relation to tumour progression and to define a role in surgical decision making.

P-R-3
THE DIAGNOSTIC VALUE OF NEW NON-INVASIVE TESTS OF VESTIBULAR FUNCTION IN VESTIBULAR SCHWANNOMA

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Objectives: The aim of this study was to determine the sensitivity and predictive value of new non-invasive tests of vestibular function in patients with vestibular schwannoma
Methods: Forty six patients with vestibular schwannoma underwent cervical- and ocular- vestibular evoked myogenic potential testing (cVEMP and oVEMP) to air- and bone- conducted stimuli, and video head impulse testing (vHIT) in all three semicircular canal planes. The sensitivity of each test was compared, first for the entire group, then across groups stratified according to tumour size. A 5-item test battery, representing the function of each individual otolith organ and semicircular canal, was used to infer the pattern of vestibular nerve involvement.
Results: All vestibular function tests demonstrated moderate to high rates of abnormalities (45.2–70.5%) with the BC cVEMP amplitude asymmetry ratio demonstrating the highest sensitivity (70.5%) overall. There was a significant positive relationship between tumour size and rates of tests abnormalities for the AC cVEMP, BC cVEMP, BC oVEMP and horizontal vHIT (chi-square test, $p < 0.001$). Use of a 5-item vestibular test battery indicated normal otolith and canal function in 24.4% of patients, all with schwannoma ¡Ü14 mm in size. Most patients demonstrated test abnormalities referable to both superior and inferior nerve divisions (62.2%). A small number of patients (13.3%) showed discrete abnormalities on one VEMP or vHIT test, implying selective involvement of a single otolith organ or canal, and/or their related nerve afferents. The area under the ROC curve (0.942; 95% CI = 0.879 to 1.000, $p < 0.001$) indicated the 5-item test battery was useful in identifying medium to large schwannoma (> 14 mm). The likelihood of a schwannoma being greater than 14 mm increased as the number of test abnormalities increased.
Conclusions: Vestibular function is often affected in patients with vestibular schwannoma, particularly when tumour diameter exceeds 14 mm. In most cases it is not possible to differentiate between cochlear, inferior and superior vestibular nerve subtypes, implying vestibular schwannoma tends to affect all eighth nerve divisions. Both the number and severity of vestibular test abnormalities were associated with tumour size.

Poster Presentations S. Migraine Including Vestibular Migraine

P-S-1
BALANCE AND EXECUTIVE FUNCTIONS, GENERAL QUALITY OF LIFE AND PHYSICAL ACTIVITY RELATED TO DISABILITY IN VESTIBULAR MIGRAINE

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Introduction: It is well known that migraine episodes cause dysfunctions and impairments in quality of life. Vestibular symptoms increase the balance dysfunctions and impairments in quality of life. Concentration and memory problems and learning disabilities have been shown in vestibular disorders. On the other hand, executive dysfunctions of migraine and vestibular migraine patients are not certain. The protective effects of physical activity on executive functions have been established in different studies.
Objectives: to examine the balance and executive functions, physical activitiy and quality of life related to disability in vestibular migraine and migraine patients without vertigo history (migraine only).
Methods: There were 19 definite vestibular migraine (VM) patients (Neuhauser criteria), 19 migraine only

patients and 19 age and gender matched controls. Balance functions were measured by Balance Evaluation-Systems Test (BESTest), subjective handicap levels by Dizziness Handicap Inventory (DHI), executive functions by STROOP Test, physical activity by International Physical Activity Questionnaire (IPAQ), quality of life status by SF-36 questionnaire and migraine disability level by Migraine Disability Assessment Test-Turkish version(MIDAS). Results: BESTest scores of VM patients and migraine only patients were lower than healthy controls and VM patients scores were lower than migraine only patients ($p < 0.05$) which means worse balance performance of VM patients than others. DHI scores, which reflect handicap levels related to balance impairments, were significantly higher in VM patients than migraine only patients and controls. Quality of life status of VM patients, measured by SF-36, were significantly worse than migraine only patients and controls. Executive functions performance in Stroop Test of VM and migraine only patients were worse than healthy controls significantly but the scores of two patient groups were not significantly different. The physical activity levels measured by IPAQ were not significantly different in 3 groups. There was no significant difference between VM and migraine only patients in terms of MIDAS scores. There were 14 patients (73.7%) of VM patients and 8 migraineurs (44.4%) in grade 4-severe disability category. VM patients in grade 4 disability category had worse performance in balance, executive function tests, lower quality of life status and lower physical activity scores than migraine in grade 4 disability category.

	VM Mean (SD)	Migraine only (MO) Mean (SD)	Controls (C) Mean (SD)	p
BESTest	86,6 (8,8)	92,4 (6,5)	95,6 (6,9)	*VM<c<="" *vm
DHI	32,6 (23,1)	18,2 (16,4)	2,4 (5,1)	*VM<c<="" *vm
STROOP	27,5 (14, 2)	20,8 (11,6)	10,1 (6,9)	*VM<="">
IPAQ (MET Level)	1553,0 (1180,8)	1055,4 (869,4)	918,1 (570,5)	
SF-36	242,1 (72, 2)	287,6 (100,4)	327,6 (66,1)	*VM<c<="">
MIDAS	31,8 (20,2)	23,5 (16,9)	(-)	

Conclusions: VM patients had significantly more balance and disability problems than migraine only patients and controls. Executive problems were significantly worse in VM and migraine only patients. The disability levels cause more dysfunction in balance and executive function tests, quality of life status and decreased physical activity.

P-S-2
CHARACTERISTIC FINDINGS IN ELECTROENCEPHALOGRAPHY FOR PATIENTS WITH MIGRAINE-ASSOCIATED VERTIGO IN JAPAN

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Introduction: Our objective was to distinguish between patients with migraine-associated vertigo (MAV) from patients with other vestibulopathies (VP) using electroencephalography (EEG).
Methods: EEG with intermittent photic stimulation (PS) at frequencies between 3 Hz and 24 Hz was recorded to quantify photic driving in MAV (N = 21) and VP (N = 15) patients. The presence or absence of photic driving was determined; for its presence in a particular frequency, a score of 1 was counted. Results: Total scores were calculated for each patient for statistical comparison. There was a significant difference in the average of total scores for each MAV and VP patient ($P < 0.05$), and photic-driving response was observed for frequencies 10, 12, and 15 Hz.
Discussion: Althoguh photic driving is not specific to migraine, the patients with MAV have higher incidence of photic-driving. The distinction between the Meniere disease and MAV by means of EEG would be another interesting topic of research.
Conclusions: The patients with MAV possibly have higher incidence of photic-driving EEG response. The occurrence of photic-driving response for stimulating frequencies 10, 12, 15 Hz can be considered as a positive indicator of MAV.

Keywords: Vertigo, Migraine-associated vertigo, Electroencephalography

P-S-3
VESTIBULAR MIGRAINE IN EPISODIC AND CHRONIC MIGRAINE

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Introduction: The clinical association between vestibular symptoms and migraine has gained increasing

recognition. International Headache Society (IHS) and Bárány Society had published consensual criteria for vestibular migraine (VM). Chronic migraine (CM) is a subtype of migraine defined by IHS. Emerging evidence suggests that CM and episodic migraine (EM) differ not only in headache frequency, but also in other clinical characteristics that they might be distinct clinical entities. Therefore, we try to find out whether there is clinical difference of VM between EM and CM.

Objective: To investigate the clinical characteristics of vestibular migraine between episodic and chronic migraine patients.

Methods: We prospectively collected new patients who have migraine at our clinic. Each patient was interviewed by a neurologist. We classified the patients into two groups, EM and CM, according to the criteria defined by IHS. Patients who met the criteria of VM were further classified into two groups, EVM from EM patients and CVM from CM patients, respectively. We recorded their clinical features based on a structured questionnaire and compared them between each group.

Results: Totally 325 new migraine patients visited our clinic during the period of study. Eighty of them were classified as CM group (24.6%). The rest 245 patients were in EM group (75.4%). Fifty-seven patients in CM group (71.2%) have dizziness whereas 154 patients in EM group (62.9%) have dizziness. Eighteen patients in CM group met the criteria of VM and were classified as CVM (22.5%). Fifty-four patients in EM group were classified as EVM (22%). Twelve patients in CVM group are female (66.7%), 77.8% of EVM group are female. In CVM group, most patients (66.7%) suffered from vestibular symptoms lasting for hours to one day. In EVM group, 53.7% were hours to one day. The averaged vertigo day per month in recent one month is 17.5 days and 10.0 days in CVM and EVM group respectively. The most common migrainous symptom is phonophobia (83.3%) in CVM and headache (59.3%) in EVM. Visual aura is present in 27.8%, 16.7% of CVM and EVM patients.

Discussion: Vestibular migraine is not uncommon in chronic as well as in episodic migraine patients. Prevalence rate of VM is similar in CM and EM group. The most common migrainous symptoms are phonophobia and migrainous headache. Most VM patients suffered from vestibular symptoms lasting for hours to one day. No obvious difference was noted in clinical characteristics between these two groups.

P-S-4
SCREENING MIGRAINOUS HEADACHE PATIENTS WITHOUT VERTIGO COMPLAINS WITH VESTIBULAR BEDSIDE TESTS

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Introduction: Migraine and vertigo are common disorders, with lifetime prevalence of 16% and 7% respectively; and a co-morbidity around 3.2%. Vestibular syndromes and dizziness occur more frequently in migraine patients (30–50%). However, the issue as how and why vestibular changes do occur in migraine remains highly controversial. Due to the relatively higher prevalence of vestibular disorders in migraineurs, clinical tests specifically designed to detect even subtle vestibular dysfunctions are expected to be abnormal in this condition. A systematic search for bedside clinical signs indicative of vestibular dysfunction in migraineurs has not been performed.

Objective: To compare vestibulo-ocular (VOR) and vestibulo-spinal (VSR) responses as estimated by bedside tests in migraineurs without history of vertigo with controls.

Patients and Methods: In this cross-sectional study sixty individuals, thirty migrainous patients (ICHD 3rd edition); 25 women, 19–62 y-o (median 39.3 years) without vertigo complains and thirty sex and age healthy paired controls were evaluated. Bedside tests were used to assess the VOR and VSR reflexes. For the first, the head impulse test (HIT), head shaking manoeuvre (HSM), dynamic visual acuity test (DVA), and the subjective visual vertical test (SVV) were performed; and for the second the applied tests were the clinical test of sensory integration and balance (CTSIB), sharpened Romberg test (SRT), Fukuda stepping test (FST), and past pointing test (PPT). All subjects underwent a neurootological examination including the minimal ice test (MIT). The Wilcoxon Signed Rank test and the McNemar chi-square test were used for statistical comparisons. p values <0.05 were considered significant. This study was approved by the local Ethics Committee.

Results: There was a tendency for migraineurs to perform worse in all tests except for the VVS test, but head to head comparisons showed that only the SRT was statistically different between patients and controls ($p =$ 0,039), (TABLE). Taken together, considering the frequency of abnormal responses, patients performed significantly worse than controls ($p = 0.003$, Wilcoxon).

Four abnormal tests discriminated the two groups with a sensitivity of 23.3% and a specificity of 93.3%.
Conclusion: Migraine patients consistently showed abnormal vestibular bedside tests when compared with healthy controls. This indicates that the vestibular function is impaired subclinically in migraineurs without vestibular complains and that bedside tests are suitable to detect such dysfunctions. Whether these changes are specific for migraine remains to be determined.

Vestibular Bedside Examination Tests					
	Migraine (n=30)		Controls (n=30)		
	Normal	Abnormal	Normal	Abnormal	p-Value
Test					
HIT	19	11	23	7	0.344
HSM	28	2	30	0	0.130
DVA	17	13	22	8	0.267
SVV	26	4	26	4	0.074
CTSIB	24	6	27	3	0.375
SRT	19	11	27	3	0.039
FST	13	17	18	12	0.302
PPT	24	6	26	4	0.754

P-S-5
CENTRAL VESTIBULAR SYSTEM MODULATION IN VESTIBULAR MIGRAINE – A VBM STUDY

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Introduction: Vestibular migraine affects 1% of the general population and 30–50% of all migraine patients describe occasionally associated vertigo or dizziness.
Objectives: We aimed to identify brain regions altered in vestibular migraine in order to evaluate the connection between migraine and the vestibular system.
Methods: Seventeen patients with definite vestibular migraine were compared to 17 controls using magnetic resonance imaging based voxel-based-morphometry.
Results: We found gray matter volume reduction in the superior, inferior and middle (MT/V5) temporal gyrus as well as in the mid. cingulate, dorsolateral prefontal, insula, parietal and occipital cortex. A negative correlation of disease duration and GM volume was observed in areas associated with pain and vestibular processing. Moreover, there was a negative correlation between headache severity and prefrontal cortex volume.
Conclusion: Alterations identified in vestibular migraine resemble those previously described for migraine, but also extent to areas involved in multisensory vestibular control and central vestibular compensation possibly representing the pathoanatomic connection between migraine and the vestibular system

