

## Oral Presentations

---

OP01-1

VEMP and Otolithic Function Tests I

### THE IMPAIRMENT EXTENT OF HEARING LOSS AND OTOLITH ORGANS DAMAGE AFTER MUMPS INFECTED

Jing WANG<sup>1</sup>, Jing YU<sup>1</sup>

<sup>1</sup>Department of Otolaryngology, Eye & Ent Hospital of Fudan University, China

**Objectives:** Investigate mumps, as a possible cause of sudden deafness, for its relationship with the impairment extent of hearing loss and otolith organs damage.

**Methods:** Twenty-two cases of unilateral hearing impairment in mumps diagnosed in the out-patient department of our hospital have been investigated with audiometry and vestibular evoked myogenic potentials (VEMP) in order to confirm the degree of permanent lesions.

**Results:** Seventeen of twenty-two cases had no response in the test of audiometry, 4 with profound sensorineural hearing loss and 1 with severe sensorineural deafness. In cervical VEMP (cVEMP) test, 14 patients (63.64%) with varied elevated threshold in the affected side, 7 cases (31.82%) with the same threshold binaural sides, 1 case (4.55%) with slightly elevated threshold in the normal side; There were statistical significant differences compared the threshold values of the affected side with that of the normal side,  $P = 0.000$ . In ocular VEMP test, 2 of 22 with no response in both sides; Among the other 20 cases, 12 cases (60%) could have at least one ear response with varied elevated threshold in the affected side, 6 cases (30%) with the same threshold binaural sides, 2 cases (10%) with slightly elevated threshold in the normal side; There were statistical significant differences compared the threshold values of the affected side with that of the normal side,  $P = 0.006$ .

**Conclusion:** Deafness from mumps is usually profound and permanent. It showed mumps also concerned otolith organs with the functional lesion in vestibular system, yet more slightly than that in auditory system.

OP01-2

VEMP and Otolithic Function Tests I

### A NEW CLINICAL METHOD TO TEST OTOLITH FUNCTION: REAL TIME VIDEO OCULOGRAPHY (VOG) OF OCULAR TORSION

Jorge OTERO-MILLAN<sup>1</sup>, Carolina TREVIÑO-GUAJARDO<sup>2</sup>, David S ZEE<sup>1,2</sup>, John P CAREY<sup>2</sup>, Amir KHERADMAND<sup>1,2</sup>

<sup>1</sup>Department of Neurology, Johns Hopkins, USA

<sup>2</sup>Department of Otolaryngology – head & Neck Surgery, Johns Hopkins, USA

Ocular counter roll (OCR) or the compensatory torsional eye movement in the opposite direction of static head tilt is driven mainly by the otolith organs. While measurement of torsion is technically demanding, we have developed a novel method for real-time video tracking of ocular torsional. Using this method we measured OCR in healthy controls and patients with loss of vestibular function after passively -imposed roll tilt of the head, 30 degrees to the left and 30 degrees to the right shoulder. The results were compared with vestibular evoked myogenic potentials (VEMPs), commonly used to test otolith-ocular pathways. Overall, OCR was significantly correlated with the ocular VEMP (oVEMP) response to auditory clicks ( $R = 0.52$ ;  $p = 0.0001$ ) and to forehead taps ( $R = 0.46$ ;  $p = 0.0008$ ). Receiver operator characteristic analysis (ROC) showed comparable accuracy between the OCR and VEMP responses (area under the curve = 0.9 for OCR, 0.92 for OVEMP tap, 0.95 for OVEMP click and 0.81 OVEMP tone

burst). Our results show that the measurement of OCR using VOG platforms can be easily applied to the clinical assessment of the otolith-ocular pathways, and that the findings are comparable to assessment of otolith pathways using VEMPs.

#### OP01-3

VEMP and Otolithic Function Tests I

#### **EVALUATION OF OTOLITHIC ORGAN AND VESTIBULAR NERVE USING VESTIBULAR EVOKED MYOGENIC POTENTIAL IN MENIERE'S DISEASE**

**Chih-Ming CHANG<sup>1,2</sup>, Fu-Shan JAW<sup>1</sup>, Yi-Ho YOUNG<sup>3</sup>, Po-Wen CHENG<sup>2</sup>**

<sup>1</sup>*Institute of Biomedical Engineering, National Taiwan University, Taiwan*

<sup>2</sup>*Department of Otolaryngology, Far Eastern Memorial Hospital, Taiwan*

<sup>3</sup>*Department of Otolaryngology, National Taiwan University Hospital, Taiwan*

**Purpose:** The vestibular-evoked myogenic potential (VEMP) can be recorded from the neck muscles and extra-ocular muscles in response to air-conducted sound (ACS), bone-conducted vibration (BCV), and galvanic vestibular stimulation (GVS). They are termed cervical VEMP (cVEMP) and ocular VEMP (oVEMP). Using VEMP tests via different stimulation modes, this study explores the physiological function of otolithic organ and vestibular nerve in patients with unilateral Meniere's disease.

**Methods:** Seventy patients with unilateral Meniere's disease were prospectively enrolled in this study. All subjects underwent ACS-cVEMP, GVS-cVEMP, BCV-oVEMP and GVS-oVEMP. The prevalence and characteristic parameters such wave latency, interval and amplitude are compared and analyzed.

**Results:** The abnormal rate of cVEMPs in diseased ears is significantly higher using ACS mode (36%) than using GVS mode (11%), and that of oVEMPs in diseased ears is also significantly higher using BCV mode (20%) than using GVS mode (9%). Furthermore, the abnormal rate of ACS-cVEMPs is significantly higher than that of BCV-oVEMPs. However, there is no significant difference of abnormal rate between GVS-cVEMPs and GVS-oVEMPs.

**Conclusion:** In diseased ear of unilateral Meniere's disease, the deterioration of otolithic organ is earlier than that of vestibular afferents, whereas the degeneration rate of superior vestibular nerve and inferior vestibular nerve are similar. Furthermore, the disease involvement of saccule is higher than that of utricle in affected ear.

#### OP01-4

VEMP and Otolithic Function Tests I

#### **IMBALANCE AND NAUSEA; TWO DIFFERENT PRESENTATIONS OF OTOLITHIC DISEASE; BUT WHY THE DIFFERENCE?**

**Art I. MALLINSON<sup>1,2</sup>, Neil S. LONGRIDGE<sup>1,2</sup>**

<sup>1</sup>*Department of Neuro-otology, Vancouver General Hospital, Canada*

<sup>2</sup>*Department of Surgery, University of British Columbia, Canada*

Patients with nontraditional vestibular disease are often referred to as "otolithic patients", as they give histories consistent with pathology of these structures. Complaints of imbalance and nausea (without spinning) are quite common in these patients. However we have recognized a group of patients in our clinic who emphasize that they have only one of these complaints without the other. Both of these complaints are arguably of otolithic origin, but we wondered why some people deny imbalance, while others deny nausea. In the past it has been suggested that the utricle is the structure responsible for nausea, and the saccule is responsible for imbalance. However, more recent work has suggested this is not the case. We decided to analyze the results and histories of patients who complained of either nausea only or imbalance only.

We wondered what the difference is between our nausea patients and imbalance patients. We assessed 50 patients referred to our tertiary care neuro-otology unit who complained of nausea only or imbalance only. We also divided the two groups into "trauma patients" (head injury, whiplash, etc.). All patients underwent a series of 5 diagnostic tests (CDP, Posturography, CVEMPs, OVEMPs and calorics). We analyzed results in each of the four groups and we will be reporting the differences in these two seemingly different patient population, in an attempt to make statements about the role each otolithic structure might play.

## OP01-5

VEMP and Otolithic Function Tests I

**SIMULTANEOUSLY-RECORDED CERVICAL AND OCULAR VESTIBULAR-EVOKED MYOGENIC POTENTIALS VIA GALVANIC STIMULATION**

**Po-Wen CHENG<sup>1</sup>, Chih-Ming CHANG<sup>1</sup>, Yi-Ho YOUNG<sup>2</sup>**

<sup>1</sup>*Department of Otolaryngology, Far Eastern Memorial Hospital, Taiwan*

<sup>2</sup>*Department of Otolaryngology, National Taiwan University Hospital, Taiwan*

**Objective:** This study compared the characteristic parameters of cervical and ocular vestibular-evoked myogenic potentials (VEMPs) via galvanic vestibular stimulation (GVS) between individual and simultaneous recording patterns in healthy and elderly subjects.

**Methods:** A total of 24 healthy and 16 elderly subjects were enrolled in this study. All participants underwent individual cervical-VEMP (cVEMP), individual ocular-VEMP (oVEMP), and simultaneous cVEMP and oVEMP testing via GVS mode in a random order. The response rates and characteristic parameters of cVEMPs and oVEMPs between individual and simultaneous tests were measured.

**Results:** All VEMP latencies, intervals, and amplitudes demonstrated no significant differences between individual and simultaneous 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:** Simultaneous GVS-cVEMP and GVS-oVEMP tests yielded similar information to that obtained in individual tests. The feasibility of the simultaneous GVS-cVEMP and GVS-oVEMP test is established.

## OP01-6

VEMP and Otolithic Function Tests I

**OCULAR VESTIBULAR EVOKED MYOGENIC POTENTIAL TESTING FOR THE PROGNOSIS OF BELL'S PALSY**

**Jaeyong BYUN<sup>1</sup>, Chulwon YANG<sup>1</sup>, Sanghoon KIM<sup>1</sup>, Seunggeun YEO<sup>1</sup>, Moonsuh PARK<sup>1</sup>**

<sup>1</sup>*Department of Otorhinolaryngology, Head & Neck, School of Medicine, Kyung Hee University, Korea*

**Objectives:** Several studies have indicated asymptomatic involvement of vestibular nerve in cases of idiopathic facial nerve palsy. The basis for such observation is the close proximity of the vestibular and facial nerves, which have a common course in the internal auditory canal (IAC). Some studies have even suggested that some of the superior and inferior vestibular nerve bundles may receive fibers from the facial nerve. The aim of this study was to investigate the correlation prognosis of Bell's palsy with involvement of vestibular organs through ocular vestibular evoked myogenic potential testing.

**Methods:** A total of 104 consecutive patients with Bell's palsy were enrolled. All of patients underwent ocular VEMP recordings within 1 week after palsy presentation. They were also treated uniformly with steroid and an antiviral agent. And we also carried out neurological evaluations, pure tone audiometry, vestibular function test including initial and final House-Blackmann grades.

**Results:** Eighty-five patients recovered completely and nineteen patients recovered incompletely. In this study, we used logistic regression analysis for evaluating the risk factors acting on the recovery prognosis of the bell's palsy. No association were observed about ipsilesional PTA threshold and electromyography between complete and incomplete recovery groups. The initial state of ENoG and initial H-B grades were significantly correlated with recovery prognosis. Also, ocular vemp asymmetry was significantly higher in incomplete recovery group than complete recovery group.

**Conclusion:** The results indicate oVEMP could be used as a useful tool for predicting the prognosis of Bell's palsy comparable to ENoG and H-B grades

## OP02-1

Vestibular Migraine

**EPISODIC VERTIGO: HOW TO DIFFERENTIATE VESTIBULAR PAROXYSMIA FROM VESTIBULAR MIGRAINE**

**Berina IHTIJAREVIC**<sup>1,2,3</sup>, Vincent VAN ROMPAEY<sup>1,2</sup>, Tony COX<sup>3</sup>, Sebastien JANSSENS DE VAREBEKE<sup>3</sup>, Paul VAN DE HEYNING<sup>1,2</sup>, Floris WUYTS<sup>1,2</sup>

<sup>1</sup>Department of University of Antwerp, Antwerp University Research Centre For Equilibrium And Aerospace (aura), Belgium

<sup>2</sup>Department of Otorhinolaryngology & Head And Neck Surgery, Antwerp University Hospital, Belgium

<sup>3</sup>Department of Otorhinolaryngology & Head And Neck Surgery, Jesse Hospital, Hasselt, Belgium

**Introduction and aim:** Vestibular paroxysmia (VP) is a syndrome defined by short vertiginous spells (often triggered by head position) caused by a microvascular compression of the eighth cranial nerve. VP may often be associated with headache and visual disturbance which makes it difficult to distinguish from Vestibular Migraine (VM). The aim of this study was to identify variables derived from history, clinical examination, audiometry and electronystagmography to enable the clinician to discriminate between VP and VM more easily.

**Material and methods:** A retrospective assessment was performed on 42 patients, 21 patients diagnosed with VP and 21 with VM. Anamnestic and clinical results (including video-oculoscopy, audiometry, electronystagmography) were examined.

**Results:** In this study 48% of the patients with VP demonstrated VM-like symptoms and some of them even fit the diagnostic criteria of VM. Overall, patients with VP experienced more dizziness and positional changes were identified more frequently as triggers. Symptoms occurred daily, lasting seconds or minutes, in patients with VP, while weekly in patients with VM. A persistent positional non-BPPV type nystagmus was observed more frequently in patients with VP. Accompanying otological symptoms such as tinnitus and hyperacusis were reported more frequently in the VM group. In the latter group, headaches and a history of migraine were dominant; accompanying symptoms during vertigo attacks were scotoma and photophobia.

**Conclusions:** Our study has identified several variables acquired during history taking and video-oculoscopy which may enable the clinician to differentiate more easily between VP and VM and reduce diagnostic delay.

## OP02-2

Vestibular Migraine

**VESTIBULAR MIGRAINE AND MENIERES DISEASE: ICTAL CHARACTERISTICS**

**Allison S YOUNG**<sup>1</sup>, Corinna LECHNER<sup>1</sup>, Druvinka BANDARANAYAKE<sup>1</sup>, Andrew P BRADSHAW<sup>1</sup>, G Michael HALMAGYI<sup>1</sup>, Miriam S WELGAMPOLA<sup>1</sup>

<sup>1</sup>Department of Neurology, Royal Prince Alfred Hospital, Australia

**Background:** episodic vertigo from early Meniere's Disease (MD) and vestibular migraine (VM) could be difficult to separate.

**Aims:** to examine ictal-nystagmus characteristics in VM and MD.

**Methods:** Sixty subjects fulfilling Neuhauser criteria for VM ( $n = 42$ ) or AAOHNS criteria for clinically-definite MD ( $n = 18$ ) were taught to perform home-video oculography using miniature stand-alone infrared video-glasses. Spontaneous and positional-nystagmus were recorded and slow-phase velocity (SPV) plotted as a function of time.

**Results:** All 18 subjects with MD demonstrated horizontal-nystagmus beating away from the affected ear (mean-SPV 19.8 deg/s). Eleven subjects recorded multiple events; six demonstrated a direction-change in spontaneous horizontal nystagmus, minutes to hours from symptom onset; one demonstrated spontaneous torsional-downbeating nystagmus evolving into horizontal-nystagmus within minutes of onset. Positional nystagmus, recorded from all, represented enhancement of spontaneous nystagmus (SPV increase by up to 50%).

Subjects with VM ( $n = 10$  definite,  $n = 32$  probable) showed spontaneous horizontal ( $n = 21$ , mean-SPV 5.3deg/s) vertical ( $n = 11$ , mean-SPV 5.62deg/s) or torsional nystagmus ( $n = 2$ ). Thirty-two subjects recorded multiple events; two demonstrated a direction change in horizontal-nystagmus on separate days. All others showed stereotyped spontaneous nystagmus profiles. Positional nystagmus was recorded in all subjects. Thirty-four showed en-

hancement of spontaneous-nystagmus (up to 80%). Eight showed horizontal-geotropic ( $n = 5$ ) or apogeotropic ( $n = 3$ ) positional-nystagmus. Eight had only positional-nystagmus whilst symptomatic. Average SPV for horizontal nystagmus recorded in VM was significantly lower than in MD ( $p < 0.05$ ).

**Conclusion:** spontaneous horizontal-nystagmus is seen in both VM and MD with higher SPV and greater likelihood of direction-change for MD. Spontaneous vertical-nystagmus, geotropic or apogeotropic positional-nystagmus are associated with VM.

#### OP02-3

Vestibular Migraine

#### PHENOTYPES AND ACCOMPANYING SYMPTOMS IN A SAMPLE OF 69 PATIENTS WITH DEFINITE VESTIBULAR MIGRAINE

**Roberto TEGGI**<sup>1</sup>, Giacinto ASPRELLA LIBONATI<sup>2</sup>, Angel BATUECAS-CALETRIO<sup>3</sup>, Sergio LUCISANO<sup>4</sup>, Rudi PECCI<sup>5</sup>, Mario S ALMEYDA BRANCO<sup>6</sup>, Antonio LOPEZ ESCAMEZ<sup>7,8</sup>

<sup>1</sup>Department of ENT, San Raffaele Scientific Institute Milano, Italy

<sup>2</sup>Department of ENT, Ospedale, Italy

<sup>3</sup>Department of ENT, Hospital Universitario Salamanca, Spain

<sup>4</sup>Department of ENT, Città Della Salute Torino, Italy

<sup>5</sup>Department of Oto-neuro-oftalmologia, University of Firenze, Italy

<sup>6</sup>Department of ENT, Hospital De Poniente, El Ejido, Almeria, Spain

<sup>7</sup>Department of Otolaryngology, Granada University Hospital, Spain

<sup>8</sup>Department of Otology And Neurotology Group Genyo, Otology And Neurotology Group- Dept of Genomic Medicine – Genyo Centre For Genomics And Oncologic Research Pfizer – Universidad De Granada, Spain

Vestibular Migraine diagnoses mainly rely on symptoms. The “VM-Phenotypes project” is a questionnaire-based, multicentric study whose objective is to assess phenotypes and accompanying symptoms according to the Barany Society grid, presence of pediatric precursors in definite VM subjects. Preliminary data of 69 patients are reported. Multiple choices were possible.

Internal vertigo was reported by 79.6% of cases, 57.9% of them referred spinning sensation; in 58.1% of these subjects vertigo presented a positional component, in 47.3% it was triggered by head motion. Dizziness was reported by 49.2%. External vertigo was referred by 37.7% of patients; 28.9% of subjects referred both internal and external vertigo. Postural symptoms were referred by 97% of subjects.

Duration of vertigo spells was less than 5 minutes in 31.9%, between 6 and 60 minutes in 20.3%, 1–4 hours in 10.1%, 5–24 hours in 36.2%, up to 3 days in 15.5%.

Thirty subjects (43.5%) referred 1 attack/year or less, 16 (23.2%) 1 in 6 months, 14 (20.3%) 1 in 3 months, 7 (10.2%) 1/month, 2 (2.8%) more than 1 per month.

Accompanying symptoms were, in order of frequency, nausea (82.6%) photophobia (59.1%), phonophobia (49.3%),, vomiting (29%), tinnitus (18.8%), palpitation (15.9%), hearing loss (10.1%), diplopia (10.1%), visual aura (10.1%), fullness (8.7%), choking (1.4%).

Twenty (29%) subjects did not refer migraine precursors in pediatric age. In order of frequency, 66.6% referred motion sickness, 11.6% abdominal pain, 10.1% cyclic vomiting, 5.8% torticollis.

We underline that hearing loss and tinnitus are reported in around 10% of subjects in VM attacks.

#### OP02-4

Vestibular Migraine

#### THE INFLUENCE OF HEADACHES IN PATIENTS WITH CHRONIC DIZZINESS

**Fumiuki GOTO**<sup>1</sup>, Miki ARAI<sup>1</sup>, Motohiro ARAI<sup>2</sup>

<sup>1</sup>Department of Otolaryngology, National Hospital Organization Tokyo Medical Center, Japan

<sup>2</sup>Department of Otolaryngology, Yokohama City Red Cross Hospital, Japan

**Objectives:** Patients with chronic dizziness often complain of headaches or general fatigue. This study investigated the influence of the frequency of headaches on dizziness impairments, anxiety, quality-of-life, and other mood states in patients with chronic dizziness.

**Method:** The subjects consisted of 100 consecutive patients with intractable dizziness. Several types of questionnaires were used in the investigations.

**Results:** Of the 85 patients, 51 had either type of headache (tension headache, 38; migraine, 13). The total score on the Dizziness Handicap Inventory correlated linearly with general fatigue ( $R = 0.39, p < 0.001$ ) and headache ( $R = 0.25, p < 0.05$ ). The patients with any type of headache had a significantly more positive family history of headache ( $p < 0.05$ ).

**Conclusion:** The frequency of headaches in patients complaining of chronic dizziness is closely related to the severity of the dizziness impairments and mood states, such as anxiety. It is, therefore, important to treat co-morbid headache in patients with chronic dizziness. The severity of the dizziness impairments and other mood states, including anxiety, did not differ between patients with migraine or non-migraine headaches.

#### OP02-5

Vestibular Migraine

#### EFFECT OF PROPHYLACTIC MEDICATION ON THE ASSOCIATED DIZZINESS AND MOTION SICKNESS IN MIGRAINE

Seung-Han LEE<sup>1</sup>, Seong-Hae JEONG<sup>2</sup>, Kwang-Dong CHOI<sup>3</sup>, Jae-Hwan CHOI<sup>3,4</sup>, Sun-Young OH<sup>5</sup>, Ji-Yun PARK<sup>6</sup>, Dong Uk KIM<sup>7</sup>, Byung Kun KIM<sup>8</sup>, Hyo Jung KIM<sup>9</sup>, Ji-Soo KIM<sup>9</sup>

<sup>1</sup>Department of Neurology, Chonnam National University Medical School, Korea

<sup>2</sup>Department of Neurology, Chungnam National University School of Medicine, Korea

<sup>3</sup>Department of Neurology, Pusan National University School of Medicine, Korea

<sup>4</sup>Department of Neurology, Pusan National University Yangsan Hospital, Korea

<sup>5</sup>Department of Neurology, Chonbuk National University School of Medicine, Korea

<sup>6</sup>Department of Neurology, Presbyterian Medical Center, Korea

<sup>7</sup>Department of Neurology, Chosun University College of Medicine, Korea

<sup>8</sup>Department of Neurology, Eulji University School of Medicine, Korea

<sup>9</sup>Department of Neurology, Seoul National University College of Medicine, Seoul National University Bundang Hospital, Korea

**Purpose:** To determine the efficacy of prophylactic medications for migraine in reducing the associated dizziness and motion sickness.

**Method:** A multicenter prospective study was conducted in nationwide 9 Neurology Centers in South Korea. We consecutively enrolled the patients with migraine with dizziness and/or motion sickness who required a preventive medication due to frequent attacks of migraine or significant disability associated with the migraine attacks. At least one of the prophylactic medications among the beta-blockers, calcium channel blockers, tricyclic antidepressants, and antiepileptic drugs was prescribed. For 3 months from the index visit, the patients had monthly assessments of the characteristics of headache (frequency and duration), dizziness handicap inventory (DHI), UCLA-dizziness questionnaire (DQ), vertigo symptom scale (VSS), and motion sickness scale (MSS).

**Result:** Of the 194 patients initially enrolled, 83 patients (49%) finished the 3-month follow-up. The prophylactic medications significantly improved the headache profiles ( $p = 0.001$ ), all 3 parameters of dizziness (DHI, UCLA-DQ, and VSS,  $p < 0.001$ ), and severity of motion sickness ( $p = 0.001$ ). The frequency of motion sickness also decreased, but it failed to reach a statistical significance ( $p = 0.07$ ).

**Conclusion:** The prophylactic medications for migraine improve associated dizziness and motion sickness as well as the headaches.

#### OP02-6

Vestibular Migraine

#### MAL DE DEBARQUEMENT SYNDROME: A SYSTEMATIC REVIEW AND PROPOSED DIAGNOSTIC GUIDELINES.

Angelique VAN OMBERGEN<sup>1,2,3</sup>, Vincent VAN ROMPAEY<sup>2,4</sup>, Leen K MAES<sup>1,3,5</sup>, Paul H VAN DE HEYNING<sup>1,2,4</sup>, Floris L WUYTS<sup>1,3</sup>

<sup>1</sup>Department of Physics, Antwerp University Research Centre For Equilibrium And Aerospace, University of Antwerp, Belgium

<sup>2</sup>Department of Faculty of Medicine And Health Sciences, University of Antwerp, Belgium

<sup>3</sup>Department of Physics, Faculty of Sciences, University of Antwerp, Belgium

<sup>4</sup>Department of Otorhinolaryngology, Antwerp University Hospital, Belgium

<sup>5</sup>Department of Speech, Hearing And Language Sciences, Faculty of Medicine, Ghent University, Belgium

Mal de débarquement (MdD) is a subjective perception of self-motion after exposure to passive motion, in most cases sea travel, hence the name. Mal de débarquement occurs quite frequently in otherwise healthy individuals for a short period of time (several hours). However, in some people symptoms remain for a longer period of time or even persist and this is then called mal de débarquement syndrome (MdDS). The underlying pathogenesis is poorly understood and therefore, treatment options are limited. In general, limited studies have focused on the topic, but the past few years more and more interest has been attributed to MdDS and its facets, which is reflected by an increasing number of papers. Up to date, some interesting reviews on the topic have been published, but a systematic review of the literature is lacking and could help to address the shortcomings and flaws of the current literature. We here present a systematic review of MdD(S) based on a systematic search of medical databases employing predefined criteria, using the terms “mal de débarquement” and “sea legs”. Based here upon, we suggest a list of criteria that could aid healthcare professionals in the diagnosis of MdDS. Further research needs to address the blank gaps by addressing how prevalent MdD(S) really is, by digging deeper into the underlying pathophysiology and setting up prospective, randomized placebo-controlled studies to evaluate the effectiveness of possible treatment strategies.

OP03-1

Epidemiology

#### PREVALENCE OF VESTIBULAR AND BALANCE DISORDER IN CHILDREN AND ADOLESCENTS ACCORDING TO THE AGE CATERGORIES

Seok Min HONG<sup>1</sup>, Jong Dae LEE<sup>2</sup>, Chang Hee KIM<sup>3</sup>, Myung-Whan SUH<sup>4</sup>, Ho Suk CHU<sup>5</sup>, Minbum KIM<sup>6</sup>, Min-Beom KIM<sup>7</sup>, Sung Huhn KIM<sup>8</sup>, Dae Bo SHIM<sup>9</sup>, Jae-Hyun SEO<sup>10</sup>, Sung Kwang HONG<sup>1</sup>, No Hee LEE<sup>11</sup>

<sup>1</sup>Department of Otolaryngology-head And Neck Surgery, Hallym University College of Medicine, Korea

<sup>2</sup>Department of Otolaryngology-head And Neck Surgery, Soonchunhyang University College of Medicine, Korea

<sup>3</sup>Department of Otolaryngology-head And Neck Surgery, Konkuk University Medical Center, Konkuk University School of Medicine, Korea

<sup>4</sup>Department of Otolaryngology-head And Neck Surgery, Seoul National University College of Medicine, Korea

<sup>5</sup>Department of Otolaryngology-head And Neck Surgery, Hana Ent Hospital, Korea

<sup>6</sup>Department of Otolaryngology-head And Neck Surgery, Catholic Kwandong University International St. Mary's Hospital, Korea

<sup>7</sup>Department of Otolaryngology-head And Neck Surgery, Sungkyunkwan University School of Medicine, Korea

<sup>8</sup>Department of Otolaryngology-head And Neck Surgery, Yonsei University College of Medicine, Korea

<sup>9</sup>Department of Otolaryngology-head And Neck Surgery, Myongji Hospital, Seonam University College of Medicine, Korea

<sup>10</sup>Department of Otolaryngology-head And Neck Surgery, Catholic University of Korea, College of Medicine, Korea

<sup>11</sup>Department of Otolaryngology, Kangseohana ENT Clinic, Korea

Children differ from adults in the expression of dizziness symptoms and cause of dizziness. In several studies, benign paroxysmal positional vertigo of childhood (BPVC) and vestibular migraine(VM) are seen exclusively in children with vertigo, but age limit of children was various, and there was a different findings in disease entities inducing vertigo in children by studies. In our study, we investigated the prevalence of vestibular and balance disorder according to the age categories in multicenter (ENT departments of 11 hospitals) in children and adolescents.

**Method:** Children and adolescents aged under 18 who visited ENT department of 11 hospitals for dizziness were included. We classified the patients three categories: preschool age(up to and including 6-year-old), school age(7- to 12-year-old), and adolescents(13- to 18-year-old). These patients were retrospectively reviewed based on clinical charts.

**Results:** In preschool age group, BPVC are most common, followed by VM. In school age group, BPVC and VM are seen commonly, followed by BPPV, VN, and posttraumatic vertigo. In adolescents, VM are most common, and BPVC, Meniere, BPPV and VN, which are seen mainly in adults, are seen in some adolescents.

**Conclusion:** In children and adolescents with vertigo, VM and BPVC are most common disease, and prevalence of disease by age shows different distribution. These findings help that we diagnose and manage the children and adolescents with vertigo.

OP03-2

Epidemiology

### **POSTURAL CONTROL AND VESTIBULAR-FUNCTION AMONG PEOPLE WITH FALL-RELATED WRIST FRACTURES**

**Berghora BALDURSDOTTIR**<sup>1,2</sup>, Palmi V JONSSON<sup>1,3</sup>, Brynjolfur MOGENSEN<sup>1,4</sup>, Hannes PETERSEN<sup>1,5</sup>, Ella K KRISTINSDOTTIR<sup>1</sup>

<sup>1</sup>Department of Medicine, University of Iceland, Iceland

<sup>2</sup>Department of Physiotherapy, Landspitali University Hospital, Iceland

<sup>3</sup>Department of Geriatrics, Landspitali University Hospital, Iceland

<sup>4</sup>Department of Emergency Medicine, Landspitali University Hospital, Iceland

<sup>5</sup>Department of Otorhinolaryngology, Landspitali University Hospital, Iceland

**Introduction:** Postural instability, falls, and fractures are significant problems with increasing age. An association of decreased postural control and vestibular-asymmetry with falls and fractures has been found. Wrist fractures may be a precursor to more serious hip fractures, which can result in decreased quality of life, increased health care costs, and death in the elderly.

**Purpose:** To investigate whether individuals with fall-related wrist fractures have impaired postural control and/or vestibular asymmetry compared with those who have not fallen and sustained a wrist fracture. Secondly to investigate whether there is a correlation between fast beat on Head-Shake Test (HST) and the opposite site of fracture.

**Methods:** Subjects: Individuals ( $n = 100$ ) aged 50–75 years having sustained a fall-related wrist fracture. Comparison group ( $n = 50$ ): a convenience sample of healthy age and gender matched individuals without previous history of fall-related wrist fractures.

Measurements included the HST and the Sensory Organization Test (SOT).

**Results:** Abnormal HST results were found among 46% of the subjects and 47% had a correlation to the site of fracture. SOT composite score were below age matched average among 19% of subjects.

**Conclusion:** Initial results indicate that a significant proportion of subjects with a fall-related wrist fracture have vestibular disturbance/asymmetry and there seems not to be a correlation between the site of fracture and site of vestibular dysfunction. Data sampling is ongoing and more detailed results will be presented.

OP03-3

Epidemiology

### **ASSOCIATION BETWEEN BONE METABOLISM WITH DIZZINESS AND VESTIBULAR PROBLEMS**

**So Young KIM**<sup>1</sup>, Hyun Suk CHOI<sup>1</sup>, Yang-Sun CHO<sup>2</sup>, Ji-Soo KIM<sup>3</sup>, **Ja-Won KOO**<sup>1</sup>

<sup>1</sup>Department of Otorhinolaryngology-head And Neck Surgery, Seoul National University Bundang Hospital, Korea

<sup>2</sup>Department of Otorhinolaryngology-head And Neck Surgery, Samsung Medical Center, Korea

<sup>3</sup>Department of Neurology, Seoul National University Bundang Hospital, Korea

**Background:** Osteoporosis contributes to the occurrence of falls and benign paroxysmal positional vertigo, particularly in elderly patients. We investigated the association between bone metabolism with vestibular problems and falling.

**Methods:** Participants of the Korean National Health and Nutrition Examination Survey (KNHANES) from 2009 to 2010 who were  $\geq 50$  years old were surveyed on their history of falling, vestibular functioning using the modified Romberg test, variables involving bone metabolism, serum levels of vitamin D and alkaline phosphatase, and they also underwent dual energy X-ray absorptiometry.

**Findings:** The vestibular dysfunction group, but not the fall group, was associated with decreased serum vitamin D levels ( $p = 0.002$ ; estimated value, 1.045; 95% confidence interval [CI], 1.017–1.073). The female group undergoing estrogen replacement therapy had significantly less vestibular dysfunction than that of females not undergoing the therapy ( $p = 0.05$ ; odds ratio [OR], 0.502; 95% CI, 0.251–0.886).

**Interpretation:** The decrease in serum vitamin D level may impact the vestibular system through neural signaling or by osteoporotic changes of the otic capsule as well as otolith particles. Decreased estrogen levels in postmenopausal women makes them more prone to osteoporotic changes, which were associated with a vestibular problem.