P-S-6
THE PREVALENCE OF VESTIBULAR MIGRAINE AT AN ENT DIZZINESS CLINIC: A RETROSPECTIVE STUDY

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Introduction: Vestibular migraine (VM) is one of the most common causes of dizziness. With this study, we wanted to study the prevalence of VM in a patient population consulting to a specialized ENT dizziness clinic. Furthermore, we wanted to assess the associated symptoms in this patient group and to evaluate the efficacy of some prescribed medication, being flunarizine and propranolol.
Methods: We reviewed charts of all patients ($n = 407$) consulting to the specialized and interdisciplinary vertigo clinic between January 2012 and January 2014 at the Antwerp University Hospital. We used the diagnostic criteria as proposed by a consensus from the Bárány Society and the International Headache Society in 2012 and assigned patients to one of the two proposed groups: vestibular migraine (VM) and probable vestibular migraine (PVM). However, we created a third group with atypical VM (AVM), defined as a category of patients who didn't fit the criteria for either group 1 or 2 but showed several symptoms suggestive for VM. Per patient, we listed all associated neuro-otological symptoms and we evaluated the efficacy of the proposed drug treatment.
Results: From the total patient population ($n = 407$), 65 (16%) were selected from which 17 patients were assigned to the VM group, 23 to the PVM group and 25 to the AVM group. Logically, the presence of migraine was significantly different distributed among the three groups ($p < 0.001$), i.e. only 8% of the AVM group presented with migraine, while this percentage was much higher for PVM and VM, respectively 42% and 50%. Furthermore, we also found a significantly different distribution among the groups for photophobia ($p = 0.035$, VM = 32%, PVM = 44%, AVM = 24%), ear pressure ($p = 0.023$, VM = 42%, PVM = 19%, AVM=39%) and scotoma ($p = 0.015$, VM = 41%,

PVM = 27%, AVM = 32%). However, the presence of migraine history, headache, photophobia, visual aura, nausea, vomiting, speech disturbances, paraesthesia, tinnitus, decreased hearing, imbalance, tendency to fall and blurred vision is not associated with the type of vestibular migraine. For all patients, the 5 most frequent associated symptoms were paraesthesia and tingling (59%), tinnitus (54%), photophobia (53%), pressure in one or both ears (43%), scotoma (41%). In total, 31 patients were treated with flunarizine of which 68% showed improvement with this treatment, 10% had no benefit of flunarizine administration and in 23% of the patients worsened, while 30 patients were treated with propranolol of which 73% showed improvement, 3% had no benefit and 23% reported being worse. For both drugs, these percentages were not significantly different for the three groups but the percentage of patients improving was significantly higher for both drugs than patients reporting no benefit or worsening of symptoms (both $p < 0.001$).

Conclusion: VM is a common disorder in patients consulting to an ENT vertigo clinic and a detailed and systemic history taking is important to prevent underdiagnosis. Our chart review shows that the majority of patients, regardless of the straightforwardness of their symptoms and thus the allocated group, can benefit from a pharmaceutical treatment. The fact that the AVM group benefits from typical anti VM medication in the same way that patients in the PVM and VM group do, suggests that some of the present criteria may have to be updated or loosened. Further prospective studies are necessary to corroborate these findings.

Poster Presentations T. Motion Sickness

P-T-1
MOTION SICKNESS OF CAR PASSENGERS IS LINKED TO SPATIAL DISTRIBUTION OF GAZE

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Introduction: Motion sickness arises when sensory information from vestibular and visual systems mismatch. During driving, the gaze behavior could play an important role for receiving correct visual information about self-motion. Looking at the interior of the car could be misinterpreted by the observer as being in rest, while looking at the bypassing landscape allows to perceive car and self motion. For car drivers, who are known to be less susceptible to motion sickness than passengers, a pro-active task-driven gaze behavior with look-ahead fixations has been shown. Passengers, in contrast, are not required to visually control the driving process. We tested whether the gaze behavior of passengers with and without susceptibility to motion sickness is different.

Methods: Eye movements of 2 persons susceptible to motion sickness and 2 persons resistant to motion sickness were recorded during a drive in a van (Volkswagen T4) while they were sitting in the back seat on a winding mountain road. For each person, the van was first driven up the mountain and subsequently down, with a total duration of $\sim$18 minutes. The eye tracker (EyeSeeCam, Munich) additionally recorded GPS data. Graybiel Motion Sickness values were obtained after the first half of the ride (immediately after reaching the top of the mountain after $\sim$7 km) and after the subsequent drive down. The individual distributions of gaze directions were analyzed with principal component analysis.

Results: In all four subjects, the first principal component was oriented mostly horizontally. However, the susceptibles showed a more isotropic spatial distribution of gaze directions than the resistants. The amount of variance in gaze distribution explained by the first principal component was 65% and 74% in the two motion sickness susceptibles, vs. 83% and 85% in motion sickness resistant.

Conclusions: This pilot study revealed a link between spatial gaze distribution to motion sickness of passengers in a moving vehicle. A narrow spatial gaze distribution is indicative of a specific fixational strategy, e.g. concentrating on watching the road. Whether instructions for gaze behavior can alter the severity of motion sickness should be further investigated.

P-T-2
MOTION SICKNESS SUSCEPTIBILITY IN VESTIBULAR DISEASE NEURO-OTOLOGY, IMPERIAL COLLEGE LONDON, UK

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Introduction: Motion sickness causes symptoms of nausea, vomiting and dizziness that resemble those seen in a number of vestibular disorders including Vestibular Neuritis (VN) and incompletely compensated peripheral vestibular disorders. By contrast those with bilateral vestibular failure (BVF) are thought to be largely immune to motion sickness symptoms. Migraine (M) is also related to motion sickness symptomatically and epidemiologically,as is the vestibular migraine (VM) subtype. However, the extent to which changes in motion sickness susceptibility may contribute to the clinical presentation of any of these disorders is unknown. This study was therefore designed to investigate the role of motion sickness in vestibular disorders.
Methods: Five groups ($n = 12$ normal controls, $n = 12$ with VN, $n = 8$ with BVF, $n = 12$ with M (no vestibular symptoms) and $n = 12$ with VM) underwent assessment using validated motion sickness questionnaires (MSSQ). These questionnaires assessed self-rated susceptibility in childhood, adulthood (over the last ten years) and after the onset of vestibular symptoms where applicable. Participants underwent a protocol of experimentally induced motion sickness using off-vertical axis rotation (OVAR). The primary outcome measures were MSSQ scores, and the length of time to moderate nausea on OVAR.
Results: None of the groups reported a significant change in motion sickness susceptibility after the onset of vestibular symptoms. The M and VM groups had the shortest tolerance of OVAR motion, with VN and normal controls showing an intermediate response and the BVF group had significantly longer tolerance ($p < 0.001$).
Conclusions: Those with BVF appear to be largely, but not completely, immune to motion sickness. The M and VM group show an increased motion sickness susceptibility, but are not significantly different from each other.

P-T-3
IS THERE A RELATIONSHIP BETWEEN ODORS AND MOTION SICKNESS?

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The aim of this study was to evaluate the relationship between olfaction and motion sickness. A sample of 18 participants was recruited and submitted to 3 sessions of nauseogenic stimulations, Off Vertical Axis Rotation (OVAR), performed under conditions of olfactory stimulation with limonene (pleasant odor), petrol (unpleasant odor) or distilled water (as a control). Motion sickness was assessed before, during and after each OVAR session. In addition, participants were asked to evaluate the intensity and hedonic valence of four odors (geraniol, limonene, butanol, petrol) as well as distilled water (as a control) before and after each OVAR session. Our analysis showed that OVAR has consistently increased the induced-motion sickness. However the addition of an odor that is pleasant or unpleasant during the rotation did not affect the occurrence of motion sickness symptoms compared to the control condition. Our results also showed that intensity of odors was significantly increased after OVAR and the intensity was significantly higher for unpleasant odors than for pleasant one. For the hedonicity, OVAR made unpleasant odors more unpleasant ($p < 0.0001$) while it made limonene odor slightly more pleasant ($p < 0.05$). The present study highlighted the lack of influence of odors in motion-induced sickness but an impact of a nauseogenic test on olfactory perception.

P-T-4
MOTION SICKNESS SUSCEPTIBILITY IN HEALTHY SUBJECTS AND VESTIBULAR PATIENTS: EFFECTS OF GENDER, AGE AND TRAIT-ANXIETY

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Several studies have suggested that anxiety may play a role in motion sickness susceptibility (MSS) variability. This study aimed to assess motion sickness susceptibility in healthy subjects and chronic vestibular patients and to investigate its relationship to gender, age and trait-anxiety. Healthy subjects ($n = 167$) and chronic dizzy patients with various vestibulopathies ($n = 94$), aged from 20 to 92 years old, were asked to complete Motion Sickness Susceptibility questionnaire (MSSQ) and trait-anxiety questionnaire (STAI-B). When patients were divided into those who had

vestibular loss ($n = 51$) vs. patients without vestibular loss ($n = 43$), the MSSQ scores (mean $\pm$ SD) for patients with vestibular loss (18.8 $\pm$ 30.9) were lower than healthy subjects (36.4 $\pm$ 34.8), who were lower than vestibular patients without vestibular loss (59.0 $\pm$ 39.7). These significant differences could not be explained by gender, age, trait-anxiety, or interaction. Women had higher MSS than men, and MSS declined with age for healthy subjects and vestibular patients. The overall relationship between anxiety and MSS scores was weak and only reached significance in healthy subjects. These results support the conclusion that the vestibular system is heavily involved in MSS and that trait-anxiety may play a role in MSS but only in healthy subjects.

Poster Presentations U. Central Aspects of Vertigo

P-U-1
NEURO-BEHCET DISEASE PRESENTED WITH DIPLOPIA MIMICKING INTERNUCLEAR OPHTHALMOPLEGIA

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Background: Behcet disease (BD) is characterized by recurrent aphthous oral and genital ulcerations, uveitis, and systemic inflammation. The nervous system involvement is one of the most serious manifestations of BD, leading to headache, confusion, paresis, cranial nerve palsy, cerebellar ataxia, or meningeal irritation signs. Neuro-Behcet disease (NBD) may be difficult to be diagnosed in patients without full-blown feature of BD. We present a patient with NBD initially presented with diplopia mimicking internuclear ophthalmoplegia.
Case: A 29-year-old man was referred to the department of Neurology with sudden onset of diplopia and dizziness. He was previously healthy and had no history of neurological disease. He had recurrent fever and intermittent multiple joint pain in the past according to patient's recall. Neuro-ophthalmologic examination showed impairment of the medial and downward gaze of the left eye, suggesting damage to left 3rd cranial nerve. Also he showed left ptosis and eyeball pain. The results of white blood cell count, C-reactive protein and urinalysis were within normal limits. The laboratory studies for C3, C4, rheumatoid factor, anti-nuclear antibodies, anti-neutrophil cytoplasmic antibodies, anti-Ro/La antibodies and HLA B51 revealed all negative findings. The cerebrospinal fluid (CSF) analysis revealed mild leukocytosis associated with mildly elevated with CSF protein. Brain MRI showed bilateral FLAIR high signal intensity lesions in basal ganglia and left thalamomesencephalic area with high ADC and multiple nodular enhancement suggesting vasculitis such as neuro-Behcet disease. After high dose pulse methylprednisolone treatment, followed by oral prednisone, neurologic status of patient was gradually improved. The second MRI showed more resolution of initially suspicious neuro-Behcet disease accompanied by an improvement of diplopia, ptosis and eyeball pain.
Conclusions: Diagnosis of NBD is sometimes difficult because all specific diagnostic manifestations may not be present at the same time and long time intervals may be needed before the appearance of characteristic clinical features to make a definite diagnosis. In this case, he had solid neurological manifestations and recurrent history of fever and multiple joint pain to be clinically considered NBD. The differential diagnoses including systemic lupus erythematosus (SLE), primary Sj?gren syndrome, primary anti-phospholipid antibody syndrome, multiple sclerosis (MS), neurosarcoidosis, viral infections and systemic vasculitis should be considered. In conclusion, we should consider the possibility of NBD as the cause of neurologic manifestations developed by ophthalmoplegia who have no alternative diagnosis. In addition we have to fully evaluate the evidence of BD if someone has typical features of NBD on the brain MRI with neurological abnormalities.

P-U-2
DOWNBEAT NYSTAGMUS INFLUENCES GAIT CONTROL

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Introduction: Downbeat nystagmus (DBN) is a common form of acquired fixation nystagmus with key symptoms of oscillopsia and gait disturbance. Gait disturbance could be a result of impaired visual feedback due to the involuntary ocular oscillations. Alternatively, a malfunction of cerebellar locomotor control might be involved, since DBN is considered a vestibulocerebellar disorder.

Methods: Investigation of walking in 50 DBN patients (age 72 $\pm$ 11 years, 23 females) and 50 healthy controls (HS) (age 70 $\pm$ 11 years, 23 females) using a pressure sensitive carpet (GAITRite®). The patient cohort comprised subjects with only ocular motor signs (DBN) and subjects with an additional limb ataxia (DBN+). Gait investigation comprised different walking speeds and walking with eyes closed.
Results: In DBN, gait velocity was reduced ($p < 0.001$) with a reduced stride length ($p < 0.001$), increased base of support ($p < 0.05$) and increased double support ($p < 0.001$). Walking with eyes closed led to significant gait changes in both HS and DBN. These changes were more pronounced in DBN patients ($p < 0.001$). Speed-dependency of gait variability revealed significant differences between the subgroups of DBN and DBN+ ($p < 0.05$).
Conclusions: (I) The gait of patients with DBN is impaired due to a disturbed balance control. (II) Impaired visual control caused by involuntary ocular oscillations cannot sufficiently explain the gait disorder. (III) Analysis of gait variability allows distinguishing DBN from DBN+: Patients with DBN only show a speed dependency of gait variability similar to that of patients with afferent vestibular deficits. In DBN+, gait variability resembles the pattern found in cerebellar ataxia.

P-U-3
BIOMARKERS IN VESTIBULAR PATIENTS WITH INADEQUATE COMPENSATION BY MEANS OF DIFFUSION-WEIGHTED MRI AND TRACTOGRAPHY – A PILOT STUDY

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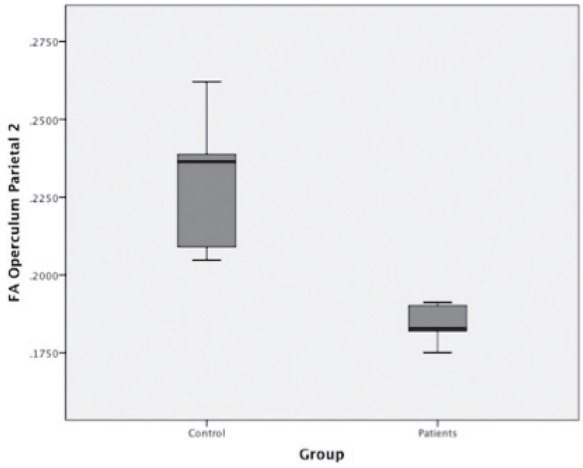
Introduction & Objectives: After a sudden vestibular lesion, patients present with a syndrome of vestibular, oculomotor and postural symptoms. However, during the first days, symptoms meliorate and patients cope with these effects, partially due to neuroplasticity. Most patients compensate rather quickly, while others with similar symptoms recover suboptimal or do not recover at all. This may be due to inadequate compensation mechanisms at specific brain regions responsible for the integration of vestibular signals. The aim of this pilot study was to gain a first insight in the process of neuroplasticity after a vestibular deficit. We therefore investigated diffusion parameters based on advanced MRI methods at certain regions of interest (ROIs) and tracts. Group differences of these MRI parameters between specific vertigo patients and matched controls were studied.
Methods: Data acquisition: Multi-shell high angular resolution diffusion weighted (DW) data were acquired on a 3T scanner using a 32-channel head coil. We used a single-shot echo-planar imaging (EPI) sequence with the following parameters: voxel size 2.5 $\times$ 2.5 $\times$ 2.5 mm3, acquisition matrix = 96 $\times$ 96, TR = 8100 ms, TE = 116 ms. Diffusion sensitizing gradients were applied at b-values of 700, 1000 and 2800 s/mm2, along 25, 45 and 75 non-collinear directions, respectively. 10 images without diffusion weighting were acquired, of which 5 were acquired with reversed phase encoding, for the purpose of EPI distortion correction. Data processing: The DW images were corrected for EPI, motion and eddy-current distortions. Investigated structures were: amygdala, superior temporal gyrus, hippocampus, parietal operculum 2 (OP2), cerebellar peduncles, corticospinal and corticobulbar tracts. For each brain structure, the average fractional anisotropy (FA), mean diffusivity, axial diffusivity and radial diffusivity were calculated.
Subjects: For this pilot study, five vestibular patients and five healthy control subject were included. The vestibular patients, selected during specialized vertigo consultancy at the department of ENT, suffered all from similar symptoms of constant vertigo, existing for several months to years, and without proper evolution or recovery. Group differences for DTI parameters were measured by means of tractography and region of interest (ROI) analysis.
Results: For the vertigo patients, we found significantly reduced FA in the right OP2 region (Mann Whitney U test, $p = 0.009$) (Image) and the cerebellar peduncles (Mann-Whitney U test, $p = 0.03$) when compared to controls. For MD and the other regions, no significant differences could be found for this small group.
Discussion: To our knowledge, this is the first study to use diffusion imaging methods in vestibular patients and to show a relation between diffusion parameters,

representing brain connectivity and clinical symptoms of vertigo. Furthermore, it is not surprising to find a difference in the right OP2 region, since this region has recently been suggested as being the core of the human vestibular cortex.

Conclusion: Reduced FA in the right OP2 region and of the cerebellar peduncles may explain the symptoms of continuous vertigo and inadequate compensation due to vestibular lesions. Thus, this pilot study suggests that diffusion parameters may serve as biomarkers for vestibular induced neuroplasticity and unravel the relationship between brain connectivity and vestibular complaints.



Poster Presentations V. Psychiatric/Physiological Aspects of Vertigo

P-V-1
DIZZINESS AND SELF-EFFICACY – A QUALITATIVE STUDY

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Introduction: Knowledge of how different behaviors and psychological factors affect people with dizziness is limited. A greater understanding of these behaviors and relevant psychological factors could lead to an improvement in care, management and treatment of these people. No previous studies have investigated how perceived self-efficacy (SE) influences activities of daily living (ADL) and symptom management in people with dizziness. Social cognitive theory (SCT), founded by Bandura in 1986, describes human behavior as a reciprocal interaction between the individual, behavior, and the environment. SCT has been used extensively to describe correlations between health status and health change. SE is one of SCT's most important active agents and is defined by Bandura as "beliefs in one's capability to organize and execute the courses of action required to manage prospective situations". Perception of SE is task, situation, and context specific. These factors must be taken into consideration in order to attain measurements sufficiently sensitive to detect changes in perceived SE over time.

Objective: To explore how people with dizziness perceive their SE to execute ADL and what factors affect SE for symptom management.

Methods: 4 focus group interviews and 1 individual interview with 16 participants (thirteen women and three men) aged 45–85 years, with a history of dizziness ranging from 4 months to 30 years were conducted in an outpatient physiotherapy setting in a hospital in Sweden. The participants had been diagnosed by ENT specialists at the otolaryngology department. 13 participants had peripheral-vestibular deficits, 2 had central vestibular deficits, and 1 had unknown etiology. A semi structured interview protocol was used with a topic guide and open ended questions to encourage discussions between the participants. During the interviews the moderator used respondent validation throughout the discussions to make sure that it was the construct of SE that was being discussed. Data was analyzed using qualitative content analysis.

Results: 10 categories and 18 subcategories consisting of 85 different codes were revealed for the theme SE for ADL. The second theme, SE for symptom management, revealed 3 categories with 10 subcategories consisting of 19 codes.

Conclusion: The use of interviews as a means of creating a questionnaire for the measurement of SE is widely recommended in the literature. This position is supported by the results of the study. Participants gave rich and detailed stories from their everyday life on how their perception of SE was perceived to change according to type of activity and the activities perceived level of difficulty. The results can be used not only to clarify what specific ADL and factors for symptom management are important to include in a questionnaire measuring SE for this population, but also which level of difficulty for each activity and which domains.

P-V-2
GAIT CHARACTERISTICS OF PATIENTS WITH PHOBIC POSTURAL VERTIGO: EFFECTS OF FEAR OF FALLING, ATTENTION, AND VISUAL INPUT

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Introduction: Phobic postural vertigo (PPV) is the most common cause of chronic dizziness in middle-aged patients. Many patients report symptoms during gait. We investigated the gait performance and its relationship to the fear of falling and attention of PPV patients.
Methods: Prospective study of 24 patients with PPV (12 females, 49 $\pm$ 15 years) and 24 healthy subjects (HS) (12 females, 48 $\pm$ 16 years) using a pressure-sensitive mat (GAITRite®). Subject walked at three different speeds (slow, preferred, fast), during cognitive dual task (DTc), and with eyes closed (EC). Fall efficacy and balance confidence were rated by the Falls-Efficacy Scale-International (FES-I) and the Activities-specific Balance Confidence Scale (ABC).
Results: PPV patients walked slower with reduced cadence (all $p < 0.01$), stride length ($p < 0.05$), and increased double support ($p < 0.01$) compared to HS. These changes correlated with FES-I ($R = -0.528$, $p < 0.001$) and ABC ($R = 0.481$, $p < 0.01$). Walking deterioration under DTc did not differ between PPV and HS, but patients showed a reduced processing speed ($p < 0.05$). When walking with EC, gait speed decreased more in PPV compared to HS ($p < 0.05$).
Conclusion: Patients with PPV show gait changes which correlate with the fear of falling and balance confidence. Absent visual feedback led to more pronounced gait deteriorations in PPV than in HS, indicating a higher reliance of the patients on visual information during gait. These findings support the view that the gait characteristics of PPV can be attributed to an inadequate, cautious gait control.

P-V-3
PSYCHIATRIC COMORBIDITY IN PATIENTS WITH DIZZINESS AND THE THERAPY OF PSYCHOTROPIC DRUGS

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Introduction: Last Barany meeting, we reported neuro -otological findings in psychiatric patients with nystagmus. In this study, we investigated 3 types of psychogenic dizziness (PsD) (narrow type, wide type and psychiatric (Psy) comorbidity) and the therapy of psychotropic drugs.
Methods: The 746 patients (238 men, 508 women, age range, 7–95; mean age Ą} SD 59.0 Ą} 18.0 years) with dizziness were classified as otolaryngologic (Otola) disorders (D): dizziness of unknown cause (DUC) in 342 (45.8%), otogenic vertigo (OV) in 141 (18.9%), Meniere's disease (MD) in 106 (14.2%), chronic cerebral insufficiency in 88 (11.8%), BPPV in 39 (5.2%) and other types of diseases in 30 (4%). Patients were diagnosed by designated physicians of mental health or psychiatrists with more than 9 years clinical experience using ICD-10.
Results: PsD narrow type was revealed in 134 (18%). Psy comorbidity was revealed in 487 (65.3%). Table 1 showed Psy comorbidity according to Otola D. Of 487 patients, various types of Psy D were found, such as anxiety or panic D (F41) in 271 (55.6%), mood D (F3) in 89 (18.3%), adjustment D or post-traumatic stress D (F43) in 28 (5.7%), dissociative D (F44) in 6 (1.2%), other neurotic D(F48) in 18 (3.7?), organic mental D (F0) in 38 (7.8%) and schizophrenia (F2) in 26 (5.3%). These patients were not only treated by otolaryngologists, but also received Psy therapy, and 380 (78%) of these patients were prescribed psychotropic drugs. Minor tranquilizer was prescribed in 269 (70.8%), sleeping pills in 126 (33.2%), antidepressant in 94 (24.7%). major tranquilizer in 71 (18.6%), anti- epileptic drugs in 24 (6.3%), lithium carbonate in 6 (4.2%), anti- Parkinson's disease drugs in 16 (4.2%), other drugs in 28 (7.4%). In various antidepressants, SSRIs were prescribed in 61 (65%) and especially Paroxetine and Sertraline were prescribed more frequently. Dizziness Handicap Inventory (DHI) scores on depression group were extremely high after regular treatment. However, addition of SSRI treatment improved those scores remarkably. Furthermore, in VOR test with rotation, DP% scores were extremely high after regular treatment. But addition of SSRI treatment improved those scores amazingly. Therefore, SSRI was

very effective for patients with dizziness and depression. We made a video presentation about some cases with dizziness and depression.

Conclusions: Recently, SSRIs have been prescribed more frequently by otolaryngologists, but they need to be careful for the treatment of patients with depression when they prescribe SSRI because of these patients may have bipolarity or hypomanic episode. To reduce the risk of these incidents of misdiagnosis, otolaryngologists are strongly encouraged to collaborate with psychiatrists when they diagnose. We believe that collaboration between psychiatrists and otolaryngologists in the hospital and/or doctors in local area can improve the mental condition and the quality of life (QOL) of patients who are suffering from dizziness with psychiatric comorbidity.

Otola D	Psy comorbidity
dizziness-UC	192/261 (73.6%)
otogenic vertigo	66/95 (69.5%)
Meniere fs disease	54/77 (70.1%)
chronic cerebral insufficiency	26/48 (54.2%)
BPPV	12/24 (50.0%)
other types of diseases	12/19 (63.2%)
total	362/746 (69.1%)

Poster Presentations W. Cognitive/Cortical Aspects of Vertigo

P-W-1
THE INFLUENCE OF 2D DEPTH CUES ON ROLL-VECTION AND POSTURAL SWAY

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Vection (the illusion of visually induced self-motion) can be more powerful when a real stationary object is placed in front of a moving pattern, and reduced when the object is placed behind the pattern. However, it has not been studied whether the same effect can be induced using mere 2D computer generated imagery commonly available. Moving patterns, furthermore, also influence postural sway, which allows for objectifying the effect of these moving patterns other than (subjective) vection. This, however, has not been studied either. We therefore studied (1) whether the positioning of a virtual object within a 2D moving pattern affects vection and (2) whether this effect can be substantiated by postural sway recordings. To that end, a monochromatic pattern of circles rotating in roll about the naso-occipital axis at 30°/s was presented on a flat 2D TV screen to 14 subjects in four conditions, using a within subjects design. These four conditions were a rotating pattern without an object (NF), and with an object, in this case a dichromatic flower, appearing behind (FB), in the same plane as (FS), and in front of that pattern (FF,Fig. 1).<IMAGE01> Vection was rated using a 3-point scale (0-no, 1-sometimes, 2-continuously). Postural sway was recorded at 100 Hz in each trial using a force plate. From the resulting center of pressure (CoP) data we calculated the sway path length (SPL), the mean moving window standard deviation (MWSD), and lean in the medio-lateral direction only. The mean MWSD was computed for 19 non-overlapping windows of 100 data points and was then averaged, yielding a mean MWSD that is not affected by the CoP shift during rotation. The lean is defined as the average position of the COP over a certain time window (19 s in our case). This measure allows us to assess whether postural effects of the rotating pattern increase over time. Each trial started with a stationary pattern to collect baseline data, immediately followed by a period of pattern rotation. In all conditions vection rates were significantly elevated by rotation of the pattern. The SPL and MWSD increased significantly during pattern rotation as compared to baseline. In addition, subjects shifted their lean in the direction of rotation. Vection rates and postural sway were not affected by the positioning of the object within the roll pattern. The lean, however, obtained while watching a roll pattern with the flower behind it, did seem to increase slower than in the other conditions. We conclude that (1) the positioning of a virtual object in 2D does not affect vection, and (2) the effect of a pattern in roll significantly affects postural sway. Moreover, (3), postural sway seems to be a more sensitive measure than vection ratings in discriminating between conditions, as evidenced by the lean values.