OP03-4

Epidemiology

#### **NEW UPDATE ON DEVELOPMENT OF EPIDEMIOLOGIC SCREENING TESTS OF VESTIBULAR FUNCTION**

**Helen S COHEN**<sup>1</sup>, Jasmine STITZ<sup>2</sup>, Ajitkumar P MULAVARA<sup>3</sup>, Brian T PETERS<sup>4</sup>, Chris MILLER<sup>4</sup>, Haleh SANGI-HAGHPEYKAR<sup>5</sup>, Susan P WILLIAMS<sup>6</sup>, Jacob J BLOOMBERG<sup>7</sup>

<sup>1</sup>*Department of Otolaryngology – Head And Neck Surgery, Baylor College of Medicine, USA*

<sup>2</sup>*Department of Medical Engineering, School of Applied Health And Social Sciences, University of Applied Sciences Upper Austria, Austria*

<sup>3</sup>*Department of Neuroscience Research Lab, Universities Space Research Association, USA*

<sup>4</sup>*Department of Neuroscience Research Lab, Wyle Science, Technology, And Engineering Group, USA*

<sup>5</sup>*Department of Obstetrics And Gynecology, Baylor College of Medicine, USA*

<sup>6</sup>*Department of Medicine, Geriatric Medicine Section, Baylor College of Medicine, USA*

<sup>7</sup>*Department of Neuroscience Research Laboratory, Nasa/ Johnson Space Center, USA*

For several years we have worked on developing new screening tests of balance, and dynamic visual acuity. We have modified the battery, reduced the number of balance tests, and added tests of the vestibulo-ocular reflex. We are currently developing the age norms for the normal cohort and we are collecting data from patients with known vestibular disorders. In this session we will provide updated findings.

Supported by NIH grant 2R01DC009031 (HSC), a grant from the National Space Biomedical Research Institute through NASA NCC 9-58 (APM, JB) and a fellowship from the Austria Marshall Plan Foundation (JS).

OP03-5

Epidemiology

#### **PREVALENCE OF VESTIBULAR DYSFUNCTION AND ASSOCIATED FACTORS IN SOUTH KOREA**

**Mun Young CHANG**<sup>1</sup>, Sook-Young WOO<sup>2</sup>, Seonwoo KIM<sup>2</sup>, Yang-Sun CHO<sup>3</sup>, **Ja-Won KOO**<sup>1</sup>

<sup>1</sup>*Department of Otorhinolaryngology-head And Neck Surgery, Seoul National University Bundang Hospital, Korea*

<sup>2</sup>*Department of Biostatistics Team, Samsung Biomedical Research Institute, Korea*

<sup>3</sup>*Department of Otorhinolaryngology-head And Neck Surgery, Samsung Medical Center, Korea*

This study aimed to report the nation-wide prevalence of dizziness and vestibular dysfunction in the Korean population and determine the associated factors. We obtained data from the 2009–2010 Korea National Health and Nutrition Examination Surveys, which were cross-sectional surveys of the civilian, non-institutionalized population of the South Korea aged 40 years and older ( $N = 3,267$ ). A field survey team performed interviews and physical examinations. Structured questionnaires and balance function tests using the modified Romberg test of standing balance on firm and compliant support surfaces were performed for participants. Failure on the modified Romberg test was regarded to indicate vestibular dysfunction. The prevalence of dizziness during the past year was 16.70% (95% confidence interval (CI): 14.65–18.76). The presence of vestibular dysfunction was noted in 1.84% (95% CI: 1.18–2.51). In addition, the prevalence of experiencing falls and positional dizziness were 1.46% (95% CI: 0.87–2.06) and 1.73% (95% CI: 1.17–2.29), respectively. Multivariable analysis revealed that dizziness was associated with increased age, female gender, hearing loss, and stress. Vestibular dysfunction was associated with increased age, history of dizziness, and hearing loss. Vertigo and dizziness are the greatest contributors to the burden of disability in the aged population. Screening for dizziness and vestibular dysfunction and management of associated factors might be important for improving compromised QOL due to postural imbalance caused by vestibular problems.

## OP04-1

Meniere's Disease and Related Disorders I

**EFFECTIVENESS OF INTRATYMPANIC CORTICOSTEROID VS GENTAMICIN IN UNILATERAL MENIERE'S DISEASE**

**Adolfo M BRONSTEIN**<sup>1</sup>, Mitesh PATEL<sup>1</sup>, Kiran AGARWAL<sup>1</sup>, Qadeer ARSHAD<sup>1</sup>, Mohammed HARIRI<sup>2</sup>, Peter REA<sup>3</sup>, Barry M SEEMUNGAL<sup>1</sup>, John F GOLDING<sup>1,4</sup>, Jonny HARCOURT<sup>2</sup>

<sup>1</sup>*Department of Neuro-otology, Imperial College London, United Kingdom*

<sup>2</sup>*Department of Ear, Nose And Throat, Charing Cross Hospital, United Kingdom*

<sup>3</sup>*Department of Ear, Nose And Throat, Leicester Royal Infirmary, United Kingdom*

<sup>4</sup>*Department of Psychology, University of Westminster, United Kingdom*

**Background:** Ménière's disease is characterized by vertigo attacks and progressive deafness. Intratympanic gentamicin ablates vestibular inner hair cell function and quells vertigo in Ménière's disease, however, Gentamicin can worsen hearing and requires careful monitoring. Intratympanic corticosteroids may reduce vertigo in Ménière's disease, potentially without harming hearing.

**Methods:** Patients with definite unilateral Ménière's disease refractory to medical therapy, were randomized to intratympanic methylprednisolone or gentamicin and followed-up over two years. The primary outcome was vertigo frequency over the final 6-month period (i.e. 18–24 month's post-injection) compared to a 6-month pre-intratympanic injection baseline. The main secondary outcome was hearing loss. Patients whose vertigo did not respond post-injection ('non-responders') were considered for additional injections by an un-blinded physician.

**Results:** Thirty patients were recruited to each arm. There were two 'non-responders', both switched from steroid to gentamicin. Vertigo frequency change was analyzed both on an intention-to-treat basis and also without 'non-responders'. The reduction in vertigo frequency at 2 years was not different between drug arms. There was no difference between drugs for hearing. However, a clinically meaningful drop in speech discrimination was seen in 9 patients after Gentamicin versus 1 patient post-steroid. The mean number of injections was not different between drug arms. There were no safety concerns.

**Conclusions:** In intractable unilateral Ménière's disease, injections of gentamicin or steroid are equally effective for vertigo control. Patients and clinicians now have a choice of two effective treatments but, on the basis of clinical wisdom, one may favour one or the other drug in specific circumstances.

## OP04-2

Meniere's Disease and Related Disorders I

**A RANDOMIZED DOUBLE-BLIND PLACEBO-CONTROLLED STUDY OF INTRATYMPANIC LATANOPROST FOR MENIERE'S DISEASE**

**Mikael KARLBERG**<sup>1</sup>, Per-Inge CARLSSON<sup>2</sup>, Ylva DAHLIN-REDFORS<sup>3</sup>, Cecilia ENGMER BERGLIN<sup>4</sup>, Elsa ERIKSEN<sup>5</sup>, Svante HUGOSSON<sup>6</sup>, Johan KNUSSON<sup>7</sup>, Helge LYCKBERG<sup>2</sup>, Claes MÖLLER<sup>6</sup>, Serge PADOAN<sup>8</sup>, Kristoffer PIEKAREK<sup>9</sup>, Michael SCHULIN<sup>10</sup>, Anette SÖRLIN<sup>11</sup>, Tatjana TOMANOVIC<sup>4</sup>, Lena WIKLUND<sup>12</sup>, Fredrik HENELL<sup>13</sup>

<sup>1</sup>*Department of Otorhinolaryngology, Lund University Hospital, Sweden*

<sup>2</sup>*Department of Otorhinolaryngology, Karlstad Central Hospital, Sweden*

<sup>3</sup>*Department of Otorhinolaryngology, Gothenburg Sahlgrenska University Hospital, Sweden*

<sup>4</sup>*Department of Otorhinolaryngology, Solna Karolinska University Hospital, Sweden*

<sup>5</sup>*Department of Otorhinolaryngology, Uppsala University Hospital, Sweden*

<sup>6</sup>*Department of Otorhinolaryngology, Örebro University Hospital, Sweden*

<sup>7</sup>*Department of Otorhinolaryngology, Västerås County Hospital, Sweden*

<sup>8</sup>*Department of Otorhinolaryngology, Kristianstad County Hospital, Sweden*

<sup>9</sup>*Department of Otorhinolaryngology, Karlskrona County Hospital, Sweden*

<sup>10</sup>*Department of Otorhinolaryngology, Linköping University Hospital, Sweden*

<sup>11</sup>*Department of Otorhinolaryngology, Sunderbyn County Hospital, Sweden*

<sup>12</sup>*Department of Otorhinolaryngology, Falun County Hospital, Sweden*

<sup>13</sup>*Department of Otorhinolaryngology, Synphora AB, Sweden*

All definite Meniere patients have endolymphatic hydrops, but all patients with hydrops do not have Meniere's disease. It reminds of glaucoma were all patients have increased intraocular pressure, but all with increased intraocular pressure do not develop glaucoma. Latanoprost, a prostaglandin F2 $\alpha$ -agonist, have revolutionized glaucoma treatment. A previous double-blind, placebo-controlled, cross-over study showed significant positive effects on hearing, tinnitus and vertigo in patients with "burned-out" Meniere [1]. In this study we study the effect on hearing and vertigo of intratympanic injections of latanoprost in patients with active Meniere's disease.

We included 100 definite stage II-III Meniere patients, having at least 3 vertigo attacks during the last 3 months and speech discrimination score less than 85%. They had either 1 injection of latanoprost ( $n = 27$ ) or placebo ( $n = 13$ ) or 3 injections of latanoprost ( $n = 40$ ) or placebo ( $n = 20$ ). They were then followed for 3 months with pure tone audiometry, speech discrimination in noise, subjective tinnitus measurement (Tinnitus Handicap Inventory) and subjective measurement of hearing, tinnitus and vertigo on Likerts scales. The number of vertigo attacks  $> 20$  minutes and the number of drop-attacks were recorded.

The results will be presented.

#### Reference

1. H. Rask-Andersen, U. Friberg, M. Johansson and J. Stjernschantz, Effects of intratympanic injection of Latanoprost in Menière's disease: A randomized, placebo-controlled, double-blind, pilot study, *Otolaryngology-Head and Neck Surgery* **133** (2005), 441–3.

#### OP04-3

Meniere's Disease and Related Disorders I

#### DIFFERENCE OF AUDITORY SYMPTOMS AND VESTIBULAR FUNCTION IN THE VERTIGO-FREE INTERVAL OF MENIERE'S DISEASE

**Liqun ZHONG**<sup>1</sup>, Zhengguang CHENG<sup>1</sup>, Menghuan XIA<sup>1</sup>, Shasha LI<sup>1</sup>, Xiaoja YUAN<sup>1</sup>, Yi REN<sup>1</sup>, Yongmei SHI<sup>1</sup>, Peiyan LIU<sup>1</sup>, Zhongjian TAN<sup>1</sup>

<sup>1</sup>Department of Department of Clinical Neurology, Dongzhimen Hospital Affiliated To Beijing University of Chinese Medicine, China

**Purpose:** Symptoms in the vertigo-free interval of Meniere's disease arise from labyrinth and cochlea and their nerves. And the relationship between symptoms and hydrops of the related nerves is still unknown.

**Method:** Four patients and fifteen healthy age-matched volunteers were enrolled. Firstly the CN8 (including vestibular nerve, cochlear nerve, auditory nerve) and CN7 (facial nerve) were analyzed by Diffusion tensor imaging (DTI), and the apparent diffusion (ADC), the fractional anisotropy (FA) of the segments of every nerve were calculated. Secondly the Dizziness handicap Inventory (DHI), Tinnitus Handicap Inventory(THI), Dynamic Gait Index(DGI) of every patients were measured and analyzed.

**Result:** The FA of bilateral-auditory nerves of patients was lower than the control group; the ADC of cochlear nerve was lower than control group too. And the ADC of auditory was higher than the control ( $P < 0.05$ ). DHI had no relationship to FA, ADC of nerves; THI had a negative correlation to FA of auditory nerve.

**Conclusion:** The present results were proven that auditory symptom was severer than vestibular symptom in the vertigo-free interval of Meniere's disease in accordance with the hydrops of nerves, especially for auditory nerve.

**Keywords:** The Meniere's disease, the vertigo-free interval, hydrops, DHI, THI

Abbreviation: CN cranial nerve; DHI Dizziness Handicap Inventory; THI Tinnitus Handicap Inventory; DTI Diffusion tensor imaging; DIG Dynamic Gait Index; FA fractional anisotropy; ADC apparent diffusion coefficient ( $10^{-6} \text{ mm}^2/\text{s}$ ).

## OP04-4

Meniere's Disease and Related Disorders I

**FUNCTIONAL CORRELATION IN THE INNER EAR OF ENDOLYMPHATIC HYDROPS REVEALED BY AN ANIMAL MODEL**Ting-Hua YANG<sup>1</sup>, Fong-Lin CHUNG<sup>1</sup>, Yi-Ho YOUNG<sup>1</sup><sup>1</sup>*Department of Otolaryngology, National Taiwan University Hospital, Taiwan*

Endolymphatic hydrops (EH) may not be the only cause of Meniere's disease but is believed to be a main mechanism. Speculation of endolymphatic hydrops in the patients was grounded on clinical symptoms and sometimes the assistance of image technology. The correlation of auditory and vestibular test results with EH was mostly based on an indefinite diagnosis. An animal model may help disclose the influence of EH on the inner ear. In the animals with induced EH, both histopathological and functional assessment were conducted for simultaneous comparison. The effect of EH on the cochlea, utricle, saccule and semicircular canals were investigated by multiple auditory and vestibular testing. Male Hartley guinea pigs were used in this study. EH was induced in the right ear by obliteration of the endolymphatic sac and vasopressin was given. 4 weeks later, ABR, cVEMP, oVEMP and caloric tests were implemented in the same animals. After the tests, the temporal bone of the animals were harvested for assessment of the extent of EH. The results showed that various level of functional damage was noted in all auditory and vestibular tests. The deficit of function correlated with the development of EH.

## OP04-5

Meniere's Disease and Related Disorders I

**IMPLANTATION OF VENTILATION TUBES FOR MENIERE'S DISEASE**Yukihiro KIMURA<sup>1</sup>, Kazuhiro OGII<sup>2</sup>, Yasuhiro MANABE<sup>1</sup><sup>1</sup>*Department of Otorhinolaryngology, Shinseikai Toyama Hospital, Japan*<sup>2</sup>*Department of Otorhinolaryngology, Head And Neck Surgery, University of Fukui, Japan*

**Objectives:** It has been considered that Meniere's disease has multifactorial risk factors, including Eustachian tube dysfunction. Therefore, insertion of a ventilation tube in tympanic membrane has been attempted as a treatment for Meniere's disease, resulting in good vertigo control in some patients. We analyzed the relationship between efficacies of implantation of a ventilation tube and hearing level or ET function in the patients with Meniere's disease.

**Methods:** 17 ears of 15 patients with intractable Meniere's disease were performed insertion of a ventilation tube. Before and after the tube insertion, frequency of vertigo attack was counted and hearing level was measured by the pure-tone audiometer. Eustachian tube function was measured by the Sonotubometry.

**Results:** The hearing levels of four ears were improved after the treatment. Four ears were diagnosed with "a stenotic tube type" and nine ears were diagnosed with "a patulous tube type" in the measurement of Eustachian tube function with Sonotubometry. There was significant relationship between the improvement hearing level and the observation period in the "a patulous tube type" cases.

**Conclusions:** Exact explanation for the effect of ventilation tubes in tympanic membrane is vague and its therapeutic effect was limited. However, this treatment might represent an effect for the improvement of hearing level in some Meniere's disease patients with a patulous Eustachian tube and so it might become a treatment option because of its simple and less-invasive procedure.

## OP04-6

Meniere's Disease and Related Disorders I

**VOR CHANGES AFTER MULTIPLE INTRATYMPANIC GENTAMICIN INJECTIONS FOR MÉNIÈRE'S DISEASE**Nicolas PEREZ<sup>1</sup>, Pedro Miguel MARQUES<sup>2</sup>, Raquel MANRIQUE<sup>1</sup><sup>1</sup>*Department of Otorhinolaryngology, University of Navarra, Spain*<sup>2</sup>*Department of Otorhinolaryngology, Centro Hospitalar De S. Joao. Porto, Portugal*

**Objectives:** To assess angular vestibular-ocular reflex (VOR) changes after treatment with multiple intratympanic gentamicin injections for unilateral Ménière's disease (MD).

**Material and methods:** Prospective study of 13 consecutive patients submitted to more than 1 gentamicin intratympanic treatment for intractable unilateral MD. The gain of the VOR elicited by rapid head impulses, before and after treatment were measured using video Head Impulse Test (vHIT).

**Results:** Mean follow-up was 18,4 months. Four patients were submitted to 2 injections, five to 3, three to 4 and one patient was submitted to 5 injections.

Gain average was reduced after the first treatment was 0.68 ( $p = 0.905$ , paired samples t-test) for the anterior semicircular canal (SCC), 0.82 ( $p = 0.049$ , paired samples t-test) for the horizontal SCC and 0.57 ( $p = 0.029$ , paired samples t-test) for the posterior SCC.