P-W-2
INVISIBLE VISUAL LANDMARKS UPDATE INTERNAL ESTIMATES OF VESTIBULAR-DERIVED ANGULAR ORIENTATION AND MOTION DURATION

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Accurately sensing one's position in space is of fundamental ecologic importance. Humans can determine their angular position in the dark using only vestibular cues. In a related paper, Kaski et al. show that lesions of the right temporoparietal cortex result in congruent impairments of perceived spatial orientation and motion duration for leftward but not rightward whole-body rotations. This suggests the brain could use an explicit temporal integration mechanism to derive spatial estimates from vestibular motion cues. The observed link between time and space perception in lesion patients could be casual and explained by a common neural substrate mediating both functions. Here we assessed, in 16 healthy volunteers (mean 25 years), whether updating internal percepts of self-location and motion duration could be influenced by subconscious ('masked') visual landmarks. Visual landmarks were printed on a cylindrical drum suspended around a computer-controlled motorised chair. Once subjects were familiarised with the visual landmarks in full light, the landmarks were rendered invisible using 'backward visual masking'. Here, the landmark is illuminated by LED lights for circa 15ms. Following 10 ms, a nonsense visual image or 'mask' was illuminated for 200ms. The duration of the landmark illumination was titrated for each subject (using a modified binary search algorithm) so that only the mask was seen. A single experimental RUN was as follows: subjects sat facing a visible cardinal image ('START') and then were rotated (OUTBOUND rotation) in the dark to some other angular location. The subject then indicated their perceived position and masked visual feedback was then provided. Subjects were then required to press a button for a time equivalent to their perceived motion duration. The subject was then rotated in the dark back to the 'START' (INBOUND rotation) with an identical but oppositely directed whole-body rotation. The 'START' position was again fully illuminated. The subject now had to provide a second motion duration estimate with a button press. The masked visual feedback could indicate either the real angular orientation or, by rotating the drum in the dark, an angular orientation that was either smaller or bigger than the true angle. Subjects' indication of temporal duration was converted to a gain (indicated/real duration). A repeated measures ANOVA with factors PHASE (OUTBOUND vs. INBOUND) and MISMATCH (SMALLER, CONTROL, BIGGER) showed no main effect of PHASE ($P = 0.6$) but a significant effect of MISMATCH upon motion duration indications [$F(2, 14) = 10.3$; $P = 0.002$]. Combining INBOUND and OUTBOUND temporal responses showed that motion duration indications were significantly larger for BIGGER perturbed feedback rotations compared to SMALLER perturbed feedback rotations. In a separate experiment with 13 volunteers, we showed that subliminal visual landmark when mismatched to the real displacement does indeed update internal estimates of self-location ($P = 0.036$; $t = 2.31$; $n = 13$; paired t-test for SMALLER vs. LARGER conditions). These data show that vestibular-guided angular path integration occurs automatically and that estimates of motion duration are embedded within encoded percepts of travelled distance derived from vestibular cues. This suggests that navigating with vestibular cues involves a timing signal.

P-W-3

CORTICAL HEMODYNAMIC RESPONSES TO MAINTAIN THE POSTURAL BALANCE IN SENSORY CONFLICT-FUNCTIONAL NEAR INFRARED SPECTROSCOPY (FNIRS) STUDY-

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Background and aim: To investigate brain activity to sensory conflict between vestibular, proprioceptive and visual inputs during standing balance, the cortical hemodynamic responses during the Sensory Organisation Test (SOT) as part of the EquiTest System were recorded simultaneously with functional near infrared spectroscopy (fNIRS)

Methods: Eleven male healthy subjects were enrolled (all right-handed). 31 NIRS probes (15 optical sources and 16 detectors) were set on the right parieto-temporal head surface and hemodynamic data was recorded from 50 fNIRS channels. After recording, 3-D locations of fNIRS probes were measured with 3-D digitizer. Changes in Oxy-Hb, which has been reported to be sensitive to neuro-hemodynamic relationships, are assessed in this study. Group statistical analyses using NIRS-SPM were performed in each SOT condition.

Results: Group statistical analyses using NIRS-SPM revealed that cerebral cortices around Sylvian fissure were activated in SOT2 @ (the subject stood on a fixed platform with eyes open), SOT5 (the subject stood with the eyes closed and the visual surround fixed but the platform moved in response to his/her sway such that the ankle joints did not bend in response to the sway)

and SOT6 (the subject stood with the eyes open and the visual surround moved in response to the participant's sway, furthermore the platform moved in response to his/her sway such that the ankle joints did not bend in response to the sway) conditions. Other cortices were also activated in SOT5 and SOT6. @

Conclusion: Cerebral regions around Sylvian fissure, especially parietal operculum, have been considered as vestibular cortices in previous studies. These results suggest that the dominant sensorial weight is shifted to normal vestibular input in sensory conflict.

Poster Presentations X. Aging and Balance

P-X-1
PREVALENCE OF VESTIBULAR DYSFUNCTION IN THE ELDERLY THAT EXPERIENCE DIZZINESS AND IMBALANCE

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Dizziness and imbalance are clinically poorly defined terms, which have been estimated to affect $\sim$30% of the adult population over 65 years of age. In these patients it is often difficult to define the primary cause of dizziness, as it can stem from cardiovascular, vestibular, psychological and neuromuscular causes. However, identification of the primary cause is vital in determining the most effective treatment strategy for a patient. For example, identification of a vestibular cause for dizziness and imbalance would lead to vestibular rehabilitation that has been shown to result in improvements in quality of life. Our aim was to accurately identify the prevalence of: Benign Paroxysmal Positional Vertigo (BPPV), peripheral, and central vestibular dysfunction in subjects aged over 50 who had experienced an episode of dizziness or imbalance within the past year. Seventy six subjects aged 51 to 92 (mean $= 69 \pm 9.5$ years) were tested using the Head Thrust Dynamic Visual Acuity (htDVA) test, Dizziness Handicap Inventory (DHI), as well as sinusoidal and unidirectional rotational chair testing, in order to obtain data for: htDVA score, sinusoidal (whole-body, 0.1–2 Hz with peak-velocity at 30°/s) Vestibulo-Ocular Reflex (VOR) gain and phase, and transient (whole-body, acceleration at 150°/s2 to a constant velocity rotation of 50°/s) VOR gain and time constant and OptoKinetic Nystagmus (OKN) gain and time constant (whole-body, constant velocity rotation at 50°/s). We found that 38% of participants experienced dizziness and vertigo as a result of a detectable peripheral vestibular cause and 1% due to a central vestibular cause. Of those with vestibular cause 63% had BPPV, which is higher than the previously reported $\sim$25% seen in dizziness clinics, suggesting that BPPV is often undiagnosed in elderly patients. Our results indicate that htDVA, sinusoidal (particularly 0.5–1 Hz) and transient VOR testing were the most effective at detecting subjects with vestibular dysfunction, whereas DHI and OKN were effective at only detecting non-BPPV vestibular dysfunction.

P-X-2
FALLS AND FEAR OF FALLING AMONG PATIENTS WITH VERTIGO AND BALANCE DISORDERS

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Introduction: Falls are a major complication among the elderly and particularly among patients with movement disorders. Fall-related sequelae can be medical but also mental impairments, like fear of falling. Although many patients with vertigo and balance disorders suffer from postural instability and gait disturbances, little is known about their risk of falling and the potential impact on their health status. This study aimed to detect the prevalence of fallers and to evaluate fear of falling in different disease groups of patients with vertigo and balance disorders.

Method: A cross-sectional study was conducted at the German Center for Vertigo and Balance Disorders (DSGZ) in Munich. 800 patients attending the outpatient clinic completed a standardized self-administered questionnaire, including all fall events during the last 12 months. The questionnaire was designed according to international recommendations for falls assessment. Fear of falling was assessed by the Falls Efficacy Scale (FES-I). We report preliminary data of 464 patients, stratified by the following disease groups: somatoform vertigo (SV, $n = 167$), unilateral vestibular failure (UVF, $n = 125$), vestibular migraine (VM, $n = 70$), cerebellar ataxia (CA, $n = 44$), central oculomotor disorder (COD, $n = 34$), bilateral vestibular failure (BVF, $n = 24$).

Results: The annual fall rate was highest in the groups of CA ($n = 30$, 68%) and COD ($n = 20$, 59%). In peripheral vestibular disorders, 42% ($n = 10$) of the patients with BVF and 33% ($n = 41$) of the patients with

UVF reported at least one fall event during the past 12 months. The proportion of fallers was 20% ($n = 14$) in VM and 19% ($n = 32$) in SV. Median FES-I scores are highest in CA and COD (sores for all groups are shown in the table).

Conclusion: Falls are frequent in patients with vertigo and balance disorders that are caused by central deficits. Accordingly, patients with CA and COD are severely affected by fear of falling. Specific fall risk factors for these groups of patients need to be identified in order to design and implement fall prevention strategies.

Disease group	FES-I score [median]
Cerebellar ataxia (CA)	30
Central oculomotor disorders (COD)	30
Bilateral vestibular failure (BVF)	21
Unilateral vestibular failure (UVF)	22
Vestibular migraine (VM)	19
Somatoform vertigo (SV)	21

P-X-3
CHARACTERIZATION OF BALANCE DISORDERS IN ELDERLY PATIENTS IN AN OTONEUROLOGICAL PRACTICE

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Objectives: The aim of this study was to describe the characteristics of balance symptoms reported by elderly patients in a private otoneurological practice and to describe their final diagnoses as recorded by the specialist. Introduction: Vertigo and dizziness in the elderly are common complaints that have been reported among 30% of elderly over 65 years of age and increasing to 60% among the elderly over 85 years of age.

Materials and Methods: This is a retrospective, descriptive study. Data were obtained from the clinical records of patients who consulted Vestibular Argentina because of balance disorders between July and December 2013. 980 patients with disequilibrium symptoms consulted during this period. Both male and female patients aged 65 or older were included.

Results: The sample consisted of 196 patients, from which 122 (62.24%) were women, with a mean (standard deviation) age of 75.25 (7.1) years. The most common symptoms were dizziness (39.8%), vertigo (36.22%) and instability (11.22%). Only 11 patients consulted because of falls, but when they were asked about falls, 32 patients reported 1 or more falls. The most common diagnoses were: Benign paroxysmal positional vertigo (BPPV) (25.51%) and multisensory dizziness (27.04%). In the group of patients with VPPB the most prevalent symptom was vertigo (64%), however 20% of these patients complained of dizziness, without positional symptoms. 58.49% of multisensory dizziness patients reported dizziness, 24.53%, instability and vertigo only 7.55%.

Conclusions: Patients over 65 reported dizziness, vertigo or instability as the main complaint. Elderly patients often fail to report falls unless specific inquiries are made and that they often do not consciously recognize falls as an abnormality that should be investigated. The most common diagnoses were multisensory dizziness and VPPB. Even if the patient did not report vertigo and positional symptoms, VPPB must be ruled out.

P-X-4
EFFECTIVENESS OF NUTRACEUTICAL SUPPLEMENTS IN SUPPORTING BALANCE REHABILITATION THERAPY IN THE ELDERLY: "TOR VERGATA" UNIVERSITY EXPERIENCE

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Balance can be frequently impaired in the elderly and this condition might lead to a highly invalidating dizziness/presbyequilibrium (DP) state due to frequent important comorbidities and neurodegenerative trend. In this field, medical literature has recently proven alpha-lipoic acid (ALA) and docosahexaenoic acid (DHA) effectiveness in preventing and reducing neurodegeneration. Specifically, ALA has been shown to decrease reactive oxygen species formation in neurons, while DHA administration, after experimental brain injury, reduced the area of tissue affected by ischemic damage. Moreover, ALA, a vitamin-like substance which can be found in all human cells, seems to be involved in the regeneration of other cellular antioxidants, such as vitamins C and E, and glutathione. These substances have been shown to cross blood-brain barrier, thus having the potential to exercise their effects directly on neurons. No adverse effects of ALA or DHA, administered at a therapeutical dosage, have been described in recent literature. This study aims at evaluating the effects of a nutraceutical formulation of ALA and DHA as integrative therapy on balance control in the elderly suffering from DP. A group of 64 elderly subjects affected by DP and undergoing the same vestibular bal-

ance rehabilitation therapy (VBRT) was randomly divided in two sub-groups. The experimental group (EG) ($n = 33$; 17 female and 16 male; mean age 70.2 $\pm$ 4.7) received an oral formulation of ALA and DHA ethyl ester (200 mg and 50 mg, respectively- Inludha-) twice-a-day over a three-month period as the control one (CG) ($n = 31$, 16 female and 15 male; mean age 69.8 $\pm$ 4.6) underwent only VBRT. Both groups, before and after the treatment, were studied by using vestibular testing, static posturography with open (OE) and closed (CE) eyes, DHI (Dizziness Handicap Inventory) and DARS (Dizziness Assessment Rating Scale) questionnaires. No side effects due to the treatment were encountered and all patients completed the trial. The mean sway area and velocity of oscillations levels decreased after treatment, both in EG and in CG, with OE and CE ($p < 0.005$). To this end, the mean differences between pre- and post-treatment sway area was superior in the EG, for OE and CE measurements, when compared to CG. Moreover, as DHI scores showed statistically significant improvement in both groups ($p < 0.005$), significant improvement in DARS was found only in the EG. Our results showed for the first time that ALA and DHA long-term admistration, as nutraceutical supplements, might lead to better results in postural control as well as in dizziness related subjective scores in those elderly subjects suffering from DP, and thus supporting VBRT.