The rate of vestibular function reduction average observed was 11,2% for the anterior SCC, 25,9% for the horizontal and 21,9% for the posterior SCC

Gains asymmetry between symptomatic and asymptomatic ear (GASM) after the first treatment was changed in the horizontal SCC (12.2 to 3.6;  $p = 0.018$ ), anterior SCC (15.5 to 8.2;  $p = 0.0447$ ) and in the posterior SCC (2.4 to 12.1;  $p = 0.135$ ).

**Conclusions:** In patients without a controlled disease after a single intratympanic gentamicin injection for MD, a scarce reduction of the VOR gain and a reduction of GASM was observed.

This occurred, in distinction with prior studies, in which a greater reduction of vestibular function was observed for those patients which achieved an effective control of the disease.

#### OP05-1

Central Vestibular Disorder I

#### GAIT ATAXIA IS THE COMMONEST NEUROLOGICAL FEATURE IN MILD-MODERATE ACUTE HEAD TRAUMA

**Barry M SEEMUNGAL**<sup>1,2</sup>, Heidi PAINE<sup>2</sup>, Qadeer ARSHAD<sup>1,2</sup>, James MILBURN<sup>2</sup>, Susie WOLSTENHOLME<sup>2</sup>, Katie COLLINS<sup>2</sup>, Mark WILSON<sup>2</sup>, Hani MARCUS<sup>1,2</sup>

<sup>1</sup>Department of Brain Sciences, Imperial College London, United Kingdom

<sup>2</sup>Department of Major Trauma Centre, Imperial College Healthcare Nhs Trust, United Kingdom

**OBJECTIVES:** Dizziness is a cardinal but supposedly non-specific feature of the post-concussion syndrome. We asked if discrete vestibular diagnoses can be discerned in acute head injury.

**DESIGN:** Single-centre cross-sectional study at a Major Trauma Centre.

**SUBJECTS & METHODS:** One hundred and eleven consecutive closed head injury patients were screened for vestibular dysfunction (via symptom questionnaire and gait exam for imbalance) and referred to BMS (the senior author) for evaluation.

**RESULTS:** 86% (96/111) had symptoms +/or signs of vestibular dysfunction. Patients were typically young men (M:F 2.7:1; median 38yrs) with mild head injury (median arrival-GCS 15). The main symptoms: imbalance (58%), headache (52%) and dizziness (40%). BMS assessed 49 patients. The main signs: gait ataxia (76%), broken smooth pursuit (61%) and +ve Hallpike (49%). Vestibular diagnoses were as follows: Gait ataxia (76%), BPPV (45%), vestibular migraine-phenotype (41%) and vestibular nerve transection (16%). Multiple vestibular diagnoses were seen in 65%. Finally, of the 37 patients with objective gait ataxia, half (18) did not feel unbalanced.

**CONCLUSIONS:** Vestibular screening is needed for all concussion patients since patients may be unaware of their deficits for which there are effective treatments.

#### OP05-2

Central Vestibular Disorder I

#### COMPUTER-CONTROLLED ROTATION HEAD IMPULSE TEST AS AN ASSESSMENT TOOL FOLLOWING A CONCUSSIVE EVENT

**Alexander KIDERMAN**<sup>1</sup>, Michael HOFFER<sup>2</sup>, Carey BALABAN<sup>3</sup>

<sup>1</sup>Department of Technology, Neuro Kinetics, Inc., USA

<sup>2</sup>Department of Otolaryngology, University of Miami, Miller School of Medicine, USA

<sup>3</sup>Department of Otolaryngology, Neurobiology, Communication Science & Disorders, And Bioengineering, University of Pittsburgh, USA

**Introduction:** Mild Traumatic Brain Injury (mTBI) is a heterogeneous condition with a diverse clinical presentation. Neurosensory symptoms, including dizziness and balance disorders, are among the most common disabilities seen after injury. Despite their prevalence, these symptoms and deficits can be difficult to quantify and analyze, particularly in the acute phase.

**Objectives:** The study examines computer-controlled rotation Head Impulse Test (crHIT) responses following a concussive event in individuals with recent onset mTBI and compares these findings to age matched, healthy controls.

**Methods and materials:** Subjects were recruited from the Emergency and Trauma Departments of two military hospitals and presented for medical exam and oculomotor, vestibular and reaction time tests within an average 2.6 days after head injury. The test battery included a crHIT test using a 100 Hz infra-red eye tracking system on the Neuro Kinetics, Inc. (NKI) I-Portal® Neuro Otologic Test Center (NOTC) to deliver six rightward and six leftward impulses randomized in direction at nominal acceleration of 1,000°/sec<sup>2</sup>.

**Results:** Comparing the results of 100 mTBI subjects to 267 controls suggests that the crHIT test has good predictability, correctly predicting 93.6% for the control group, 76% for the mTBI group, and 88.8% overall.

**Conclusion:** These results suggest that the crHIT test can be an important clinical component of a balance or dizzy clinics' evaluation of Mild Traumatic Brain Injury patients.

#### OP05-3

Central Vestibular Disorder I

#### PROPOSED DIAGNOSTIC CRITERIA FOR CEREBELLAR ATAXIA WITH NEUROPATHY AND VESTIBULAR AREFLEXIA SYNDROME (CANVAS)

**David J SZMULEWICZ**<sup>1</sup>, Leslie ROBERTS<sup>2</sup>, Catriona A MCLEAN<sup>3</sup>, Hamish G MACDOUGALL<sup>4</sup>, G Michael HALMAGYI<sup>5</sup>, Elsdon STOREY<sup>6</sup>

<sup>1</sup>Department of Balance Disorders & Ataxia, Royal Victorian Eye & Ear Hospital, University of Melbourne, Australia

<sup>2</sup>Department of Neuroscience, St Vincent's Hospital, Melbourne, Australia

<sup>3</sup>Department of Anatomical Pathology, Alfred Hospital, Melbourne, Australia

<sup>4</sup>Department of Vestibular Research Laboratory, University of Sydney, Australia

<sup>5</sup>Department of Neurology, Royal Prince Alfred Hospital, Sydney, Australia

<sup>6</sup>Department of Neuroscience, Monash University, Australia

**Objective:** To create a diagnostic classification for CANVAS in order to aid clinical diagnosis and support further research.

**Background:** CANVAS is a novel inherited ataxia comprising three key etiological foci of ataxia: cerebellar, vestibular and sensory. Whilst this disorder implicates three of the four cardinal props of balance (only vision remains unaffected), it is slowly progressive in comparison to other similar ataxias. The search for causative gene(s) in CANVAS is underway, but our initial attempts indicate that the pattern of inheritance is unlikely to be straightforward. Our experience to date suggests that as a clinical entity, CANVAS may comprise greater than one causative gene, significant phenotypic heterogeneity and phenocopies, in addition to a complex pattern of inheritance. Diagnosis of ataxic disorders is an important clinical challenge upon which prognostication, management, patient solace and above all, the hope of future treatment all rely. Heritable diseases and the possibility of affected offspring carry the added burden of portending adverse health, social and financial ramifications.

**Design/methods:** Retrospective analysis of over 80 patients with a diagnosis of CANVAS in whom oculomotor, electrophysiological, MRI, post-mortem neuro- and otopathology have been gathered.

**Results:** We propose a staged diagnostic criterion for CANVAS based on the identified pathology in the vestibulum, cerebellum and spine.

**Conclusions:** Identification of the pathological gene(s) in CANVAS will lead to the development of a definitive diagnostic test and provide the hope of treatment advances.

## OP05-4

Central Vestibular Disorder I

**PROLONGED VESTIBULO-OCULAR REFLEX ONSET LATENCY IN PROGRESSIVE SUPRANUCLEAR PALSY**

**Luke CHEN<sup>1</sup>, Sally M ROSENGREN<sup>1</sup>, Michael J TODD<sup>1</sup>, Steven TISCH<sup>2</sup>, Neil MAHANT<sup>3</sup>, Victor Sc FUNG<sup>3</sup>, Michael HALMAGYI<sup>1</sup>, Swee T AW<sup>1</sup>**

<sup>1</sup>Department of Neurology, Rpa Hospital, Australia

<sup>2</sup>Department of Neurology, St Vincent's Hospital Sydney, Australia

<sup>3</sup>Department of Neurology, Westmead Hospital, Australia

**Background:** Evidence suggests impaired otolith mediated reflex in progressive supranuclear palsy (PSP). We explored this further with electrically-evoked VOR (eVOR) and ocular vestibular evoked myogenic potentials (oVEMP).

**Method:** We studied 24 probable PSP with 1) electrical vestibular stimulation, consisting of 100ms, bipolar, transmastoid 2.5–7.5 mA direct current stimuli and recording evoked three-dimensional eye movements with dual scleral search coils, and 2) oVEMP evoked by Fz bone-conducted vibration. Results were compared to normal subjects.

**Results:** Onset latency of eVOR was prolonged most marked in the torsional (~ 11 ms) and vertical (12.5 ms) components, whilst sparing the horizontal (10.5 ms). Tonic and phasic eVOR were overall within normal range, though some exhibited increased response in the vertical component. N1 peak latency of oVEMP was mildly prolonged (10.9 ms). The occurrence of either absent or reduced oVEMP was low (12%).

**Conclusion:** Vestibular abnormality in PSP is characterized by prolonged onset latency but preserved response magnitude, indicating that the VOR is delayed but not abolished. Our findings further support impaired otolith-ocular reflex in PSP. VOR onset latency should be further investigated as a potential biomarker for differentiation of PSP from other parkinsonian syndromes.

## OP05-5

Central Vestibular Disorder I

**THE INVESTIGATION ON THE LINK BETWEEN RESTRICTION OF NECK MOVEMENT AND CERVICAL VERTIGO.**

**Ewa ZAMYSLOWSKA-SZMYTKE<sup>1</sup>, Tomasz ADAMCZWSKI<sup>2</sup>, Joanna MAJAK<sup>1</sup>, Mariola SLIWINSKA-KOWALSKA<sup>1</sup>**

<sup>1</sup>Department of Audiology And Phoniatrics Clinic, Balance Disorders Unit, Nofer Institute of Occupational Medicine, Lodz, Poland

<sup>2</sup>Department of Clinic of Medical Rehabilitation,, Medical University of Lodz,, Poland

Study was performed to investigate if restriction in neck rotation and increased neck muscle tension may activate the cervical afferent response, which in turn could be linked to cervical vertigo. Normal caloric test was the major inclusion criterion. Seventy-eight patients reporting vertigo and/or unbalance were included; 53 of them (R+ group) showed restriction of cervical rotation and painful muscle tension in the flexion-rotation test.

Increased mean gain of cervico-ocular reflex (COR) and the positive relationship between COR and vestibulo-ocular reflex (VOR) were observed in R+ group. Cervical torsion test revealed increased nystagmus velocity and slowing the blood flow in basilar and contralateral vertebral arteries. Increased cervical proprioception and slight asymmetry in blood flow seems to be possible explanation of the vertigo and imbalance.

## OP05-6

Central Vestibular Disorder I

**THE DIFFERENCE OF CHARACTERISTIC OF APOGEOTROPIC NYSTGMUS BETWEEN CAUSED BY CENTRAL LESION AND BY PERIPHERAL LESION**

**Takao IMAI<sup>1</sup>, Atsuhiko UNO<sup>2</sup>, Kayoko HIGASHI – SHINGAI<sup>3</sup>, Suzuyo OKAZAKI<sup>1</sup>, Tomoko OKUMURA<sup>1</sup>, Yumi OHTA<sup>1</sup>, Tetsuo MORIHANA<sup>1</sup>, Takashi SATO<sup>1</sup>, Hidenori INOHARA<sup>1</sup>**

<sup>1</sup>Department of Otorhinolaryngology – Head & Neck Surgery, Osaka University Graduate School of Medicine, Japan

<sup>2</sup>Department of Otorhinolaryngology - Head & Neck Surgery, Osaka General Medical Center, Japan

<sup>3</sup>Department of Otolaryngology, Suita Municipal Hospital, Japan

We experienced six cases showing apogeotropic nystagmus with central lesion from August 2010 to August 2015. In this study, we showed difference of nystagmus of patients between with central lesion and peripheral lesion. In patients with peripheral lesion, the apogeotropic nystagmus had a regular form, but in three patients with central lesion the apogeotropic nystagmus had irregular form. In patients with peripheral lesion, the apogeotropic nystagmus was persistent, but in two patients with central lesion the apogeotropic nystagmus was transient. In most patients with peripheral lesion, both the bowing nystagmus and leaning nystagmus was horizontal nystagmus and the direction of bowing nystagmus was opposite to the direction of leaning nystagmus. In three patients with central lesion, both the bowing nystagmus and leaning nystagmus was vertical nystagmus and the direction of bowing nystagmus was opposite to the direction of leaning nystagmus. When a patients show the apogeotropic nystagmus in supine and the nystagmus has an irregular form or transient, we should take into account of the possibility that the patients has central lesion. And also when a patients shows the apogeotropic nystagmus in supine, we should check the bowing nystagmus and leaning nystagmus. When the patient showed vertical bowing nystagmus and leaning nystagmus, we should take into account of the possibility that the patients has central lesion.

#### OP06-1

Perilymphatic Fistula and Superior Canal Dehiscence Syndrome

#### THE CHARACTERISTICS OF NYSTAGMUS IN PERILYMPH FISTULA

Ji Eun CHOI<sup>1</sup>, Il Joon MOON<sup>1</sup>, Won-Ho CHUNG<sup>1</sup>, Yang-Sun CHO<sup>1</sup>

<sup>1</sup>Department of Otorhinolaryngology – Head And Neck Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Korea

**Background:** This study investigates the characteristics of nystagmus in patients with barotraumatic perilymph fistula.

**Method:** Medical chart was retrospectively reviewed for 26 patients who underwent exploratory tympanotomy under the suspicion of barotraumatic perilymph fistula from August 2005 to January 2016. We reviewed the caloric test and pattern of nystagmus in 14 patients who were observed nystagmus before surgery.

**Result:** Three out of 14 only showed spontaneous nystagmus and two patients showed decreased vestibular function on the lesion side in caloric test. The other 9 patients were observed with positional nystagmus similar to benign paroxysmal positional vertigo. Every patient who showed positional nystagmus had torsional nystagmus on both lesion and normal side. The amplitude of nystagmus was stronger when lie on the lesion side. Four of these patients had horizontal nystagmus against the lesion side while another four patients had ageotropic or geotropic nystagmus. Unlike typical BPPV, latency was absent and fatigability was rare, and reversibility of nystagmus was not observed.

**Conclusion:** Barotraumatic perilymph fistula showed positional nystagmus and multi-directional nystagmus including torsional nystagmus. This is thought to be caused by partially dissected wall of membranous labyrinth compressing the crista ampullaris ending up pushing it against the utricle. Therefore, when a patient complains sudden sensorineural hearing loss after trauma event and shows atypical positional nystagmus, it is important to suspect barotraumatic perilymph fistula and consider early surgical correction.

#### OP06-2

Perilymphatic Fistula and Superior Canal Dehiscence Syndrome

#### BIOMARKER FOR DIZZINESS AND HEARINGLOSS. – CTP WILL HELP US BETTER UNDERSTAND INNER EAR DISEASES –

Tetsuo IKEZONO<sup>1</sup>, Han MATSUDA<sup>1</sup>, Tomohiro MATSUMURA<sup>2</sup>, Shinnichi USAMI<sup>3</sup>, Mamoru SUZUKI<sup>4</sup>, Kaoru OGAWA<sup>5</sup>

<sup>1</sup>Department of Otorhinolaryngology, Saitama Medical University Faculty of Medicine, Japan

<sup>2</sup>Department of Biochemistry & Molecular Biology, Nippon Medical School, Japan

<sup>3</sup>Department of Otorhinolaryngology, Shinshu University, the Genetic And Anomalous Ear Diseases Study Group,

Japan, Japan

<sup>4</sup>Department of Otorhinolaryngology, Tokyo Medical University, the Peripheral Vestibular Disorder Research Committee, Japan, Japan

<sup>5</sup>Department of Otorhinolaryngology, Keio University, the Acute Severe Hearing Loss Study Group, Japan, Japan

**Background:** Numerous biomarkers for dizziness and hearing loss has been reported including autoantibodies, inflammatory cytokines. Among these, CTP (Cochlin tomo-protein, an isoform of Cochlin), perilymph specific protein, is a novel and unique biomarker. We reported a biochemical test for PLF detecting CTP in middle ear lavage (MEL, 0.3 ml saline). Recently we could establish a highly reliable ELISA-kit to detect CTP. The Japanese PLF diagnosis criterion is now based on the visual identification of the fistula (not a leakage) and/or detecting CTP. With a help of private clinical test enterprise (SRL inc.) in Japan, CTP test is widely available nationwide, in 150 hospitals.

**Diagnostic accuracy:** If there is 2 µl of leaked perilymph in the MEL, the test is positive. The diagnostic performance of the test has a high reliability, and the AUC in ROC analysis was greater than 0.90.

**What We Could Learn from the CTP Test:** The pattern of hearing loss of CTP positive PLF cases varies, including sudden onset, progressive, fluctuating or recurrent. Surprisingly, in some patients, dizziness is their chief complaint not hearing loss.

We believe CTP test will give the answer to the long-standing debate about the existence of PLF.

#### OP06-3

Perilymphatic Fistula and Superior Canal Dehiscence Syndrome

#### THE BALANCE AND COGNITIVE DISABILITIES OF CHRONIC PERILYMPHATIC FISTULA

**Jeremy HORNIBROOK<sup>1,2</sup>**

<sup>1</sup>Department of Otolaryngology-head And Neck Surgery, Christchurch Hospital, New Zealand

<sup>2</sup>Department of Communication Disorders, University of Canterbury, New Zealand

Perilymph fistula (PLF) has been a contentious topic in otolaryngology and vestibular medicine for over fifty years [1]. The main criticisms have been a lack of reliable symptoms and diagnostic tests, operative traps for reliably 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 claim that descriptions of “spontaneous” perilymph fistulas were a threat to the whole credibility of otolaryngology and that “no characteristic signs, symptoms or diagnostic tests exist...”. This is not true, and nearly always a traumatic cause can be found. In the literature there is confusing loose terminology to describe the vestibular symptoms.

Chronic window perilymph fistula is a rare example of an unstable peripheral vestibular abnormality with a unique balance abnormality [2] and often significant cognitive sequelae, and is the most disabling vestibular condition which is curable.

The background to the controversy and features of 23 patients with successfully repaired window fistulas will be presented, including a 2015 case demonstrating the balance abnormality and profound cognitive features, recently published on YouTube [3].

1. J. Hornibrook, Perilymph fistula: fifty years of controversy. ISRN Otolaryngology Volume 2012, Article ID 281248, 9 pages doi: 10/5402/2012/281248.

2. J. Hornibrook, A balance test for chronic perilymph fistula. Int J Otolaryngol Volume 2012, Article ID 16391, 8 pages doi: 10.1155/2012/16391.

3. Jeremy Hornibrook. The balance abnormality of chronic perilymph fistula.

‘Perilymph Fistula’ on Google search and YouTube reference: <https://youtu.be/2DXgQMnlgbw>

## OP06-4

Perilymphatic Fistula and Superior Canal Dehiscence Syndrome

**POSITIONAL VERTIGO AND NYSTAGMUS IN SUPERIOR CANAL DEHISCENCE SYNDROME**

**Luca VERRECCHIA**<sup>1,3</sup>, Tony PANSELL<sup>2</sup>, Maoli DUAN<sup>1,3</sup>, Krister BRANTBERG<sup>1,3</sup>

<sup>1</sup>*Department of Clinical Sciences, Intervention And Technology, Karolinska Institutet, Sweden*

<sup>2</sup>*Department of Clinical Neurosciences, Karolinska Institutet, Sweden*

<sup>3</sup>*Department of Audiology And Neurotology, Karolinska University Hospital, Sweden*

Superior canal dehiscence (SCD) syndrome is characterized by various audio-vestibular symptoms. One of them, positional vertigo, has not been given much attention. In our experience, quite a few SCD patients have features that could readily be mistaken for benign paroxysmal positional vertigo (BPPV). Here we present the characteristics of the eye movements induced by positional changes in four SCD patients with incapacitating positional vertigo. The eye movements were recorded in their vertical, horizontal and torsional components using video-oculography (Chronos C-ETD equipment). The results were compared to those in three BPPV patients. It was found that the principle nature of the nystagmus was the same in SCD and BPPV patients, i.e. positional changes caused vertigo with torsional-vertical nystagmus. They did, however, differ in some respect. The duration of the torsional-vertical nystagmus following Dix-Hallpike's diagnostic test was somewhat longer and somewhat less intense in SCD patients. Further, the positional nystagmus could, as expected, no longer be initiated in BPPV patients following a standard Epley's repositioning maneuver. In contrast, the positional nystagmus remained the same in the SCD patients following the maneuver. Actually, positional vertigo/nystagmus in SCD patients may not be unexpected. Theoretically, also small intracranial pressure changes induced by positional changes may cause significant movements of endolymph/perilymph if there is a broader communication between CSF and the labyrinth. Consequently, SCD related positional vertigo/nystagmus should be regarded as a possible diagnostic alternative to BPPV, especially when repositioning maneuvers are ineffective.

## OP06-5

Perilymphatic Fistula and Superior Canal Dehiscence Syndrome

**A COMPARISON OF DIFFERENT TECHNIQUES IN TRANSMASTOID SURGERY FOR SUPERIOR CANAL DEHISCENCE SYNDROME.**

**Niklas DANCKWARDT-LILLIESTROM**

*Department of Oto-rhino-laryngology, Surgical Sciences, University Hospital, Uppsala, Sweden*

**Introduction:** Surgical treatment is an option to treat patients with debilitating symptoms due to superior canal dehiscence syndrome. Several surgical methods as well as approaches have been described. Transmastoid approach can be used instead of middle fossa approach if the anatomy of the temporal bone fulfil certain criterias.

**Purpose:** To validate two different methods, plugging and capping of the superior semicircular canal with transmastoid approach in terms of relieve of symptoms, complication rate and postoperative recovery.

**Method:** Ten patients were operated with plugging and nine patients with capping using transmastoid approach. Preoperative and postoperative balance function, hearing, tinnitus, autophony, complication rate as well as general health aspects were evaluated.

**Results:** For both method a good relieve of the autophony symptoms were obtained. One patient in each group experienced a sensorineural hearing loss but not deafness. Plugging of the canal caused a general longer postoperative balance disturbance. In two cases using the capping method the whole dehiscence were not covered on postoperatively CT scans. One patient in the plugging group regretted to have done the surgery.

**Conclusions:** Transmastoid approach can be used successfully to treat patients with superior canal dehiscence syndrome. The temporal bone must be well aerated with no dural overhang lateral to the superior semicircular canal to make transmastoid capping possible. With more dural overhang plugging of the canal might be possible. Transmastoid approach is less invasive compared to middle fossa approach but offers no direct exposure of the dehiscence which is an advantage of the middle fossa approach.

## OP07-1

Benign Paroxysmal Position Vertigo I

**DESIGN OF RANDOMIZED-CONTROLLED TRIAL FOR PREVENTION OF BENIGN PAROXYSMAL POSITIONAL VERTIGO**

Seong-Hae JEONG<sup>1</sup>, Ji-Soo KIM<sup>2</sup>, Hyo-Jung KIM<sup>3</sup>, Kwang-Dong CHOI<sup>4</sup>, Ji-Yun PARK<sup>5</sup>, Seung-Han LEE<sup>6</sup>, Seo Young CHOI<sup>4,7</sup>, Sun-Young OH<sup>8</sup>, Jeong-Yoon CHOI<sup>2,9</sup>

<sup>1</sup>*Department of Neurology, Chungnam National University Hospital, Korea*

<sup>2</sup>*Department of Neurology, Seoul National University Bundang Hospital, Seoul National University College of Medicine, Korea*

<sup>3</sup>*Department of Biomedical Laboratory Science, Kyungdong University, Korea*

<sup>4</sup>*Department of Neurology, Pusan National University Hospital, Pusan National University School of Medicine, Korea*

<sup>5</sup>*Department of Neurology, Presbyterian Medical Center, Seonam University, Korea*

<sup>6</sup>*Department of Neurology, Chonnam National University Medical School, Korea*

<sup>7</sup>*Department of Neurology, Chubuk National University Hospital, Korea*

<sup>8</sup>*Department of Neurology, Chonbuk National University School of Medicine, Korea*

<sup>9</sup>*Department of Neurology, Korea University Ansan Hospital, Korea University College of Medicine, Korea*

**Purpose:** We designed a randomized-controlled study to determine the role of vitamin D and calcium supplementation in reducing the recurrences of benign paroxysmal positional vertigo (BPPV) in patients with lower serum vitamin D.

**Methods:** The eligible patients were randomly allocated to the intervention and control groups. The patients in the intervention group had evaluation of serum 25-hydroxyvitamin D, calcium, phosphorus and parathyroid hormone, and had taken 800 IU of vitamin D and 1000 mg of calcium as calcium carbonate per day for one year when the serum vitamin D level was lower than 20 ng/ml. In contrast, the patients in the control group were arranged for follow-up without evaluation and medication. The participants had a monthly telephone interview for the occurrences of falling, fracture and quality of life in addition to vertigo attacks during the preceding month.

**Results:** By the end of 2015, this study had recruited 1,317 patients from eight University Hospitals in Korea. After initial exclusion of 367 patients, 950 patients were randomly allocated to the intervention or control group and 544 (544/950, 57.3%) patients completed the follow-up for one year with a drop-out rate at 17.0% by the end of 2015. Based on the estimation of the sample size ( $n = 934$ ,  $\alpha = 0.05$ ,  $\beta = 0.20$ , equal randomization, Poisson regression analysis), this study is expected to be completed by early 2017.

**Conclusion:** This study will determine the therapeutic efficacy of vitamin D and calcium supplementation for reducing the recurrences of BPPV in patients with BPPV and decreased serum vitamin D.

## OP07-2

Benign Paroxysmal Position Vertigo I

**EFFICACY OF CANALITH REPOSITIONING PROCEDURE ASSISTED BY REHABILITATION CHAIR VERSUS HOME PRACTICE IN BPPV**

Hui WANG<sup>1</sup>, Dongzhen YU<sup>1</sup>

<sup>1</sup>*Department of ENT, shanghai Jiao Tong University Affiliated Sixth People's Hospital, China*

**Objective:** The purposes of this study were to compare the efficacy of canalith repositioning procedure (CRP) assisted by rehabilitation chair versus home practice in patients with benign paroxysmal positional vertigo (BPPV).

**Methods:** A total of 147 patients with BPPV were randomly recruited to the CRP assisted by rehabilitation chair group and CRP with or without home practice. Patients were assessed at 1 week, 2 weeks after their first treatment. All participants were comprehensively interviewed regarding their medical history, characteristics of the first attack of vertigo, associated symptoms, and number of hospital visits.

**Results:** Treatment efficacy of patients in CRP assisted by rehabilitation chair group was significantly better than that of patients in the CRP group 1 week after the first treatment. The canalith repositioning procedure (CRP) assisted by rehabilitation chair group and with home practice was effective in 97.3%, 93.2% of patients after the first

repositioning maneuver respectively. On average, patients visited hospitals no more than two times before the final vertigo disappeared.

**Conclusion:** The CRP is very effective for patients with BPPV. CRP assisted by rehabilitation chair or with home practice, affords a promising sensitive method by which to manage the BPPV.

#### OP07-3

Benign Paroxysmal Position Vertigo I

#### RANDOMIZED TRIAL ON SHORT-TERM EFFICACY OF VIBRATION AND GUFONI MANEUVER FOR APOGEOTROPIC HORIZONTAL BPPV

Hyun Ah KIM<sup>1</sup>, Hyung LEE<sup>1</sup>, Sang Won PARK<sup>2</sup>, Jungil KIM<sup>3</sup>, Bong Gu KANG<sup>4</sup>, Jun LEE<sup>5</sup>, Byung In HAN<sup>6</sup>, Jung Im SEOK<sup>7</sup>, Eungi CHUNG<sup>8</sup>, Jaeyoung KIM<sup>9</sup>

<sup>1</sup>Department of Neurology, Keimyung University Dongsan Hospital, Korea

<sup>2</sup>Department of Neurology, Daegu Fatima Hospital, Korea

<sup>3</sup>Department of Neurology, Kyungil Neurologic Clinic And Internal Medicine, Korea

<sup>4</sup>Department of Neurology, Andong Medical Group Hospital, Korea

<sup>5</sup>Department of Neurology, Yeungnam University Medical Center, Korea

<sup>6</sup>Department of Neurology, Do Neurology Clinic, Korea

<sup>7</sup>Department of Neurology, Catholic University of Daegu, School of Medicine, Korea

<sup>8</sup>Department of Neurology, Daegu Municipal Medical Center, Korea

<sup>9</sup>Department of Preventive Medicine, Keimyung University Dongsan Hospital, Korea

**Objective:** To determine the immediate and short-term efficacy of vibration and Gufoni maneuvers in apogeotropic type of horizontal canal BPPV (HC-BPPV), we designed a randomized, prospective, sham-controlled study.

**Methods:** In 8 nationwide dizziness clinics in Korea, 209 consecutive patients with apogeotropc HC-BPPV were enrolled. Patients were randomly assigned to single application by Gufoni ( $n = 70$ ), vibration ( $n = 67$ ), or sham-maneuver ( $n = 72$ ). During vibration maneuver, patients were taking mastoid oscillation with heads turned to the lesion side 135 degree and healthy side 90 degree. Immediate and second day responses were determined by the result within 1 hour after each maneuver and in the following day, respectively. Short-term responses were determined by the cumulative response for 2 days. Successful treatment was defined as resolution of positional nystagmus, or as transition into geotropic horizontal nystagmus.

**Results:** Immediate response of 30 minutes after single application, Gufoni (33/70, 47.1%) and vibration (32/67, 47.8%) maneuvers showed better responses than the sham maneuver (14/72, 19.4%) ( $p = 0.00$ ). The second day results did not differ between three groups ( $p = 0.53$ ). The short-term outcome determined were also better with Gufoni (52/68, 76.5%) and vibration (47/65, 72.3%) maneuvers compared with the sham maneuver (38/71, 53.5%) ( $p = 0.00$ ). However, therapeutic efficacies did not differ between the Gufoni and vibration-groups in terms of both immediate and short-term outcomes ( $p = 0.69$ ).

**Conclusion:** Both the Gufoni and vibration maneuver are valid methods for treating apogeotropic horizontal canal BPPV with a success rate of approximately 70% at one maneuver during short-term follow up period.

#### OP07-4

Benign Paroxysmal Position Vertigo I

#### DPRM (DYNAMIC PARTICLES REPOSITIONING MANEUVER): A NEW MANEUVER TO TREAT LC-BPPV

**Thomas RICHARD VITTON**

Department of ENT, Private Clinic of Marignane, France

Proposition of a new therapeutic maneuver using a mechanical assistance to treat LC-BPPV.

This study selected 520 subjects experiencing with some positional vertigo or unsteadiness and presenting with positional nystagmus typical from lateral canalithiasis.

The TRV armchair allows rotation of patients wearing infrared video goggles, in all semi-circular planes. An abutment with shocks absorber permits to briskly smoothly stop the rotation of the horizontal rotation of the chair when

the patient becomes horizontalized. The analysis of the positional nystagmus in the total darkness permits to have a better detection of the horizontal component even if it is a very little one. The maneuver consists to make 6 series of 8 smooth shocks on the shock absorber placing prior the involved ear toward the floor, nose turned at 90° from the ceiling, in supine position. Each series is made after a 45° more rotation toward the safe side to make the sixth position 45° nose down the floor to the safe side. These series of shocks permit to give to the very little particles, that could be to light to progress thanks to the gravity, some hypergravity that helps its to move.

Four hundred seventy-five patients were totally freed of symptoms with one session. The persistent unsteadiness or drunkenness sensations which often occur after a therapeutic maneuver for PC and LC-BPPV and so called post-BPPV otolithic syndrome could be some residual lateral canalithiasis linked to a very few otoliths in the canal and could be successfully treated with this new maneuver.