P-X-5
FALL OCCURRENCE AND PERFORMANCE ON SCREENING TESTS OF STATIC AND DYNAMIC BALANCE IN INDEPENDENT ADULTS IN CAPE TOWN SOUTH AFRICA: A PILOT STUDY

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Introduction: Falls are a global phenomenon of concern as the population ages. Falls are associated with significant morbidity and mortality. Fall prevalence is well described in developed countries but results from developing countries are lacking. Normative data on static and dynamic balance and other fall risk factors are similarly sparse from Africa. Evidence is emerging that the African population is ageing; however public health policy remains focussed on management of communicable diseases. Prevention and health promotion strategies are effective in fall management, but first the need for such measures should be evaluated in developing regions.

Objectives: 1) to conduct a survey to establish the occurrence of falls in an independent adult population over the age of 40years in Cape Town, South Africa. 2) to establish normative data for tests of static modified Clinical Test of Sensory Integration of Balance (mCTSIB) and dynamic Timed Up and Go in three conditions (TUG simple, cognitive and manual) balance in this population. 3) to describe fall risk factors (including results from objective 2)and fall-related injuries in this population.

Method: Purposive sampling resulted in 150 adults over the age of 40 years being recruited from community settings (churches, shopping centres). Participants answered a survey regarding fall risk factors, occurrence and injuries sustained in falls. They then completed the tests of static and dynamic balance as per a prescribed protocol.

Results: Occurrence of falls: overall 40% ($n = 60/150$) reported having fallen in the preceding 12 months with a significantly higher occurrence for females (71.6%, $n = 43$, p-value $= 0.1$. More than half of those who had fallen had done so repeatedly (56.65). Injuries are analysed according to Schwenk et al.'s (2012) protocol. Association of falls and tests of static and dynamic balance: no statistical significance between age, results of the mCTSIB and fall occurrence could be established. Tests of dynamic balance (TUG simple, $p = 0.037$, cognitive, $p = 0.037$ and manual, $p = 0.005$) were significantly associated with the occurrence of falls. As expected dual tasking produced longer completion times and results increased with age for each of the components of the TUG. Association of falls and presence of risk factors for falls: in this sample age was not associated with fall risk. Risk factors which were associated with reports of falls included medication ($p = 0.02289$); particularly sedatives and anti-depressants, self-reports of unsteadiness when walking ($p = 0.03063$) and fear of falling ($p = 0.03396$). Other risk factors cited by literature such as co-morbidities and balance-related illnesses (e.g. arthritis, visual deficits, osteoporosis, dizziness, hypertension)did not reach statistically significant associations.

Conclusions: Fall occurrence in this sample is compatible with results from developed regions, but higher than preliminary studies in Africa. Differences could result from fall definition, ethnicity and levels of physical activity. Results from this study suggest falls and injurious falls are challenges faced by some South Africans. High occurrence of falls presents a special challenge for older adults in Africa with the AIDS

pandemic which has profoundly changed the fabric of African society; adding to the responsibilities of older people. Results further suggest that TUG tests were sensitive to the presence of falls while the mCTSIB was not.

P-X-6
AMBULATORY ASSESSMENT OF UNSTEADINESS AND REHABILITATION INTERVENTION RESULTS IN ELDERLY POPULATION. BIOMEDICAL RESEARCH PROGRAM OF THE LABORATORIO DE OTONEUROLOGIA, HOSPITAL BRITÁNICO AND UNIVERSIDAD CATOLICA DEL URUGUAY

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Introduction: Elderly people instability is a major public health concern as it impacts their quality of life, reducing their functional capabilities as well as causing severe injuries and dependence situations. Its associated expenses for the health system are a topic of special attention, where fall-related costs mean near 70% of total costs for this population [1,2]. Increasing life expectancy and worldwide population aging give special relevance to this issue, leading to the need of developing new intervention and monitoring strategies. Considering the difficulties of transferring elderly to hospitals and knowing their real postural response, assessing gait remotely at the patient's home becomes an interesting approach. Motion capture systems based on inertial sensors, which have the autonomy and high portability needed, could be used for this purpose.
Objectives: This work presents an ambulatory gait analysis system designed towards remote analysis, and studies its suitability to evaluate unsteadiness and response to therapeutic interventions in older adults.
Methods: Gait analysis. Gait was analyzed using 3 xIMU inertial (x-io Technologies, UK). One of them was placed over sacrum and the other two were placed on each foot over the metatarsus. Inertial sensor's data were collected at 256 Hz and stored in a microSD card. Low power consumption, together with 1000mAh LiPo batteries allow a minimum of 10 hs autonomy. Stance, double support, step time, speed, stride length, feet and sacrum ranges of motion (ROM) for anterior-posterior (AP) and medio-lateral (ML) directions were estimated from accelerometer and gyroscope signals of inertial sensor, using the method described in [3]. For all parameters, the first and last detected cycles of gait are discarded to avoid the effect of acceleration and deceleration. Population. A group of 25 elderly patients with unsteadiness and vestibular pathologies (PG) (75 $\pm$ 13 years), were studied using the gait analysis system and compared to a control group (CG) of 17 adults (63 $\pm$ 9 years). PG was assessed with ENG and Dizziness Handicap Inventory tests. Also, a group of 6 elderly patients was assessed before and after a vestibular rehabilitation and physical therapy program (RPG). The program consisted of 8 sessions over one month, including static and dynamic vestibular training, customized home exercises, and physical therapy if needed. Statistics. To identify main changes in gait related to unsteadiness, gait parameters of the PG and CG were compared using independent samples t-student test. The evaluation of the evolution of those parameters for the RPG was performed using Wilcoxon signed-rank test. Results. Gait parameters values for PG and CG together with statistical significance are shown in the table. Speed, double support, stance and ML sacrum ROM also had significative changes in the RPG after the rehabilitation program ($p = 0.031$).

Parameter	Control group. Mean (std)	Pathological group. Mean (std)	p-value
Speed (m/s)	1.13 (0.177)	0.768 (0.160)	0*
Stride length (m)	1.25 (0.114)	0.945 (0.155)	0*
Double support (%)	20.2 (4.06)	26.5 (4.53)	0*
Stance (%)	60.1 (2.03)	63.2 (2.27)	0*
Step time (s)	0.563 (0.051)	0.624 (0.055)	0.001*
AP feet ROM average (º)	89.8 (7.46)	67.9(12.6)	0*
ML feet ROM average (º)	17.6(4.37)	16.6(5.42)	0.482
AP sacrum ROM average (º)	2.65 (1.20)	3.12(0.719)	0.149
ML sacrum ROM average (º)	3.92 (0.945)	3.05 (1.08)	0.008*

Conclusions: System sensitivity is capable to detect gait alterations due to unsteadiness and to follow up rehabilitation programs. Future work could take advantage of its portability to implement real life gait and postural behavior monitoring at patient's home. Allowing registration of during-day variations and the evaluation of medications effect, as well as detecting events that might not be produced during medical examination, it would help to understand fall mechanisms and the effect of therapeutic interventions in daily life, in a real environment.

P-X-7
VERTIGO IN THE ELDERLY WHO CONSULTED OUR HOSPITAL

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Introduction: The vertiginous diseases which arise in the elderly could restrict their daily activity, lead to the deterioration of their health, and sometimes to the accidental fall. The clinical process we see vertigo patients is identical in all the age population, however, there are some problems when we see the elderly patients complaining vertigo; 1) the symptom is attributed to two or more causes in some cases, 2) we cannot sometimes execute some physical examinations (ex. the positioning examination) because of the orthopedic problem of their neck or hip, 3) medical treatment is sometimes restricted because they have already used considerable amount of medicines, 4) physical treatments (rehabilitation) are restricted because of low daily activities.
Objectives: We investigated the clinical feature of vertigo or dizziness found in the elderly patients (65 years old or older), and their clinical course after treatment to see the underlying mechanisms of them arise in the elderly.
Methods: We investigated the clinical feature of vertigo or dizziness found in the elderly patients who visited the vertigo clinic of our hospital (Kitasato Institutional Hospital, Tokyo) from April 2011 to December 2013. We analyzed the underlying diseases, feature of the vertigo or dizziness, and the course of the symptom after treatments.
Results: 550 patients complaining vertigo had consulted us during the period mentioned above, among them 216 patients (39.3%) were 65 years or older. Among the 216 elderly patients the underlying disease which had caused vertigo were identified in 161 patients (74.5%); benign paroxysmal positional vertigo (BPPV) 57(26.4%), Meniere's disease 22(10.0%), vertebral basilar insufficiency (VBI) 22(10.0%), sudden idiopathic deafness with vertigo 13(6.0), vestibular neuritis 6(2.7%) were the frequent diseases. Furthermore, there are some diseases which we should put on mind although not frequent; three patients had dizziness induced by drugs, two had acoustic neurinoma, and two proved to have suffered from cerebellar infarction. Even less frequently we saw a patient with syncope caused by carotid sinus syndrome, the one with dizziness cause by hypotension, and the one with gait disturbance caused by waist herniated disk. On the other hand we could not find any obvious cause of dizziness in 55 patients (24.9%). The clinical course of these patients were carefully observed in our vertigo clinic. The symptom disappeared in 43 patients, and did not change in 12 patients. Among 12 the symptoms were not so severe as to affect their daily living in 10 patients, but the other two sometimes suffer from sudden onset of vertigo attack.
Conclusions: We have difficulty in detecting the causes of vertigo in the elderly since they often have more than one pathological state. However we found main underlying cause in 74% patients which could explain the symptoms. The thorough examinations are essential also in seeing elderly patients including eye movements, standing, positioning, hearing, and neurological test. MRI and MRA examinations should be done depending on the case since the incidence of cerebrovascular disorder is high in the elderly. We have to take into consideration that elderly often have several chronic diseases, and they use a considerable amount of drugs. We should observe the course carefully if the pathology is not detected on their first visit.

P-X-8
CONCURRENT VALIDITY OF A NEW BALANCE TEST IN OLDER ADULTS: PRELIMINARY RESULTS

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Introduction: Older adults have a greater risk of falling than the general population. The effects of these falls can be life threatening. Existing balance tests can identify elderly individuals with increased risk of falling and monitor gross changes in balance. Their disadvantages include ceiling effects and low sensitivity to detect changes in balance. The Zur Balance Test (ZBT) has been recently developed by a physical therapist in Israel. It is easy to perform and can differentiate between factors that cause imbalance, and thus might provide information regarding the most appropriate treatment.
Objectives: To determine the concurrent validity of the ZBT compared to the BBT.
Methods: 300 permanent residents of two residential care centers were invited to attend a lecture entitled 'Balance and Falls' and to participate in the study; with a goal of enrolling 100 participants. Balance was assessed with the ZBT and the Berg Balance Test (BBT). Oculomotor tests (Head Impulse Test, Dynamic Visual Acuity Test, Head Shaking Nystagmus Test and the Dix-Hallpike Test) were conducted to assess vestibular deficit. Participants complete five questionnaires:

The Activities-specific Balance Confidence Scale, The Dizziness Handicap Index, The University of California Los Angeles Dizziness Questionnaire, The Short Anxiety Screening Test and the Montreal Cognitive Assessment. The ZBT is scored based on three different measures. The 'General Score' (GS) is a combination of head movements and the time balance is maintained. The 'Protector Score' (PS) consists of four balance conditions (Cond 1, 4, 7, and 9). The third score is the mean of the GS and the PS. Results: These preliminary results are based on the first 37 subjects. Concurrent validity is indicated by the correlation of each of the 3 ZBT scores with the BBT: GS ($r = +0.64$, $P < 0.0001$), PS ($r = +0.61$, $P < 0.0001$), and mean score ($r = +0.65$, $P < 0.0001$).

Conclusions: BBT is currently a 'gold standard' for testing elderly individuals, but with limited usefulness for patients post-stroke or with high risk of falling. Based on preliminary results, the ZBT might be accurate for testing elderly individuals with mild-to-moderate balance disorders. Additional data will be presented at the conference.

Poster Presentations Y. Intratympanic Treatment

P-Y-1
TREATMENT OF MÉNIÈRE DISEASE WITH TRANSTYMPANIC GENTAMICIN, FINDINGS FROM A 10 YEAR FOLLOW UP OF A 109 PATIENT GROUP. INSTITUTO DE NEUROCIENCIAS DE BUENOS AIRES (INEBA)

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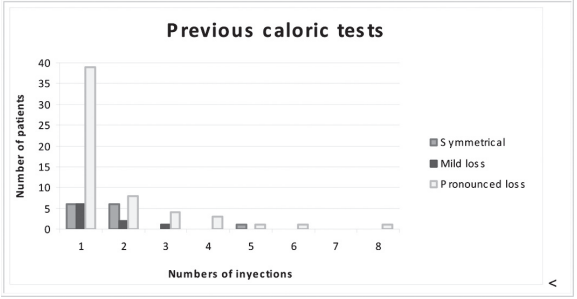

Introduction: Transtympanic Gentamicin (TTG) has shown to be an efficient and safe therapy for the treatment of Ménière Disease (MD) where there is no response to medical treatment. Yet, there is no agreement as to the protocol to be followed and there is non-matching data about the impact on hearing d vertigo control.