OP07-5

Benign Paroxysmal Position Vertigo I

#### **EFFICACY OF OTOLITH REPOSITIONING MANEUVERS FOR LATERAL CANAL BPPV WITH APOGEOTROPIC NYSTAGMUS (RCT)**

**Eun-Ju JEON<sup>1</sup>, Sung-II NAM<sup>2</sup>, Soon Hyung PARK<sup>2</sup>, Seog-Kyun MUN<sup>3</sup>, Shin-Young YOO<sup>4</sup>, Seok-Min HONG<sup>5</sup>, Jin Woong CHOI<sup>6</sup>, Sung-Hyun BOO<sup>7</sup>, Seung-Hwan LEE<sup>8</sup>, Jae-Ho CHUNG<sup>8</sup>, Ja-Won KOO<sup>9</sup>, Min-Beom KIM<sup>10</sup>, Jae-Hyun SEO<sup>11</sup>, Kyu-Sung KIM<sup>12</sup>, Min-Bum KIM<sup>13</sup>, Seong-Ki AHN<sup>14</sup>, Shi-Nae PARK<sup>15</sup>, Won-Ho CHUNG<sup>16</sup>**

<sup>1</sup>*Department of Otolaryngology-head And Neck Surgery, Incheon St. Mary's Hospital, the Catholic University of Korea, College of Medicine, Korea*

<sup>2</sup>*Department of Otorhinolaryngology, School of Medicine, Keimyung University, Korea*

<sup>3</sup>*Department of Otorhinolaryngology-head And Neck Surgery, College of Medicine, Chung-ang University, Korea*

<sup>4</sup>*Department of Otolaryngology, Soree Ear Clinic West Center, Korea*

<sup>5</sup>*Department of Otorhinolaryngology,, Hallym University College of Medicine, Korea*

<sup>6</sup>*Department of Otolaryngology-head And Neck Surgery, Chungnam National University School of Medicine, Korea*

<sup>7</sup>*Department of Otolaryngology, Samsung Changwon Hospital, Sungkyunkwan University School of Medicine, Korea*

<sup>8</sup>*Department of Samsung Changwon Hospital, Sungkyunkwan University School of Medicine, Hanyang University College of Medicine, Korea*

<sup>9</sup>*Department of Otorhinolaryngology, Seoul National University Bundang Hospital, Korea*

<sup>10</sup>*Department of Otolaryngology-head And Neck Surgery, Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Korea*

<sup>11</sup>*Department of Otolaryngology-head And Neck Surgery, Bucheon St. Mary's Hospital, the Catholic University of Korea, Korea*

<sup>12</sup>*Department of Otolaryngology-head & Neck Surgery, Inha University Hospital, Inha University School of Medicine, Korea*

<sup>13</sup>*Department of Otolaryngology, International St. Mary's Hospital, Catholic Kwandong University, Korea*

<sup>14</sup>*Department of Otorhinolaryngology, School of Medicine, Gyeongsang National University, Korea*

<sup>15</sup>*Department of Otolaryngology-head And Neck Surgery, Seoul St. Mary's Hospital, the Catholic University of Korea College of Medicine, Korea*

<sup>16</sup>*Department of Otorhinolaryngology-head And Neck Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Korea*

Gold standard treatment for lateral canal BPPV has not been established yet. To establish most efficient treatment for lateral canal BPPV with apogeotropic nystagmus (LC-apo), we aimed to compare the therapeutic efficacy of two representative otolith repositioning maneuvers (ORM). A randomized controlled trial was performed through multicenter study which includes 15 hospitals. 72 patients were randomly allotted to 3 treatment groups: therapeutic head shaking (THS), Gufoni maneuver (G) and barbecue rotation with vibrator (BBQ-V). Same treatment maneuver was repeated weekly for 4 weeks. Treatment success was defined as resolution of both vertigo and nystagmus. Total number of ORM session for treatment success and failure rate were compared among the treatment groups. The number of patients in each group was THS/G/BBQ-V: 19/24/24. Total number of ORM necessary for treatment

success was THS: 2.1 0.9, G: 2.3 0.9, and BBQ-V: 1.7 0.7. BBQ-V needed significantly fewest number of ORM to achieve treatment success ( $p = 0.042$ ). Treatment failure rate at 4 week period was 10.5% in THS, 8.3% in G, and 0% in BBQ-V. Entire patients in groups BBQ-V was successfully treated within 2 weeks, showing rapid and high treatment efficacy. This results suggest BBQ-V may be more effective ORM compare to THS or Gufoni maneuver.

#### OP07-6

Benign Paroxysmal Position Vertigo I

#### **COMPARISON OF TWO REPOSITION MANEUVERS FOR BPPV OF ANTERIOR SEMICIRCULAR CANAL**

**Yongkang OU<sup>1</sup>, QiuHong HUANG<sup>1</sup>, Junwei ZHONG<sup>1</sup>, Ling CHEN<sup>1</sup>, Yiqing ZHENG<sup>1</sup>, Xiaowu TANG<sup>1</sup>**

<sup>1</sup>*Department of Otolaryngology, Sun Yat-sen Memorial Hospital, Sun Yat-sen University, China*

**Objective:** The aims was to explore and compare the repositioning maneuver efficacy to anterior canal BPPV (ASC-BPPV)between two repositioning maneuvers.

**Method:** All consecutive patients with diagnosis of ASC-BPPV enrolled were divided into 3 groups as the orders of receiving treatment with 3 maneuvers. The efficacy of 7 days and 30 days after repositioning treatment was evaluated.

**Result:** There were 43 patients enrolled in reverse Epley maneuver group (REM) and 50 patients in Li repositioning maneuver group (LEM) and 43 patients in Sham maneuver group (SM). Chi-square test showed that significant difference in complete and cumulative resolution exist among the three groups 7 days after repositioning treatment.The rate of complete and cumulative resolution in LEM and REM was higher than in SM ( $p < 0.01$ ,  $p < 0.01$ ). The complete resolution in LEM and REM was respectively 77.1% and 51.2%, there was significantly different ( $p < 0.01$ ). There was no significant difference between the 2 groups in the cumulative resolution ( $p = 0.065$ ). Chi-square test showed that no statistical significant differences in complete and cumulative resolution exist among the three groups 30 days after repositioning treatment.The average times of reposition maneuvers for REM to achieve resolution was  $1.61 \pm 0.84$ , while for LEM was  $1.29 \pm 0.59$ ,there was no significant different ( $p > 0.05$ ). the rate of one-time relief in LEM was higher than in REM (respectively, 77.3% and 55.6%), there was significantly different ( $\chi^2 = 4.257$ ,  $p = 0.039$ ).

**Conclusion:** Li repositioning maneuver can achieve higher rate of complete resolution in short-term, while both of 2 maneuvers can obtain a better long-term effect.

#### OP08-1

Head Impulse Test I

#### **CLINICAL DECISION SUPPORT SYSTEM FOR VIDEO HEAD IMPULSE TEST USING FUZZY REASONING**

**Thi Anh Dao NGUYEN<sup>1</sup>, Jang-Woo KWON<sup>1</sup>, Sangmin LEE<sup>2,4</sup>, Hyun-Ji KIM<sup>3</sup>, Kyu-Sung KIM<sup>3,4</sup>**

<sup>1</sup>*Department of Computer and Information Engineering, Inha University, Incheon, Korea*

<sup>2</sup>*Department of Electronic Engineering, Inha University, Incheon, Korea*

<sup>3</sup>*Department of Otolaryngology-Head & Neck Surgery, Inha University Hospital, Incheon, Korea*

<sup>4</sup>*Institute for Information and Electronics Research, Inha University, Incheon, Korea*

**Objectives:** The goal of our study was to propose a novel clinical decision support system for Video Head Impulse Test (vHIT) results based on Fuzzy reasoning. This stand-alone application autonomously and collaboratively provides the statistical data of vHIT VOR check-up and the suggested normality of about the subject's response.

**Methods:** The statistical data are of position VOR gain (calculated by our algorithm), velocity VOR gain (from the recording device), covert and overt catch-up saccade. Afterwards, the detected catch-up saccades and position VOR gain were used as inputs to three fuzzy inference systems. The first one provides the efficiency of each impulse due to the positon VOR gain. The second one gives different output caused by covert catch-up saccade occurrence and position VOR gain. In addition, the third inference system analyzes the statistical data of position VOR gain and the proportion of detected catch-up saccades for the whole dataset of one patient.

**Results:** The developed software provides abundance of vHIT's statistical data to support the diagnosis statement of physicians. Furthermore, it provides the response's normality, in which the position VOR gain and catch-up saccades are articulated via three fuzzy inference systems.

**Conclusions:** In this paper, we presented the clinical decision support system with the above aiming. It might be practical and useful to the analysis and clinical decision for vHIT.

**Keywords:** Vestibulo-ocular response; video head impulse; velocity gain; position gain; desaccade

**Acknowledgement:** This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded in part by the Ministry of Education (2010-0020163) and in part by the Ministry of Science, ICT & Future Planning (NRF-2013R1A2A2A04014796).

This research was supported by the MSIP (Ministry of Science, ICT and Future Planning), Korea, under the ITRC (Information Technology Research Center) support program (IITP-2015-H8501-15-1019) supervised by the IITP (Institute for Information & communications Technology Promotion)

#### OP08-2

Head Impulse Test I

#### THE VIDEO HEAD IMPULSE TEST (VHIT) IN YOUNG CHILDREN: CHARACTERISTICS WITH AGE

Sylvette R WIENER-VACHER<sup>1</sup>, Thierry VAN DEN ABEELE<sup>1</sup>

<sup>1</sup>Department of ORL, Ap Hp Hopital Robert Debré, France

**Goal of the study:** Test feasibility of the VHIT in young children and characterize the vestibuloocular responses (VOR) at high frequencies as a function of age.

**Methods:** VHIT (Synapsys®) was chosen because it increases in absence of goggles VHIT feasibility in young children and tolerates body movements since head and eye movements (position and velocities) are recorded on the same image (at 100 Hz). 199 children (4 months to 15 years old (yo), with 48 less than 2 yo) and 17 subjects from 16 to 58 yo were included in the study. They had normal canal and otolith vestibular responses to a complete battery of tests, no neurological impairments and normal psychomotor development.

**Results:** The head thrusts were performed at 15520°/s (peak acceleration (pa) = 3471°/s<sup>2</sup>) for the lateral canals and 10712°/s (pa = 2210°/s<sup>2</sup>) for the vertical canals. We performed 3 to 7 head thrusts per canal. Compare to adults, the gain of the VOR is significantly lower (t test,  $p < 0.05$ ) for young children (from 4 months to 7 yo) (gain for  $\leq 2$  yo: 0.90 0.11, for 2 to 7 yo: 0.95 0.10) but not for children older than 7 yo (gain of 0.99 0.08 for children 7 to 15 yo and subjects  $\geq 16$  yo).

**Conclusion:** The VOR gain for high velocity head movement in children younger than 7 yo is smaller than in older children and adults. VHIT is feasible in very young children (from the age of 4 months) and can be used to evaluate high frequencies VOR in pediatric pathology

#### OP08-3

Head Impulse Test I

#### QUANTITATIVE ANALYSIS OF GAINS AND CATCH-UP SACCADES OF VIDEO-HEADIMPULSE TESTING BY AGE IN NORMAL SUBJECTS

Chan Joo YANG<sup>1</sup>, Myung Hoon YOO<sup>2</sup>, Je Yeon LEE<sup>1</sup>, Byung Chul KANG<sup>1</sup>, Hwan Seo LEE<sup>1</sup>, Hong Ju PARK<sup>1</sup>

<sup>1</sup>Department of Otolaryngology, Asan Medical Center, University of Ulsan College of Medicine, Korea

<sup>2</sup>Department of Otorhinolaryngology-head & Neck Surgery, Korea University Ansan Hospital, Korea

**Objectives:** To evaluate video-head impulse test (vHIT) results in normal subjects, to determine the normative values of vHIT for the vestibulo-ocular reflex (VOR), and to characterize the catch-up saccades (CSs).

**Design:** Prospective cohort study.

**Setting:** Tertiary care academic referral center.

**Participants:** Fifty healthy subjects with no history of vestibular impairment, ten each in their 20's, 30's, 40's, 50's, and 60's, underwent vHITs in the lateral semicircular canal plane.

**Main outcome measures:** vHIT gains and the incidence and amplitudes of covert and overt CSs.

**Results:** The mean vHIT gain was  $1.02 \pm 0.07$ , and the mean gain asymmetry was  $2.39 \pm 1.96\%$ , with no significant differences among age groups. CSs were observed during 22.6% of the trials and in 49% of the ears. The incidence

of CSs was not associated with age. The mean velocity of CSs was  $55.5 \pm 16.9^\circ/\text{s}$ , and its mean interaural difference was  $11.8 \pm 10.7^\circ/\text{s}$ .

**Conclusions:** vHIT gains were consistently equal to 1.0 in all age groups (20's to 60's), suggesting that abnormal criteria for vHIT gain (e.g., 0.8) and gain asymmetry (e.g., 8%) can be used, regardless of age. CSs were observed in about half of normal ears, suggesting that VOR is a hypometric system. The amplitudes and interaural difference of CSs were also similar in all age groups, suggesting that abnormal criteria for CS amplitude (e.g.,  $100^\circ/\text{s}$ ) and interaural difference (e.g.,  $40^\circ/\text{s}$ ) can be used, regardless of age.

#### OP08-4

Head Impulse Test I

#### VOR GAIN CALCULATION METHODS IN VIDEO HEAD IMPULSE RECORDINGS

Ewa ZAMARO<sup>1</sup>, Ali S SABER TEHRANI<sup>2</sup>, Jorge KATTAH<sup>3</sup>, Karin EIBENBERGER<sup>4</sup>, Cynthia I GUEDE<sup>3</sup>, Marco D CAVERSACCIO<sup>1</sup>, David E NEWMAN-TOKER<sup>2</sup>, Georgios MANTOKOUDIS<sup>1</sup>

<sup>1</sup>Department of Otorhinolaryngology, Head And Neck Surgery, Inselspital Bern, University of Bern, Switzerland

<sup>2</sup>Department of Neurology, Johns Hopkins University School of Medicine, Baltimore, USA

<sup>3</sup>Department of Neurology, University of Illinois College of Medicine, Peoria, USA

<sup>4</sup>Department of Medical Engineering, University of Applied Sciences Upper Austria, Austria

**Objective:** International consensus on best practices for calculating and reporting vestibular function is lacking. Quantitative vestibulo-ocular reflex (VOR) gain using a video head impulse test (HIT) device can be calculated by various methods.

**Methods:** We compared VOR gain calculation methods using 1300 horizontal HIT traces from 26 patients with acute vestibular syndrome. We analyzed the ratio between eye and head velocity at specific time points (40 ms and 60 ms after onset of head movement), ratio of velocity slopes (regression gain), and ratio of area under the curves after de-saccading (position gain). We also analyzed interactions between artifacts and calculation method.

**Results:** There was no mean difference between VOR gain at 60ms and position gain, both showing a significant correlation ( $\rho = 0.63$ ,  $p = 0.01$ ) for artifact-free recordings. Other calculation methods showed significant mean gain differences (range 0.02–0.19), but with gains still remaining within the expected normal or abnormal range. Artifacts affected normal gains more than abnormal gains, independent of calculation method. Artifacts reduced normal gains significantly (mean range  $-0.087$  to  $-0.122$ ,  $p < 0.05$ ). The impact on abnormal gain was variable (depending on the artifact type) compared to the reference.

**Conclusions:** There is no clear superiority of a single gain calculation method for video HIT testing. Artifacts cause small but significant reductions of measured VOR gains in normal HITs, regardless of calculation method. Specific artifacts interact differently with calculation method in abnormal HITs, increasing measurement noise. This suggests a larger number of HITs should be performed to confirm abnormal results, regardless of calculation method.

#### OP08-5

Head Impulse Test I

#### VIDEO HEAD IMPULSE TEST IN MENIERE'S DISEASE PATIENTS

Dusan PAVLOVIC

Department of Neuro-otology, Hearing And Balance Center Belgrade, Serbia

**Aim:** To measure vestibulo-ocular reflex (VOR) gain at patients with Meniere's disease and compare it with caloric test results.

**Method:** Twentynine patients with unilateral Meniere's disease fulfilling AAO-HNS criteria were included. Caloric test measures canal paresis (CP) and unilateral weakness (UW), while video head impulse test (VHIT) measures VOR gain in horizontal plane.

**Results:** Caloric test was abnormal in 76% of patients, while VHIT showed deficient VOR gain in 55%. In all, 45% with abnormal caloric test had normal VHIT, whereas 25% with abnormal VHIT had normal caloric test.

**Conclusion:** Most patients with Meniere's disease has deficient VOR. VOR deficit is more often affected at low frequencies (caloric test) than at high frequencies (VHIT) test. Therefore, VHIT is good additional tool in evaluating vestibular deficit in Meniere's disease patients.

## OP08-6

Head Impulse Test I

**DISEASE PATTERN OF POSTERIOR SEMICIRCULAR CANAL HYPOFUNCTION ON VIDEO-HEAD-IMPULSE TESTING**

**Alexander Andrea TARNUTZER<sup>1</sup>, Christopher J BOCKISCH<sup>1,2,3</sup>, Elena BUFFONE<sup>1</sup>, Konrad P WEBER<sup>1,3</sup>**

<sup>1</sup>*Department of Neurology, University Hospital Zurich, Switzerland*

<sup>2</sup>*Department of Otorhinolaryngology, University Hospital Zurich, Switzerland*

<sup>3</sup>*Department of Ophthalmology, University Hospital Zurich, Switzerland*

**Background:** The video-head-impulse test (vHIT) provides a functional assessment of individual semicircular canals (SCC) by quantifying the vestibulo-ocular reflex. With vHIT, isolated posterior SCC hypofunction can occasionally be diagnosed, though this is poorly characterized. Here we retrospectively studied cases with SCC hypofunction restricted to the posterior canals regarding underlying causes and asked how well vHIT-findings correlated with results from calorics and vestibular-evoked myogenic potentials (VEMPs).

**Methods:** We identified 44 patients (out of 2710 vHIT-datasets) with SCC hypofunction restricted to one/both posterior canals who also received calorics and VEMPs. Pure-tone audiograms were available in 34 cases. We determined gains and cumulative saccade amplitudes and calculated the fraction of cases with isolated posterior SCC involvement vs. those with a more extensive pattern.

**Results:** Most frequent diagnoses were history of vestibular neuropathy (13/44), vertigo/dizziness of unclear origin (13/44) and Menière's disease (8/44). Seemingly isolated posterior SCC hypofunction on vHIT was accompanied by a deficient horizontal SCC (calorics), saccule and/or utricle ipsilesionally in 33/44 (75%). Ipsilesional hearing-loss was noted in 23/34 (67.6%). The rate of involvement of other parts of the vestibular organ varied, being highest for schwannoma and history of vestibular neuropathy.

**Conclusions:** Our observations suggest that up to three quarters of patients with isolated posterior SCC hypofunction on vHIT actually have deficits of other parts of the vestibular organ as well. Patients with posterior SCC hypofunction on vHIT should therefore receive additional vestibular testing (i.e., caloric irrigation and VEMPs) to allow a more complete assessment of peripheral vestibular function.

## OP09-1

Clinical Tests for Vestibular Function I

**THE ROTATORY GAIN-TC PRODUCT TO QUANTIFY RESIDUAL VESTIBULAR FUNCTION**

**Timothy Carl HAIN<sup>1</sup>, Nicolas PEREZ<sup>2</sup>**

<sup>1</sup>*Department of Neurology, Northwestern University, USA*

<sup>2</sup>*Department of Otorhinolaryngology, University of Navarra, Spain*

Dizzy patients with inner ear damage often ask "how much damage do I have"? A possible answer to this question can be found in the product of the rotatory chair high-frequency gain and the average time constant – the gain-TC product or GTC. For a linear system with a single pole, this quantity can be shown to be equal to the slow cumulative eye position (SCEP), which is the total eye displacement for a unit step of head velocity. This quantity thus expresses the total eye movement response produced by the vestibular apparatus for a unit change in head velocity.

We computed the gain-TC product (GTC) in three groups: normal subjects, patients with complete unilateral vestibular loss, and patients with little or no vestibular function due to gentamicin ototoxicity. We chose these groups because their residual vestibular function is known – 100%, 50%, and 0%. The average GTC was  $11.16 \pm 2.9$  in the 24 normal subjects,  $4.68 \pm 1.76$  in 14 unilateral loss patients, and 1.14 in 21 subjects with bilateral vestibular loss. When the GTC was computed from published data in the literature, the results were similar.

We conclude that one may estimate residual vestibular function by dividing the product of the rotatory chair gain and time constant by 11.1. This simple computation may be useful both for patient counseling as well as to follow vestibular function over time.

## OP09-2

Clinical Tests for Vestibular Function I

**SO STONED: HISTORY TAKING OF THE DIZZY PATIENT BASED 8 DISCRIMINATING DIMENSIONS.**

**Floris WUYTS<sup>1</sup>, Vincent VAN ROMPAEY<sup>1</sup>, Leen MAES<sup>2</sup>**

<sup>1</sup>Department of Antwerp University Research Centre For Equilibrium And Aerospace, University of Anwerp, Belgium

<sup>2</sup>Department of Speech And Language Pathology And Audiology, University of Ghent, Belgium

To help the process of differentiating aetiologies of vertigo in dizzy patients, we propose a tool that uses 8 dimensions. The key factors are based on the time profile, symptom profile and trigger profile of the disease. The here proposed mnemonic “SO STONED” comprises eight different dimensions that characterise the vertigo-related complaints of the patient and guide the clinician in his or her decision scheme. All the letters “SO STONED” have a specific meaning: Symptoms, Often (Frequency), Since, Trigger, Otology, Neurology, Evolution, Duration. Since the most common vestibular diseases have different fingerprints when all dimensions are considered, this tool can facilitate the identification of the appropriate vestibular diagnosis.

Classification of the vestibular diseases was based on the ICD-11 beta version of the WHO classification, which divides vertigo in three different categories, namely acute, episodic and chronic. The list of diagnoses comprises: Vestibular Neuritis, Labyrinthitis, Benign Paroxysmal Positional Vertigo (BPPV), Ménière’s Disease (MD), Vestibular Migraine (VM), Vestibular Paroxysmia (VP), Semicircular Canal Dehiscence (SCD) /Perilymphatic Fistula (PF), Persistent Postural Perceptual Dizziness (PPP) and Bilateral Vestibulopathy (BVP). Since posterior fossa stroke can manifest itself as acute vertigo, stroke was added to the table of diagnoses.

We present a table with 8 questions (SO STONED) as well as a table to identify the most likely diagnoses, based on the answers on the aforementioned questions.

## OP09-3

Clinical Tests for Vestibular Function I

**VALIDATION AND DEMONSTRATION OF A NEW BALANCE TEST AMONG OLDER ADULTS**

**Oz ZUR<sup>1,2</sup>, Tamar SHAKI<sup>1</sup>, Eli CARMELI<sup>3</sup>**

<sup>1</sup>Department of Physical Therapy, Ben Gurion University of the Negev, Israel

<sup>2</sup>Department of Director, The Israeli Center For Dizziness And Balance Disorders, Israel

<sup>3</sup>Department of Physical Therapy, University of Haifa, Israel

**Background:** Adults over the age of 70 are at risk of falling. Various balance tests have been developed to identify balance dysfunctions. Their disadvantages including ceiling effects, low sensitivity and specificity, and duration, led us to develop a new balance scale.

**Aim:** To determine the concurrent validity, reliability, sensitivity and specificity of the Zur Balance Scale (ZBS) and to demonstrate how the test is performed.

**Methods:** Descriptive, cross-sectional study, older adults were recruited from an independent senior living community and administered the Berg Balance Scale (BBS) and the ZBS. The BBS was used as the standard of comparison. The ZBS includes head movements and time to maintain balance.

**Results:** All volunteers ( $n = 76$ ) completed the tests. Concurrent validity was  $r = 0.782$  ( $p < 0.0001$ ). The ZBS had high intra-tester reliability (ICC = 0.897) and inter-tester reliability (0.934) correlation coefficients. The ZBS had sensitivity of 60% and specificity of 91% for identifying falls.

**Discussion:** The dynamic portions of the ZBS captures the integration of the visual, vestibular, and somatosensory systems, as it mimics dynamic spatial aspects of daily activities.

**Conclusion:** The ZBS is reliable compared with BBS. It is simple, easy to administer and may be able to predict future risk of falls.

## OP09-4

Clinical Tests for Vestibular Function I

**THE VIBRATORY MASTOID TEST - SENSITIVITY AND SPECIFICITY: CORRELATION WITH CALORICS AND VIDEO HEAD IMPULSTE TEST**Pedro ARAÚJO<sup>1</sup>, Maria Fernanda VARGAS<sup>2</sup>, Herminio Pérez GARRIGUES<sup>2</sup>, António LARROUDÉ<sup>1</sup><sup>1</sup>*Department of Otolaryngology, Hospital Da Luz, Portugal*<sup>2</sup>*Department of Otolaryngology, Hospital La Fé, Spain*

The Mastoid vibratory test (MVT) was first introduced in 1973, by Lücke.

MVT sensitivity, in the literature, ranges from 75 to 98%, with differences probably due to the frequency of the applied stimulus (60–100 Hz), vibration devices, method of stimulation and detection. Specificity ranges from 94 to 100%.

Despite a well known test for over 30 years, there are few studies, that evaluate the sensitivity and specificity, and there are no well-defined criteria, to what is a positive MVT.

The aim of this study was to analyze the frequency variation (30, 60 and 100 Hz), sensitivity and specificity, in patients with acute rotatory vertigo and compare it, with calorics, video head impulse test and a control group of healthy subjects.

The study was conducted in both institutions, using the same method and stimulation device. Each institution developed its control group. In both patients and control group the MVT, was applied to each mastoid, using the V.VIB 3Fstimulator (Synapsys, Inc., Marseille, France) at growing stimulus frequencies of 30, 60, and 100 Hz for 10 seconds. Nystagmus was recorded by a 2-dimensional videonystagmograph. The response was considered positive, if the produced a sustained, non direction changing nystagmus, with a slow phase velocity, higher than 2,5°/s, at a frequency over 1 Hz, starting after the beginning of the stimulus, and abolished at the cessation. The responses were compared with the video head impulse.

In 25 patients diagnosed with vestibular neuritis, the sensitivity and specificity was 64%, 100%/30 Hz, 68%, 97%/60 Hz and 64%, 97%/100 Hz, respectively.

## OP09-5

Clinical Tests for Vestibular Function I

**EFFECTS OF SPONTANEOUS NYSTAGMUS ON SMOOTH PURSUIT IN PATIENTS OF SUDDEN HEARING LOSS WITH VERTIGO**Wei WANG<sup>1,2</sup>, Taisheng CHEN<sup>1,2</sup>, Kaixu XU<sup>1,2</sup>, Chao WEN<sup>1,2</sup>, Qiang LIU<sup>1,2</sup>, Peng LIN<sup>1,2</sup><sup>1</sup>*Department of Otorhinolaryngology Institute of Tianjin, Tianjin First Central Hospital, China*<sup>2</sup>*Department of Otorhinolaryngology Head And Neck Surgery, Tianjin First Central Hospital, China*

**Objective:** To evaluate the effects of spontaneous nystagmus on smooth pursuit in patients of sudden hearing loss with vertigo.

**Method:** All the 66 patients enrolled were diagnosed as sudden hearing loss with vertigo. The course of disease was no more than 7 days. All of them accepted detections of smooth pursuit, spontaneous nystagmus both with fixation and nonfixation situation. Data were recorded include wave type and gain value of smooth pursuit, direction and intensity of spontaneous nystagmus both in fixation and nonfixation situation.

**Results:** Among the 66 cases, 21 cases showed a non-fixation spontaneous nystagmus, while 7 cases showed a non-fixation spontaneous nystagmus. To the smooth pursuit wave, 40 cases were type 1, 15 cases were type 2, 11 cases were type 3. The relationship between onset of spontaneous nystagmus in fixation and smooth pursuit gain was different significantly ( $PL = 0.019, r = 0.289$ ;  $PR = 0.009, r = 0.319$ ), that of non-fixation was different but not significantly ( $PL = 0.479, r = 0.089$ ;  $PR = 0.074, r = 0.221$ ). While, the onset of spontaneous nystagmus showed no relationship with the type of smooth pursuit wave ( $P > 0.05$ ). Further, the spontaneous nystagmus intensity was different according to different type of smooth pursuit wave significantly. Both of the spontaneous nystagmus intensity in fixation ( $P = 0.143$ ) and in non-fixation ( $P = 0.017$ ) increased with the smooth pursuit wave.

**Conclusions:** Spontaneous nystagmus maybe one important factor influencing on smooth pursuit in patients of sudden hearing loss with vertigo. The type 3 wave of smooth pursuit does not always predict central nervous system lesions.

## OP09-6

Clinical Tests for Vestibular Function I

**ACUTE VIDEO-OUCLOGRAPHY FOR VERTIGO IN EMERGENCY ROOMS FOR RAPID TRIAGE (AVERT) PHASE II RANDOMIZED CLINICAL TRIAL**

**David E. NEWMAN-TOKER**<sup>1</sup>, Jorge C. KATTAH<sup>2</sup>, Kevin A. KERBER<sup>3</sup>, Ari BLITZ<sup>4</sup>, John P. CAREY<sup>5</sup>, Vahid ESLAMI<sup>1</sup>, Cinthya I. GUEDE<sup>2</sup>, Daniel F. HANLEY<sup>1</sup>, Kathleen B. QUINLAN<sup>1</sup>, David S. ZEE<sup>1</sup>

<sup>1</sup>Department of Neurology, The Johns Hopkins University School of Medicine, USA

<sup>2</sup>Department of Neurology, University of Illinois College of Medicine At Peoria, Illinois Neurological Institute, USA

<sup>3</sup>Department of Neurology, University of Michigan Health System, USA

<sup>4</sup>Department of Radiology, The Johns Hopkins University School of Medicine, USA

<sup>5</sup>Department of Otolaryngology, The Johns Hopkins University School of Medicine, USA

**Background:** Vertigo and dizziness lead to 4.4 million US emergency department (ED) visits. Of these, ~ 3–5% are due to stroke. Roughly 35% of strokes are missed initially. In addition, most of the ~ 1 million patients with peripheral vestibular causes are over-tested, misdiagnosed, and undertreated.

**Purpose:** To compare the impact of a novel, video-oculography (VOG)-guided diagnostic care pathway relative to standard ED diagnostic care on diagnostic accuracy, resource utilization, costs, treatments, and short-term health outcomes.

**Methods:** This study (NCT02483429) is a multicenter (3-site), patient-level randomized, parallel design (1:1 ratio) Phase-II clinical trial of VOG-guided vs. standard care to improve diagnosis and initial management for patients with vertigo or dizziness suspected to be of vestibular cause. We will recruit 226 adult ED patients with a chief symptom of < 7 days vertigo or dizziness and at least one abnormal vestibular eye movement on pre-randomization VOG testing. We will perform VOG testing on all subjects using a portable device that measures eye movements quantitatively at the bedside. Patients will then be randomized to VOG-guided vs. standard care. In VOG-guided care, patients will be diagnosed and treated according to a standard, predefined protocol determined from VOG results using automated, evidence-based decision rules. All patients will undergo follow-up testing at one week that includes 3-Tesla MRI with contrast, laboratory-based vestibular function tests, and a neuro-otology exam.

**Conclusion:** We will evaluate the accuracy, safety, and efficiency of the VOG-guided rapid triage to differentiate peripheral from central vestibular disorders in ED patients presenting acute vertigo or dizziness.

## OP10-1

Ocular Motility: Physiology and Pathology

**THE BEAT-TO-BEAT CONTROL OF HUMAN OPTOKINETIC NYSTAGMUS SLOW PHASE DURATIONS**

**Carey David BALABAN**<sup>1</sup>, Joseph M FURMAN<sup>1</sup>

<sup>1</sup>Department of Otolaryngology, University of Pittsburgh, USA

This study provides the first clear evidence that the generation of optokinetic nystagmus fast phases is a decision process that is influenced by performance of a concurrent choice reaction time task (CRT). Ten subjects performed an auditory CRT during constant velocity optokinetic stimulation. Eye movements were measured in three dimensions with a magnetic search coil. Slow phase (SP) durations were defined as the interval between fast phases (FPs). There were three main findings. Firstly, human optokinetic nystagmus SP durations are consistent with the existence of a Gaussian basic interval generator (a clock), such that FPs can be triggered randomly at the end of a clock cycle (mean duration: 200–250 ms). Secondly, the FP need not be triggered at the end of a clock cycle, so that individual SP durations represent single or multiple clock cycles. Thirdly, the probability of generating a FP at the end of each clock cycle decreases significantly during performance of a CRT. These findings indicate that the alternation between SPs and FPs of optokinetic nystagmus is not purely reflexive. Rather, the triggering of the next FP is postponed more frequently if a recently presented CRT is pending action when the clock cycle expires. Hence, optokinetic nystagmus FPs show dual-task interference in a manner usually attributed to voluntary movements.

## OP10-2

Ocular Motility: Physiology and Pathology

**SUPRANUCLEAR PATHWAYS FOR VERTICAL SACCADE COMPARED WITH THOSE FOR HORIZONTAL SACCade AND VESTIBULOOCULAR REFLEX**

**Yuriko SUGIUCHI<sup>1</sup>, Mayu TAKAHASHI<sup>1</sup>, Yoshikazu SHINODA<sup>1</sup>**

<sup>1</sup>*Department of Systems Neurophysiology, Tokyo Medical And Dental University, Japan*

Our previous study on the neural circuit for horizontal saccades showed that the shortest excitatory pathway from the superior colliculus (SC) to abducens motoneurons (MNs) was disynaptic via excitatory burst neurons (horizontal EBNS), whereas the shortest inhibitory pathway from the SC to abducens MNs was disynaptic via inhibitory burst neurons (horizontal IBNs). The recent study showed that trochlear MNs received disynaptic excitation from the SC via the Forel's field H (FFH) (the riMLF in monkeys) and disynaptic inhibition from the SC via the interstitial nucleus of Cajal (INC). The present study analyzed input-output organization of last-order premotor neurons mediating collicular inputs to trochlear MNs and oculomotor MNs, using intracellular recording from those premotor neurons. INC neurons that projected to the contralateral trochlear nucleus, inferior rectus MNs, FFH and INC during upward saccades received monosynaptic excitation from the ipsilateral medial SC (upward saccade area) and disynaptic inhibition via the INC from the contralateral lateral SC (downward saccade area). Another group of INC neurons that projected to the contralateral superior rectus, inferior oblique MNs, INC and FFH during downward saccades received monosynaptic excitation from the ipsilateral lateral SC and disynaptic inhibition from the contralateral medial SC. Therefore the inhibitory vertical IBNs in the INC for upward saccades on one side and those for downward saccades on the other were mutually inhibited. This pattern of input-output organization of inhibitory INC vertical IBNs suggests that the basic neural circuits for horizontal and vertical saccades are similar, and use the same coordinate as the VOR.