Material and Methods: We studied 89 patients without significant differences in age between the 3 groups (average 54) – Multiple dose protocol, means multiple applications with the end-point of lack of response in the caloric tests: 11 patients – Titration protocol, means one applications or multiple applications until reaching the clinical control of the symptoms: 98 patients.

Results: With all the modalities of the treatment control Class A of vertigo (according to Committee on Hearing and Equilibrium Guidelines for Diagnoses and Evaluation of Therapy in Meniere's Disease, AAOHNS Board of Directors) was reached in all the cases except one, with this differences: – Multiple dose protocol: the average of applications was 2, the average (in months) the average of control of the symptoms in this group was 61 months (5 years) – Titration protocol: the average of applications was 2, the average (in months) between the injection and the diagnosis of MD was 60 months (5 years). Anyhow, in this protocol in most cases a satisfactory symptoms improvement was achieved after one application (see table 1). – The best indicator for the number of doses need for symptom control was the degree of vestibular function loss when beginning with applications (see Table 2). – As regards auditory compromise the db variation was 15/20 and only two cases suffered from anacusia after one of the application with very severe and repetitive crises.

Conclusions: We did not find significant differences between those groups in terms of vertigo control. Better results are achieved using a single dose and deciding on new doses based on control. In most cases there was no significant impact on hearing in most cases.

P-Y-2
LOW-DOSE INTRATYMPANIC GENTAMICIN FOR CONTROL OF VERTIGO IN MENIERE'S DISEASE RESISTANT TO MEDICAL TREATMENT

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Objetives: To establish the effectiveness of low-dose intratympanic gentamicin treatment (a total dose being 4–16 mg) for the control of vertigo caused by Meniere's disease resistant to medical treatment, as well

as to determine the treatment's impact on hearing abilities.
Patients and methods: This is a longitudinal prospective study. Twenty-four patients unresponsive to medical treatment (14 female and 10 male) were treated with 4–16 mg of gentamicin, 4 mg per dose (only one patient had 16 mg). We checked spontaneous and head-shaking nystagmus, and audiometric control of frequencies of 0.5, 1, 2 and 3 KHz. A follow-up lasting one to five years was carried out. The criteria established by the 1995 AAO-HNS Committee of Hearing and Equilibrium were used.
Results: Complete control of vertigo (AAO-HNS Class A) was obtained in 15 patients (63 %), a significant control was achieved in 6 patients (AAO-HNS Class B) and vertigo was not controlled in three patients (AAO-HNS Class C). Twenty-one patients (88%) had good response. Hearing loss worse than 10 dB occurred in 17% and an improvement of more than 10 dB in 13%, whereas in 70% of cases hearing remained unchanged. The intensity and duration of tinnitus decreased in 29% of the patients, whereas it remained the same in the remaining 71%.
Conclusions: The low-dose intratympanic gentamicin treatment is a safe, efficient, low-cost, low-risk method presenting a reduced risk of hearing-loss post-treatment and thus it should be regarded as the primary treatment for vertigo control caused by Meniere's disease resistant to medical treatment.

P-Y-3
ISOSORBIDE CONCENTRATION IN PERILYMPH OF THE GUINEA PIG AFTER ORAL ADMINISTRATION VERSUS THAT AFTER ROUND WINDOW PERFUSION

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Objectives: The aims of this study were to investigate the feasibility of isosorbide delivery into perilymph through the round window membrane, and to compare the intracochlear isosorbide concentration in perilymph after oral administration (PO) versus that after round window perfusion (RWP).
Methods: Sixteen male guinea pigs (32 ears) were used. Isosorbide, an osmotic diuretic, was administered via RWP or PO. First, to investigate the optimal perfusion time, perilymph sampling of scala tympani from the round window membrane was performed after RWP for 15, 30, or 60 min. Second, to compare the drug concentration after RWP versus that after PO, perilymph was aspirated at 3 and 6 h after administration. Intracochlear concentration of isosorbide was analyzed by high-performance liquid chromatography coupled to refractive index detection.
Results: Isosorbide passed through the round window membrane into perilymph after RWP. After RWP for 15, 30, and 60 min, mean isosorbide concentrations in perilymph were 116.27 ¡3/3 44.65, 245.48 ¡3/3 112.84, and 279.78 ¡3/3 186.32 mM, respectively. The intracochlear concentration after RWP for 30 min was higher than that after RWP for 15 min (P = 0.043). At 3 and 6 h after PO, isosorbide concentrations in perilymph were 28.88 ¡3/3 4.69 and 12.67 ¡3/3 2.28 mM, respectively. In contrast, the corresponding concentrations after RWP were 117.91 ¡3/3 17.70 and 75.03 ¡3/3 14.82 mM at 3 and 6 h, respectively. Isosorbide concentrations in perilymph following RWP were significantly higher than those following PO at both 3 and 6 h (p = 0.025 and 0.034, respectively).
Conclusion: Isosorbide can rapidly pass through the round window membrane after RWP in guinea pigs, and 30 min of perfusion is considered to be appropriate. In addition, over a 6-h period, RWP can deliver higher concentrations of isosorbide into perilymph than those achieved with PO.

Poster Presentations Z. Vestibular Compensation, Rehabilitation, New Treatments

P-Z-1
WALKING TO THE TOILET IN PATIENT WITH VERTIGO (4TH REPORT)

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Introduction: From 2008, at the meetings of the Barany Society, we have reported on our studies of walking to the toilet in patients with vertigo, identifying complicating hypertension as a factor prolonging the restoration of their ability to walk to the toilet without the assistance of medical staff (hereinafter referred to as "the number of days to walking ability restoration.") We report on our further investigation of vertigo patients with complicating hypertension.
Subjects and Endpoints: Of 159 patients who presented to our department with vertigo, 47 patients with complicating hypertension were admitted to the Department of Otorhinolaryngology, Kochi Health Sciences Center, on the day of the onset of vertigo. The

endpoints examined consisted of sex, age, number of days necessary to restore the ability to walk to the toilet without assistance, hypotensive(s) taken, and the type of infusion fluid. For the patients who became capable of walking to the toilet on the first day of hospitalization, the number of days taken to restore the ability to walk to the toilet was counted as 0. When the patient was being treated with a single hypotensive with two different action mechanisms, e.g., a combination drug consisting of ARB and a diuretic, the number of hypotensives taken was counted as 2. The study population was divided into two groups according to the type of infusion fluid: patients receiving or not receiving Atarax P. Patients suffering "sudden deafness accompanied by vertigo," a disease usually treated by steroid therapy, were excluded from the study.

Results: The study population was found to consist of 23 male patients and 24 female patients, with a mean age of 67.5 years. The mean number of days to walking ability restoration was 2.0. Patient population breakdown by status of use of hypotensives was as follows: a single agent alone taken by 23 patients, 2 agents or more taken by 18 patients, no agents taken by 1 patients, and status unknown for 5 patients. Regarding the patients aged 65 or elder, those taking a single hypotensive showed a significantly higher number of days to walking ability restoration than the group taking 2 hypotensives or more. In the group taking a single hypotensive, the number of days to walking ability restoration was not significantly different among "the different hypotensives taken". No significant difference was found in the number of days to walking ability restoration between the use and non-use of Atarax P.

Discussion and Conclusion: Elderly patients who took a single hypotensive exhibited a significantly higher number of days to walking ability restoration compared to those who took 2 hypotensives or more. In the group taking a single hypotensive, the number of days to walking ability restoration was not significantly different among the different hypotensives taken. This suggests the possible involvement of two different circulatory conditions in the patient's action of walking to the toilet. Hence, in the elderly patients taking a single hypotensive, the additional use of any hypotensive with a different action mechanism may reduce the number of days to walking ability restoration. The results suggested that Atarax P is not involved in the number of days to walking ability restoration. This drug should be used if the patient has severe vomiting and/or vertigo symptoms.

P-Z-2
VESTIBULAR REHABILITATION IN VESTIBULAR MIGRAINE PATIENTS

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Objective: To investigate the effects of vestibular rehabilitation program on balance and gait functions in vestibular migraine patients and examine the effects of motions sickness complaints, anxiety and panic status on improvement.

Methods: Fifty patients diagnosed with definite vestibular migraine (VM) by Neuhauser criteria were enrolled in this prospective trial. Patients were instructed in vestibular adaptation and habituation exercises for 8 weeks. The balance and gait performance were assessed with clinical [Berg Balance Scale(BBS), the Dynamic Gait Index(DGI), the Falls Efficacy Scale (FES) and the Dizziness Handicap Inventory(DHI)] and objective measurements [modified Clinical Test of Sensory Interaction on Balance –mCTSIB] before and after 8 weeks of rehabilitation. Anxiety and panic status of patients were assessed with Anxiety Sensitivity Index (ASI) and Panic-Agoraphobia Scale (PAS) before the rehabilitation. Motion sickness complaints were assessed with Motion sickness susceptibility questionnaire short-form (MSSQ-Short), divided by childhood and adult scores.

Results: The balance and gait scores were significantly improved of vestibular migraine patients after rehabilitation program ($p < 0.05$). BBS scores were correlated significantly with DHI ($P = 0.003$), DGI ($p = 0.000$), FES ($p = 0.000$). MSSQ childhood scores were correlated significantly with BBS ($P = 0.003$). MSSQ adult scores were correlated significantly with BBS ($p = 0.048$), DHI ($p = 0.030$), DGI ($p = 0.049$). ASI scores were correlated significantly with BBS ($p = 0.038$), DHI ($p = 0.002$) and PAS ($p = 0.001$).

	Pre-rehabilitation Mean (SD)	Post-rehabilitation Mean (SD)	p
BBS	48.05 (6.85)	51.80 (2.89)	0.002
DHI	54.57 (20.82)	29.17 (21.57)	0.000
FES	27.11 (19.06)	15.08 (8.53)	0.000
DGI	13.97 (5.46)	18.05 (4.25)	0.000

Conclusion: All VM patient's balance and gait performance were improved after vestibular rehabilitation. On the other hand, MSSQ, Anxiety Sensitivity Index scores, Panic-Agoraphobia Scale scores had an impact on balance and gait scores.

P-Z-3
EVALUATION OF COMPENSATION VESTIBULAR POST-VESTIBULAR NEURONITIS THROUGH OPTOKINETIC-AFTER NYSTAGMUS (OKAN). PRELIMINARY REPORT

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Clinica Anglo Americana

Objective: To evaluate the behavior of vestibular compensation process through OKAN in patients with vestibular neuronitis (VN).
Material and Methods: This is a prospective study in which spontaneous nystagmus, the OKAN and dizziness in eight patients with vestibular neuronitis, four women and four men were evaluated. All patients were treated at the Emergency on the first day of assessment and the same day the spontaneous nystagmus, OKAN and dizziness was measured. VNG Interacoustics was used. All patients were hospitalized , received corticosteroids, intravenous diazepam and dimenhydrinate day one. The next day they went home with oral corticosteroids and vestibular rehabilitation exercises. Spontaneous nystagmus was measured in the absence of visual fixation. The OKAN was measured for 30 seconds after a stimulus optokinetic 75 ° / second for thirty seconds. The stimulus was delivered in both directions, right and left. The result of OKAN was classified as: normal when there was nystagmus in as many beaten up in less than 50 % difference in both directions; bilateral absent when there was no nystagmus in both directions, absent unilateral if there is not nystagmus in one direction; asymmetric when there was a difference of at least 50 % in the number of nystagmus and unilateral inverse when it changed the direction of nystagmus in one direction. Dizziness was classified as mild (1 +), moderate (2 +), severe (3 +) and absent or normal.
Results: The first evaluation was performed between the first and fourth day of the onset of VN. Every patients had spontaneous nystagmus in the first evaluation. In six was from 2.6 to 9.1 ° / sec and two were 21.4 and 24.6 ° / sec. In the six patients with low speed of spontaneous nystagmus in the first evaluation, the spontaneous nystagmus is it resolved in the first two weeks. In the two patients with higher velocity resolution occurred between 2.5 and four months. All patients had unilateral OKAN spent the first day of evaluation. The evolution of OKAN was: unilateral inverse, absent unilateral, asymmetrical, bilateral absent and normal. In one patient the OKAN normalized to four months. In four reached bilateral absent at 3 weeks, 2.5, 3 and 5 months. In the two higher speed asymmetric reached at 4 to 6 months. In one OKAN was unilateral absent after four months. The dizziness disappeared at all. In three this occurred in the first two weeks. In the remaining five disappeared between 1.5 and 4 months. In the two higher speed was at 2.5 and 4 months. If we consider the bilateral absent OKAN as a symmetrical response, we will have three (37.5%) the OKAN was abnormal until 4 to 6 months follow up.
Conclusions: The evolution of OKAN in patients with VN we studied shows different stages of activity of the vestibular nuclei in the process of vestibular compensation. In some cases the activity of the vestibular nuclei modified remained for several months.

P-Z-4
CLINICAL AND FUNCTIONAL RECOVERY IN PATIENS WITH CERVICAL VERTIGO THROUGH VESTIBULAR HABITUATION EXERCISES: CASE SERIES

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Introduction: Cervical Vertigo is supported by cervicogenic hypothesis: degenerative, inflammatory or mechanical cervical process that causes local pain and triggers vascular/ propioceptive/sympathetic mechanisms, which manifestation would be dizziness. Although this concept cannot clearly explain its mechanism, physiotherapy focused at cervical level approach has a consensus approval for the healthcare environment. However, vertigo in the light of current knowledge implies some kind of vestibular dysfunction. This allowed another therapeutic approach in these patients who could be treated with Vestibular Rehabilitation.
Objective: To analyze the outcome in patients with Cervical Vertigo treated with Vestibular Habituation Exercises, without any physical therapy intervention at cervical level.
Method: Case series, consecutive sampling of Cervical Vertigo outpatients resident in CABA, detected in the records of Physical Therapy Unit. Were only included those who were approached solely through Vestibular Habituation Exercises during 2010–2013. The evolution of the cases as regards the percentage of improvement in impairments and activity limitations detected through physical therapy evaluation was analyzed. Statistics: Mc Nemar test, paired t-test, á < 0.05.
Results: Of 41 subjects with cervical vertigo admitted to Vestibular Habituation Exercises, 20 completed

treatment: 17 women, mean age 57 (22–88) years. Positional vertigo associated with neck pain, with a pattern of vestibular dysfunction by modified Clinical Test of Sensory Organization and Balance test was described. Average evolution of vertigo was 5.2 (10.6) months. Patients performed 6.7 (2.8) vestibular habituation sessions (45 minutes) and home exercises for 2.1 (0.9) weeks. Significant improvements ($p < 0.05$): – Impairment Level: vertigo 95%, Vertigo Symptom Scale went down 14 points; instability 83.3%, vegetative symptoms 80%, nuchal myalgia 85.7%, painful active neck mobility 100%; saccadic in slow phase VOR 71.4%; gaze evoked nystagmus 100%, 86.6% Head Thrust Test, walk deviation 85.7; Barany index test 88.8%, Barany Indication test 90.9%, Romberg test 100%, Babinski Weil test 93.3%; instability in the turns 100%, Fukuda Step test 76.9%, tandem walk 81.25%. – Activity Limitation Level: Dizziness Handicap Inventory went down 25 points.

Conclusion: Vestibular Habituation Exercises as isolated treatment of Cervical Vertigo was able to recover the level of activity in these patients, as well as the reversal of both cervical and vertiginous symptoms.

P-Z-5
IMPACT OF ANXIETY AND DEPRESSION ON OUTCOME IN PATIENTS WITH UNILATERAL VESTIBULAR HYPOFUNCTION: PRELIMINARY RESULTS

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Purpose/Hypothesis: Although vestibular exercises are known to reduce symptoms in patients with unilateral vestibular hypofunction (UVH), up to 25% do not improve. We hypothesize that patients with anxiety and/or depression (A/D) will demonstrate poorer outcomes than patients without A/D. The purpose of this preliminary study was to identify the relationship between the presence of A/D and rehabilitation outcome in patients with UVH.

Methods: Sixty patients who met the inclusion criteria of a documented peripheral UVH and multiple sessions of vestibular rehabilitation were identified and included in the final analyses. The presence of A/D was based on past medical history, medication, and diagnosis by a neurologist. Outcome measures included measures of symptom complaints including Balance Confidence (ABC), Disability Score (DS), percent time symptoms interfere with life (PSIL), Vestibular Rehabilitation Benefits Questionnaire (VRBQ), intensity of oscillopsia (oVAS), dysequilibrium (dVAS) and head movement induced dizziness (hmVAS); measures of physical function including gait speed (GS), fall risk (DGI) and visual acuity during head movement (DVA), and psychometric tools (Positive Affect, Negative Affect Scale (PANAS), Beck Anxiety Inventory (BAI), and Hospital Anxiety and Depression Scale (HADS)). Measures were obtained at initial visit and at discharge. Statistical analysis: Bivariate correlations were used to determine the strength of the relationship between psychometric measures at initial visit. Relative strengths of correlations were defined as: 0.25 to 0.50 = fair to moderate, 0.50 to 0.75 = moderate to good and 0.75 to 1.00 = strong relationships. Differences in outcomes between patients with A/D and those without were determined using repeated measures ANOVA; level of significance was set at $p < 0.008$ to control for the large number of variables examined.

Results: There were no differences between groups in age, time from onset or number of PT treatments. Patients without A/D tended to have a greater asymmetry ($78 + 29.8\%$) than did patients with A/D ($58.9 + 31.8\%$) ($p < 0.02$). Concurrent validity of the PANAS scale was demonstrated by fair to good correlations between initial scores of PANAS(A) and HADS(A) ($r = 0.738$), VRBQ(A) ($r = 0.383$), and BAI ($r = 0.627$); moderate to good correlation was found between PANAS (D) and HADS(D) ($r = -0.534$). The relationships between the psychometric measures and the MD diagnosis of anxiety and/or depression were not significant. There was a significant improvement in symptoms and physical function in both groups. Compared to patients without anx/dep, patients with anx/dep demonstrated a trend toward poorer outcome in 5/10 subjective outcome measures. There were no differences in the measures of physical function at discharge.

Conclusions: The results of this preliminary study suggest that the presence of A/D has a negative effect on outcome in terms of subjective complaints but not in physical function. Degree of deficit was probably not a factor in this because patients with A/D had the lesser degree of deficit. The correlation analyses suggest that PANAS, HADS or BAI are adequate to measure A/D within this population. PANAS and HADS have the benefit of assessing for both anxiety and depression. Clinical impression does not appear to be adequate for identifying either anxiety or depression and,

clinicians should assess baseline anxiety and depression levels for optimal rehabilitation outcomes.

P-Z-6
SCREENING FOR PROTECTIVE EFFECT IN KAMPO (HERBAL MEDICINE) USING THE ZEBRAFISH LATERAL LINE HAIR CELL

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Introduction: The zebrafish lateral line is a powerful system for studying hair cells and hair cell death. Hair cells can be easily labeled and imaged in vivo with fluorescence microscopy. We have previously described a screening system to rapidly assess drugs for possible ototoxic effects in anti-cancer drugs (Hirose et al., 2011). Also it is possible to screen protective effect against some ototoxicity drugs.
Objectives: We have screened the eight herbal medicine (Shosaikoto, Orengedokuto) Tokishakuyakusan, Shigyakusan, Hochuekkito, Juzentaihoto, Unseiin and Shimotsuto) for protective effects against aminoglycoside.
Methods: 5–7 dpf Zebrafish (Danio rerio) embryos of the AB wild type strain were used in this study. Zebrafish larvae were exposed to herbal medicine (1, 10, 100, 1000 μg/ml) for 1 hour before 200 uM Neomycin for 1 hour. After that, they were fixed in 4% paraformaldehyde, incubated with anti-par- valbumin, Alexa 594, and hair cell damage was assessed by fluorescent microscope. Also, we evaluate an antioxidative effect. 5 dpf alive zebrafish were used in this experiment.We made control group, Nemycin group, and Shimotsuto+Neomycin group. Zebrafish larvae were exposed to Shimotsuto (1000 μg/ml) for 1 hour before 200 uM Neomycine for 5 minutes. H2DCF was used as marker of oxidative stress.
Results: We made dose-response carves to evaluate protective effect. All of the Kampo medicine shows protective effects against Neomycin hair cell damage.
In oxidative stress experiment, Neomycin enforce H2DCF staining and Shimotsuto reduce. This suggests Neomycin generates strong oxidative stress, and Shimotsuto weaken.
Conclusions: In conclusion, herbal medicine show protective effect against zebrafish hair cell, this study shown that can be a powerful protective drug against inner ear damage.

P-Z-7
THE EFFECT OF OPTOKINETIC STIMULATION ON VISUAL DEPENDENCY IN PATIENTS WITH VISUAL INDUCED DIZZINESS

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Introduction: People with chronic vestibular disorders often become visually dependent, leading to visually induced dizziness whereby symptoms are provoked or exacerbated in certain environments with visual motion stimuli (crowds, supermarket aisles). Vestibular rehabilitation incorporating optokinetic stimulation (OKS) significantly improve these symptoms, however, it is unknown whether it also reduces visual dependency and optimal OKS intensity has not been clarified.
Objectives: To investigate the effect of customised vestibular rehabilitation incorporating short-term, intensive, OKS graded exposure on treatment outcome for people with visually induced dizziness.
Methods: Thirty-two patients with a peripheral vestibular disorder and visually-induced dizziness were randomly allocated into two groups, customised vestibular rehabilitation with (Group OKS) and without (Group C) OKS. Individuals attended supervised therapy sessions for five consecutive days and were provided with a customised home exercise programme for weeks 2–8. Response to treatment was assessed at baseline, five-days, four and eight-weeks. Assessment included rod-and-disc and visual roll-motion posturography tests for visual dependency, Functional Gait Assessment (FGA) and subjective questionnaires concerning symptoms, symptom-triggers, perceived handicap from symptoms, and psychological state.
Results: Twelve patients in each group completed treatment. At final assessment, both groups showed significant reductions (i.e. improvement) in subjective visual vertical deviation and total sway path induced by the rotating stimulus; only Group OKS showed significant improvements on the Kinetic Quotient (disc rotation/eyes open sway path ratio) ($p < 0.05$). FGA, visually induced dizziness, perceived handicap from dizziness, functional ability, and emotional status scores improved significantly for both groups ($p < 0.05$). No significant between-group differences were noted, but final scores across all measures suggested a trend for better outcome in Group OKS.
Conclusions: Customised vestibular exercises provide improvements for subjective symptoms, functional gait

and subjective visual vertical measurements. However improvements in visual roll-motion posturography are only noted with additional OKS exposure. Patients appear to subjectively respond better with OKS exposure than customised exercises in isolation.

P-Z-8
COURSE OF POSTURAL SWAY AND SYMPTOMS IN VISUAL-VESTIBULAR MISMATCH PATIENTS DURING EXPOSURE TO OPTIC FLOW – PRELIMINARY RESULTS

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Introduction: Patients with visual-vestibular mismatch (VVM) suffer from a heterogeneous set of symptoms, such as dizziness, subjective misery and increased postural sway. These symptoms are aggravated when exposed to certain visual stimuli containing optic flow. A theoretical framework including visual-vestibular interactions can explain the relationship between subjective misery and postural sway. On the basis of this theory, subjective misery and postural sway are correlated in some cases and not in others, depending on central nervous system tuning of integrated sensory signals.
Objectives: This exploratory study had a twofold aim. First, we questioned whether visual motion is a necessary factor causing VVM related symptoms. Secondly, we investigated the relationship between subjective misery and postural sway during and after prolonged exposure to an optic flow pattern.
Methods: 5 patients with VVM and without peripheral disorders participated in two sessions applied in a random order on the same day. In one session, seated patients were exposed to a visual pattern rotating in roll about the naso-occipital axis (motion session). In the other session patients were exposed to the same, but stationary pattern (stationary session). Each session was divided in four blocks of five minutes each. After each session patients were given three times 5 minutes (blocks) of rest. Before, and after each block, postural sway and subjective misery were assessed. Postural sway was measured using a force platform and quantified by the sway path length (SPL) and the standard deviation (SD) in medio-lateral and antero-posterior directions. Subjective misery was rated using an 11-point misery scale (MISC; 0 = no problems at all, 1–5 = any sickness symptom except nausea, 6–9 = nausea, 10 = vomiting). All patients were asked to report when their symptom severity significantly increased afterwards up till 24 hours after both sessions.
Preliminary results: During the motion session, postural sway was increased compared to baseline in for 4 out of the 5 patients. After this session, postural sway decreased in 3 out of 5 patients. MISC rates were increased in all patients during the motion session and decreased afterwards. One patient reported a MISC of 7 and discontinued the motion session. During the stationary session, postural sway did not increase or even decreased in all 5 patients. MISC rates did not change throughout the stationary session. 3 out of 5 patients reported an increase of symptom severity during the 24h after the sessions.
Discussion and conclusions: These preliminary results seem to indicate that visual motion plays an important role in causing VVM related symptoms. However, the after-session reports raise some concerns regarding the use of optic flow patterns in VVM treatment. Although other studies did report a reduction of subjective misery in their patients after repeated exposure, changes in postural sway are still unknown. In future studies on the treatment of VVM using repeated exposures to optic flow, it seems to be of interest not only to consider subjective misery, but also postural sway. Such data may as well provide further insight in the underlying mechanism as, for example, hypothesized by the theoretical framework including visual-vestibular interactions.

P-Z-9
TONGUE TACTILE BIOFEEDBACK IN PATIENTS WITH DEGENERATIVE CEREBELLAR DISEASE

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Introduction: Cerebellar damage typically results in ataxia and can be caused by stroke, tumor, or some degenerative diseases. Since few pharmacological options are available, most treatments rely heavily on rehabilitation therapy. A possible way to improve balance is the use of a biofeedback system in balance prosthesis. Tyler et al. developed a head position-based, tongue-placed biofeedback system whose underlying principle is to transmit artificially sensed

head orientation/motion with respect to gravitational vertical along anteroposterior and mediolateral axes through electrotactile stimulation of the tongue. The aim of present study was to assess the effectiveness of a 2-week intensive tongue-placed biofeedback program for patiens with progressive cerebellar ataxia.
Methods: Subjects were nine adult patients (age 55.6 $\pm$ 11.6, mean $\pm$ SD) suffering from cerebellar degeneration. Rehabilitation program consisting of postural exercises executed with the biofeedback system for 10 to 20 minutes, twice a day over a 2-week period. Postural control was assessed with static posturography. Effects of treatment were determined by comparing Pre, Post and one month follow-up experimental sessions.
Results: Analysis of measured CoP parameters for tests on showed a significant main effect of visual condition and no difference across test sessions under open eyes condition. Under eyes closed condition, there were significant differences between Pre versus Post and Pre versus Retention, while the difference Post versus Retention was not significant.
Conclusions: These preliminary results suggest that a balance rehabilitation program with postural exercise performed with a head position-based tongue-placed biofeedback system could significantly improve bipedal postural control in patients suffering from ataxia due to cerebellar degeneration. Further comparative studies are needed to determine the clinical validity and outcome of balance rehabilitation therapy.

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P-Z-10
LONG-TERM EFFECTS OF INTERMITTENT TRANSTYMPANIC LOW-PRESSURE THERAPY WITH THE TRANSTYMPANIC MEMBRANE MASSAGE DEVICE IN PATIENTS WITH MENIERE'S DISEASE AND DELAYED ENDOLYMPHATIC HYDROPS
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The long-term effects of the transtympanic membrane massage (TMM) device for intractable vertigo in patients with Meniere's disease (MD) and delayed endolymphatic hydrops (DEH) were evaluated according to the 1995 American Academy of Otolaryngology Head and Neck Surgery Foundation (AAO-HNS) reporting guidelines. The subjects comprised 10 patients who failed to respond to medical treatment including diuretics prior to transtympanic low-pressure treatment. MD was diagnosed in 8 patients and DEH in 2 patients. We used the diagnostic criteria for MD proposed by the Meniere's Disease Research Committee of Japan supported by the Ministry of Health, Labour and Welfare of Japan in 1974, and for DEH, those proposed by the committee of the Japan Society for Equilibrium Research in 1987. All patients were treated with the TMM device twice daily and were followed up for more than 24 months after treatment. Diuretic and vestibular suppressant medications were used as needed. The frequency of vertigo after treatment was significantly lower than before treatment in all 10 patients. AAO-HNS class A and class B results occurred in 90% and 10% of patients, respectively. No complications were directly attributable to treatment with the TMM device. The TMM device is a minimally invasive option that provide effective transtympanic low-pressure treatment for intractable vertigo in patients with MD and DEH.

P-Z-11
PYRROLOQUINOLINE QUINONE CAN PROTECT VESTIBULAR HAIR CELLS AGAINST THE NEOMYCIN OTOTOXICITY
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Background: Pyrroloquinoline quinone (PQQ) is an organic molecule that was discovered as a redox cofactor. The molecule was reported as the new vitamins (Nature 2003). It is to be involved in mitochondrial function, and the animals with PQQ deficiency showed development disorder, immunodeficiency and infertility. In addition, the animals which received the molecules showed myocardial protective effect and neuroprotective effect from ischemia for a strong antioxidant activity. In the present study, we evaluated the protective effect on the inner ear sensory cells against neomycin ototoxicity.
Objectives: In this study, we investigated the role of PQQ in mammalian vestibular hair cell death induced by amino glycoside.
Methods: Cultured utricles of CBA/N mice were used. Cultured utricles were divided to three groups (Control group, Neomycin group, Neomycin + PQQ group). In the Neomycin group, utricles were cultured with neomycin (2 mM) to induce hair cell death.

In Neomycin + PQQ group, utricles were cultured with neomycin and PQQ (100–1$\mu\mu$M). Twenty-four hours after exposure to neomycin, the cultured tissues were fixed with 4% paraformaldehyde. To label hair cells, immunohistochemistry were performed using anti-calmodulin antibody. The rate of survival vestibular hair cells was evaluated with the fluorescence microscope. In addition, immunohistochemistry against 4-hydroxy-2-nonenal was performed to evaluate the product of hydroxy radical.

Results: The survival rate of hair cells in Neomycin + PQQ group was significantly more than that in Neomycin group. The signals of 4-hydroxy-2-nonenal were inhibited in neomycin + PQQ group. The results indicated that PQQ protects sensory hair cells against neomycin-induced death in mammalian vestibular epithelium.

Discussion: These data indicated that PQQ protects sensory hair cells against neomycin-induced death in the vestibular epithelium. These results show that PQQ can be used as the protective molecules against the aminoglycoside ototoxicity.?

P-Z-12
DYNAMIC VISUAL ACUITY BEFORE AND AFTER UNILATERAL INCREMENTAL VESTIBULO-OCULAR REFLEX ADAPTATION TRAINING IN NORMAL SUBJECTS

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Introduction: Unilateral vestibulo-ocular reflex (VOR) adaptation is a technique that increases the VOR response for head rotations to one side (the adapting side). Previous studies have shown unilateral VOR gain adaptation in healthy humans led to ∼25% VOR gain increase (gain = eye velocity/head velocity) with a concomitant worsening of VOR gain asymmetry (percent difference between leftward and rightward VOR gain). We hypothesize that an increase in VOR gain asymmetry will also lead to a functional decrease in gaze stability stability, which can be measured via active (self-generated predictable head rotations) and passive (imposed unpredictable head rotations) head rotation (dynamic visual acuity (DVA) testing).

Background: In a previous pilot study we built a portable helmet device that sensed horizontal angular head velocity and produced a visual stimulus derived from this velocity signal that drove the VOR gain to 1.5 for head rotations towards the adapting side. That study showed that VOR gain asymmetry could be maximised when the visual feedback signal used during adaptation training for rotations towards the non-adapting side, drove the VOR gain to unity (gain = 1). The limitation of that study was that the helmet device was heavy and prone to slipping, and the analog visual feedback control gain resolution was too low, which did not allow us to train subjects using the incremental unilateral VOR adaptation technique shown to more effectively adapt the VOR.

Methods: We built a second version of the helmet device that was light-weight and used a digital microprocessor to precisely control visual feedback so that we could implement incremental VOR adaptation training. We measured the active and passive VOR gain and dynamic visual acuity (DVA) before and after adaptation training consisting of active head impulses. The head impulses consisted of rapid, horizontal head rotations with peak-amplitude 15o, peak-velocity 150o/s and peak-acceleration 3000o/s2. The training comprised 10 epochs lasting 90 seconds each. Visual feedback during epoch 1 drove the VOR gain to 1.1, and each subsequent epoch drove the gain higher by an increment of 0.1, until epoch 10 where the gain was driven to 2.

Results: In these 7 normal subjects, the VOR gain, measured before and after training, increased towards the training side by ∼12%. During training it increased by ∼23%. During passive DVA testing two subjects showed a decrease in score (i.e., DVA became worse) after training for rotations towards the adapting side. The remaining five showed an increase or no change in score. Similarly, during active DVA testing, two subjects showed an increase in score, while the remaining subjects showed no change. One might have expected DVA to worsen given that the VOR gain after training produced an overly large response for head rotations towards the adapting side, but no such trend was observed.

Conclusion: Contrary to our hypothesis, we did not detect a significant correlation between VOR gain asymmetry and DVA score. However, repeated exposure to VOR adaptation training and other measures of balance function such as changes in gait or balance might show a better correlation. Our results suggest that normal subjects exposed to asymmetric VOR adaptation training perform like well-compensated vestibular patients that have normal DVA scores.

P-Z-13
DYNAMIC VISUAL ACUITY BEFORE AND AFTER INCREMENTAL VESTIBULO-OCULAR REFLEX ADAPTATION TRAINING IN PATIENTS WITH PERIPHERAL VESTIBULAR HYPOFUNCTION

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Introduction: Incremental vestibulo-ocular reflex (VOR) adaptation is a technique that can be used to increase the VOR response for head rotations towards the ipsilesional side in patients with unilateral or bilateral vestibular hypofunction. We hypothesize that increasing the ipsilesional vestibulo-ocular reflex (VOR) gain (gain = eye velocity/head velocity) closer to unity (for typical viewing gain = 1) will result in a functional increase in visual stability, which can be measured via active (self-generated predictable head rotations) and passive (imposed unpredictable head rotations) dynamic visual acuity (DVA) testing.
Background: In a previous study we increased VOR gain asymmetry (percent difference between leftward and rightward VOR gain) in normal subjects to determine whether a correlation existed between VOR gain asymmetry (which leads to over compensatory eye movements for rotations to one side resulting in poor vision stabilisation) and DVA score. These normal subjects underwent unilateral VOR adaptation training using a head-mounted apparatus, which sensed angular head velocity in three dimensions and produced a visual target that drove a VOR (adaptation) gain increase for rotations towards one side. That study showed no statistically significant correlation between VOR gain asymmetry and DVA score, but it was postulated that vestibular patients may show improved DVA scores if their existing VOR gain asymmetry was decreased and their gains brought closer to ideal.
Methods: In 7 patients with unilateral (UVH) and bilateral vestibular hypofunction (BVH) we measured the active and passive VOR gain and dynamic visual acuity (DVA) before and after adaptation training consisting of active head impulses. The head impulses consisted of rapid, horizontal head rotations with peak-amplitude 15°, peak-velocity 150°/s and peak-acceleration 3000°/s2. The training comprised 10 epochs lasting 90 seconds each. UVH patients underwent unilateral adaptation training towards the ipsilesional side, whereas BVH patients underwent bilateral adaptation training. The gain for epoch 1 was set to the pre-adaptation passive VOR gain for each side (UVH patients had fixed gain = 1 for rotations towards the contralesional side), and each subsequent epoch drove the gain higher by an increment of 0.1, until epoch 10.
Results: DVA scores towards the lesioned side/s improved in 4/6 vestibular patients after adaptation training. Three patients showed a steady increase in VOR gain and decrease in VOR gain asymmetry throughout the training. Four patients showed steady gain increases until they reached a peak value, usually $\sim$25% increase in gain, after which the gain began to decrease.
Conclusion: These findings show that VOR gains closer to unity (and reduced gain asymmetry) result in better dynamic visual acuity for most patients. Our study also found that for some patients training increased the VOR gain until the VOR demand reached a threshold where the training was no longer effective, during that particular training session. Perhaps these patients required more exposure to the training protocol to reinforce the new gain level. Several of these patients on follow-up reported improved visual stability for up to 2 weeks after their single 15 minute adaptation training session.

P-Z-14
INVESTIGATION OF PRESBYASTASIS PATIENTS USING THE CROSS TEST

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To investigate the equilibrium function of elderly patients experiencing dizziness caused by age-dependent physiological vestibular dysfunction (presbyastasis) and evaluate the effects of a vestibular rehabilitation program the author conducted a new balance training program, the cross test. Nine patients aged over 65 years with presbyastasis who had complained of equilibrium dysfunction for at least 6 months were enrolled in this study. The standing balance training system with gravicorder was used to examine their equilibrium. The cross test indicates the equilibrium function based on ankle mobility and the center of gravity when individuals move forward, backward, right and left in turn on the gravicorder. The cross test was carried out once a month or two months at least more than 5 times, and the results were subjected to statistical analysis. After undergoing the vestibular rehabilitation program, the range of ankle motion improved in all 9 patients compared with the pretraining values ($p < 0.001$). These

findings suggested that the cross test is a reliable methods to estimate the equilibrium function and the effects of a balance training program for patients with presbyastasis. Furthermore, it appears that it is associated with prompt improvement of equilibrium dysfunction and thus is an effective therapeutic option along with medication and conventional vestibular training programs.

P-Z-15
IN VIVO IMAGING OF CEREBRAL GLIAL ACTIVATION AFTER UNILATERAL LABYRINTHECTOMY

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Background and aim: Reactive gliosis may be beneficial for central compensation after unilateral inner ear damage. The aim of the present study was to visualize whole brain glial activation in vivo and over time by serial [18F]-GE180-μPET in a rat model of chemical unilateral labyrinthectomy (UL).
Methods: Ten Sprague-Dawley rats underwent a left-sided UL by transtympanic injection of bupivacaine and arsenilate, ten rats received a left-sided middle-ear injection of saline as a control group. Behavioural testing for symptoms of vestibular tone imbalance including registration of nystagmus and postural asymmetry was performed 1 day before and at days 1, 3, 7, 15, 30 after UL/sham injection. For functional imaging of glial activation, whole-brain μPET with [18F]-GE180, a novel translocator protein (tspo) ligand, was performed before and on 7, 15, 30 days after UL/sham injection. In vivo autoradiography was done at the respective time points for crosscheck and combined with Nissl-staining of the corresponding slices for detailed anatomic mapping.
Results: All rats showed clinical signs of an acute vestibular syndrome following UL with a maximum at 2 and 3 days. Nystagmus disappeared until day 5, postural asymmetry decreased significantly until day 15. In the UL group, [18F]-GE180-μPET depicted a glial activation in the ipsilesional vestibular, cochlear and facial nucleus at day 7, which further increased until day 15 and was only slightly visible at day 30. In addition no other regions of the brain showed signs of glial activation. In the sham group, glial activation was found in the facial nucleus at day 7 and 15. The time course and anatomic localisation of glial activations were confirmed by in vivo [18F]-GE180 autoradiography and Nissl-staining.
Conclusions: 1) Glial activation takes place in the ipsilesional vestibular and cochlear nucleus within the first 30 days after an inner ear lesion and thereby parallels the establishment of central vestibular compensation. 2) μPET is a feasible method to show upregulation of the tspo protein in vivo as a sign of reactive gliosis induced by unilateral labyrinthectomy. 3) Tspo ligands may be a novel pharmacological principle to augment central vestibular compensation.