## OP10-3

Ocular Motility: Physiology and Pathology

**SACCADIC PALSY FOLLOWING CARDIAC SURGERY: POSSIBLE ROLE OF PERINEURONAL NETS**

**Scott EGGERS<sup>1</sup>, Anja HORN<sup>2,3</sup>, Sigrun ROEBER<sup>3,4</sup>, Wolfgang HÄRTIG<sup>5</sup>, Govind NAIR<sup>6</sup>, Daniel REICH<sup>6</sup>, R. John LEIGH<sup>7</sup>**

<sup>1</sup>*Department of Neurology, Mayo Clinic, Rochester, Minnesota, USA*

<sup>2</sup>*Department of Institute of Anatomy And Cell Biology I, Ludwig-maximilians University, Munich, Germany*

<sup>3</sup>*Department of German Center For Vertigo And Balance Disorders, Ludwig-maximilians University, Munich, Germany*

<sup>4</sup>*Department of Institute For Neuropathology And Prion Research, Ludwig-maximilians University, Munich, Germany*

<sup>5</sup>*Department of Paul Flechsig Institute For Brain Research, University of Leipzig, Leipzig, Germany*

<sup>6</sup>*Department of National Institute of Neurological Disorders And Stroke, National Institutes of Health, Bethesda, Maryland, USA*

<sup>7</sup>*Department of Neurology, Case Western Reserve University, Cleveland, Ohio, USA*

Within the ocular motor system, excitatory burst neurons and omnipause neurons are needed to generate rapid eye movements – saccades. Experimental lesions cause slow or absent saccades. Both groups of neurons contain the calcium-binding protein parvalbumin and are ensheathed by perineuronal nets (PN), a specialized extracellular matrix around certain highly active neurons that may help stabilize synaptic contacts, promote local ion homeostasis, or play a protective role. Selective palsies of saccades in humans are reported following cardiac surgery, but such cases have shown normal brainstem neuroimaging, with only one clinicopathological study that demonstrated paramedian pontine infarction. Our objective was to test the hypothesis that lesions of PN surrounding these saccade-related neurons may cause saccadic palsy. With four controls we studied the brain of a patient who had developed a permanent selective saccadic palsy following cardiac surgery and died several years later. Brainstem sections were applied to double-immunoperoxidase staining of parvalbumin and three different components of PN. Triple immunofluorescence labeling for all PN components served as internal controls. Combined immunostaining of parvalbumin and

synaptophysin revealed intact synapses. Excitatory burst neurons and omnipause neurons were preserved and still received synaptic input, but their surrounding PN showed severe loss or fragmentation. Our findings support current models and experimental studies of brainstem saccade-generating neurons and indicate that damage to PN may permanently impair the function of these neurons that the PN ensheathes. We propose that the well-studied saccadic system provides an accessible model to evaluate the role of PN in health and disease.

## OP10-4

Ocular Motility: Physiology and Pathology

**TECTAL COMMISSURAL CONNECTIONS AND THEIR FUNCTIONAL ROLE OF VERTICAL SACCADES IN RELATION TO LISTING'S LAW AND VOR**

**Mayu TAKAHASHI<sup>1</sup>, Yuriko SUGIUCHI<sup>1</sup>, Yoshikazu SHINODA<sup>1</sup>**

<sup>1</sup>*Department of Systems Neurophysiology, Tokyo Medical And Dental University, Japan*

The commissural connection between the superior colliculi (SCs) was known to be inhibitory, but we recently found that strong excitatory commissural connections also exist. The present electrophysiological study showed that caudal tectoreticular neurons (TRNs) received only inhibition, whereas rostral TRNs received excitation and inhibition from the opposite rostral SC. TRNs in the medial and lateral SCs received excitation from the contralateral medial and lateral SC, respectively, and received inhibition from the contralateral lateral and medial SC, respectively. These findings suggest that inhibitory commissural connections exist from the medial (lateral) SC representing upward (downward) oblique saccades on one side to the lateral (medial) SC representing downward (upward) oblique saccades on the other. This pattern of reciprocal inhibition between the up-oblique saccade system in one SC and the down-oblique saccade system in the opposite SC is very similar to that seen in the commissural connections between anterior canal-related vestibular nucleus neurons (VNNs) on one side and posterior canal-related VNNs on the other. This similarity implies that the SC saccade system may use the same coordinate system as the vestibuloocular reflex. In contrast, mirror-symmetric excitatory connections between medial – medial and lateral – lateral SCs play roles in generating conjugate upward and downward vertical saccades, respectively, because commissural coactivation of TRNs in symmetric sites of the two SCs produces the torsional components in the opposite directions in each eye, which seem to cancel each other in individual eyes, leaving mainly vertical components without torsions. Therefore, these tectal excitatory commissural connections may contribute to Listing's law.

## OP10-5

Ocular Motility: Physiology and Pathology

**TYPE OF PRISM TREATMENT FOR BINOCULAR VISION DYSFUNCTION CORRELATED WITH O-VEMP AND C-VEMP RESULTS**

**Arthur J ROSNER<sup>1</sup>, Mark S ROSNER<sup>2,3,4</sup>, Debby FEINBERG<sup>4</sup>, Johnathan RECKNAGEL<sup>1</sup>, Michael HOUGHAN<sup>4</sup>**

<sup>1</sup>*Department of Otolaryngology, William Beaumont Oakland University Medical School, USA*

<sup>2</sup>*Department of Emergency Medicine, St. Joseph Mercy Hospital, USA*

<sup>3</sup>*Department of Emergency Medicine, University of Michigan, USA*

<sup>4</sup>*Department of Optometry, Vision Specialists Institute, USA*

**Purpose:** During the last 20 years over 8000 patients with dizziness, headache, anxiety, and neck pain have been successfully treated with neutralizing prismatic eyeglass lenses. Are utricle and saccule dysfunction part of the cause of symptomatic binocular vision dysfunction (BVD)? Does the type of prism correction correlate with VEMP results? Is utricle dysfunction necessary for vertical heterophoria?

**Methods:** During a one-year period 80 symptomatic patients with elevated Binocular Vision dysfunction Questionnaire scores were evaluated by neuro-optometry. Only patients with complete VEMP data were included. VEMP was performed with sound stimulation at 500 HZ. Patients were treated with split prism (vertical heterophoria (VH)), prism in one lens (superior oblique palsy (SOP)), horizontal prism, or no prism.

**Results:** Forty-three patients had VH, 21 SOP, 6 horizontal prisms, and 10 did not respond to prism. Eighty per cent of patients responding to vertical prism (VH + SOP) had some VEMP abnormality compared to 4% in the

general population.  $P < 0.001$ . 67% of patients with VH had abnormal O-VEMPs and 61% of patients with SOP had abnormal O-VEMPs. 44% of patients with VH had abnormal CVEMPs and 62% of patients with SOP had abnormal CVEMPs.

**Conclusions:** Utricle and saccule dysfunction are common, but not necessary, in patients with binocular dysfunction disease. Dysfunction of the utricle and saccule are likely part of the pathophysiology along with muscle weakness, nerve weakness, and a structural high eye. VEMP testing could not predict how prism was applied (VH, SOP, horizontal or no prism).

#### OP10-6

Ocular Motility: Physiology and Pathology

#### **ACTIVITY OF FRONTAL EYE FIELD FIXATION NEURONS AND ITS RELATION TO THE SUPPRESSION OF SACCADES AND SMOOTH PURSUIT**

**Yoshiko IZAWA**<sup>1</sup>, Hisao SUZUKI<sup>1</sup>

<sup>1</sup>*Department of Systems Neurophysiology, Graduate School of Medicine, Tokyo Medical And Dental University, Japan*

We have shown previously that focal electrical stimulation in the frontal eye field (FEF) suppresses the generation of saccadic and smooth pursuit eye movements at an intensity lower than the threshold for eliciting electrically evoked saccades. We found a localized area of the FEF in the caudal part of the arcuate gyrus facing the inferior arcuate sulcus in which stimulation suppressed the generation of saccades and pursuit in bilateral directions and also where fixation neurons discharging tonically during fixation were concentrated. Fixation neurons usually showed a reduction in activity during saccades. The present study analyzed the activity of fixation neurons in the FEF during pursuit in trained monkeys. Fixation neurons showed a variety of discharge patterns during pursuit, ranging from a decrease in activity to an increase in activity. Of these, more than two thirds of fixation neurons were found to show a reduction in activity during pursuit toward ipsilateral or bilateral directions. When catch-up saccades during the initiation of pursuit were eliminated by step-ramp target routine, the reduction in activity of fixation neurons survived. The present results suggest that fixation neurons in the FEF may contribute to the generation of pursuit suppression. These findings support the idea that this type of fixation neuron assembly as a whole in the FEF may be part of a more generalized visual fixation system through which suppressive control is exerted on pursuit as well as saccades.

#### OP11-1

Functional, Psychiatric, Autonomic Disorders and Others I

#### **ADDITIONAL TEACHING AND PRESENTATION TOOLS FOR THE FREE AVOR ‘APP’**

**Hamish Gavin MACDOUGALL**<sup>1</sup>, Stephen John ROGERS<sup>1</sup>, Leigh Andrew MCGARVIE<sup>2</sup>, Ian Stewart CURTHOYS<sup>1</sup>

<sup>1</sup>*Department of Psychology, University of Sydney, Australia*

<sup>2</sup>*Department of Neurology, Royal Prince Alfred Hospital, Australia*

Since February 2012, the free aVOR (angular Vestibulo-Ocular Reflex) ‘app’ for vestibular education and public outreach has been downloaded more than 36,000 times, to 104 countries and in 8 languages.

The app has been more popular for teaching and presentation on external monitors and video projectors than originally anticipated so the new version (v1.2) features additional functions including:

- Counter-Rotating Head: With this selection, the head on the screen rotates opposite to the device rotation (iPhone, iPad, ...) so that people watching an external monitor or projector can see the movements.
- Highlighted Touches: Displays white, yellow, or green dots where the operator’s fingers are touching the screen. This is useful when someone is showing other people how to use the app with an external monitor.
- Start Tutorial: Forces the app to start with the tutorial that normally only runs the first time it is used. This makes it possible to demonstrate the app the way new users experience it.
- Animation File Import: A data file that a user can import from their PC so that the app will animate their own arbitrary motion sequences.

- Network Port: a remote network connection (UDP or TCP) which controls the head and/or eye animation in real time from simulations or live sensor data (eye tracker, ...)
- Additional language support for French and Korean has been implemented.

In this presentation we will demonstrate these new functions for those that might find them useful for their own teaching and presentations.

#### OP11-2

Functional, Psychiatric, Autonomic Disorders and Others I

#### **NYSTAGMUS ELICITED IN THE MRI: MODIFICATIONS ACCORDING TO THE MAGNETIC FIELD IN NORMAL SUBJECTS**

**Nicolas PEREZ<sup>1</sup>, Ivan CORTES<sup>2</sup>, Javier BURGUETE<sup>2</sup>, Maria FERNANDEZ-SEARA<sup>3</sup>, Raquel MANRIQUE<sup>1</sup>**

<sup>1</sup>*Department of Otorhinolaryngology, University of Navarra, Spain*

<sup>2</sup>*Department of Physics And Applied Mathematics, University of Navarra, Spain*

<sup>3</sup>*Department of Neuroimaging Laboraory-cima, University of Navarra, Spain*

The purpose of this study is to analyze the effect of the modifications of the magnetic field in the nystagmus elicited in normal subjects. In order to be included in the study subjects were to be with normal hearing and without previous dizziness. In all of them the VOR was normal as evaluated with the vHIT as the VEMP (ocular and cervical).

The subjects were 21 and the initial study was done in a 3T MRI under constant magnetic field. Subsequently in periods of 60 seconds with a resting period of 2 minutes, they were subjected to different time dependent modifications in the magnetic field: form 2 Hz to 20 Hz.

We have found an increase in the intensity of the elicited nystagmus and the implications of this finding will be discussed in the presentation as well their clinical applications.

#### OP11-3

Functional, Psychiatric, Autonomic Disorders and Others I

#### **EFFICACY AND SAFETY OF A NOVEL SPECS DEVICE FOR CHRONIC DIZZINESS TREATMENT**

**Carlos R GORDON<sup>1</sup>, Ruth TAMIR<sup>2</sup>, Rachel FURAS<sup>2</sup>, Colin KLEIN<sup>1</sup>, Raanan ROTH<sup>3</sup>**

<sup>1</sup>*Department of Department of Neurology, Meir Medical Center, Kfar-saba And Sackler Faculty of Medicine, Tel Aviv University, Israel*

<sup>2</sup>*Department of Department of Physical Therapy, Meir Medical Center, Kfar-saba And Sackler Faculty of Medicine, Tel Aviv University, Israel*

<sup>3</sup>*Department of SpotOn Therapeutics Ltd, SpotOn Therapeutics Ltd., Israel*

**Background:** Chronic Dizziness (CD) is a frequent complaint in clinical practice but its mechanism and treatment are still unsatisfactory. Because visual stimuli play a crucial role in space orientation and motion perception, it is reasonable to hypothesize that certain visual stabilizing signals applied on the peripheral visual field could be of help in patients with dizziness. This is the rationale of a novel device (SpotOn-SpecsTM) developed to alleviate dizziness by using eyeglasses with stabilizing marks.

**Objective:** To evaluate efficacy and safety of SpotOn-Specs in CD.

**Methods:** Thirty six patients with stable symptoms of CD for more than three months (22 subjects diagnosed as primary CD or Persistent Postural Perceptual Dizziness and 14 as CD secondary to a stable peripheral vestibular loss) participated in a 4-week, double blind, randomized treatment with Active Specs or Sham Specs. Efficacy was assessed using validated semi-quantitative scales and questionnaires of vertigo, dizziness and anxiety and by subjective reports. Safety evaluations included monitoring of any adverse event.

**Results:** Twelve of 18 subjects (67%) treated with Active Specs reported substantial remission of symptoms compared to six (33%) with Sham Specs ( $p = 0.04$ ). The Active Specs group showed significant reduction in the Vertigo Visual Scale score ( $p = 0.01$ ) and a consistent trend of improvement measured by the Dizziness Handicap Inventory (DHI), Vertigo Symptom Scale Short Form (VSS- SF) and Beck Anxiety Inventory (BAI). There were no reports of any important adverse event.

**Conclusions:** SpotOn-Specs seems to be a safety and promising novel treatment for chronic dizziness.

## OP11-4

Functional, Psychiatric, Autonomic Disorders and Others I

**PHYSICAL FUNCTIONING IN OLDER PERSONS WITH DIZZINESS: A POPULATION-BASED STUDY****Lena KOLLEN<sup>1</sup>, Helena HÖRDER<sup>2</sup>, Claes MÖLLER<sup>3</sup>, Kerstin FRÄNDIN<sup>4</sup>**<sup>1</sup>*Department of Occupational Therapy And Physiotherapy, Sahlgrenska University Hospital, Gothenburg, Sweden*<sup>2</sup>*Department of Division of Neuropsychiatric Epidemiology, Neuroscience And Physiology, University of Gothenburg, Sweden*<sup>3</sup>*Department of School of Health Sciences Örebro University, Audiological Research Centre, Örebro University Hospital, Sweden*<sup>4</sup>*Department of Neurobiology, Division of Physiotherapy, Karolinska Institute, Stockholm, Sweden***Background:** Dizziness is one of the most prevalent symptoms in old age and tends to increase with age.**Aims:** To report physical functioning, health-related aspects and gender differences in elderly persons with and without dizziness in a population-based sample of 75-year-olds.**Methods:** A cross-sectional sample of 75-year-olds from Gothenburg ( $n = 675$ , 398 women and 277 men) was examined by means of questionnaires and functional tests. The questions concerned dizziness/imbalance, physical activity level, walking habits, falls efficacy, number of falls, subjective health or general fatigue and medication. The tests included were self-selected and maximum gait speed, stair climbing capacity, one leg stance and grip strength.**Results:** More women than men reported dizziness/imbalance (40% vs 30%,  $p < 0.001$ ).Persons with dizziness, compared to those without dizziness, less often regularly exercised at a moderate intensity level (summer: 62% vs 74%,  $p < 0.001$ ; winter: 41% vs 51%,  $p < 0.001$ ), less often took a daily walk ( $p < 0.05$ ), had lower scores on the FES(S) ( $p < 0.001$ ), more often reported general fatigue ( $p < 0.001$ ), more often had fallen in the previous year (40% vs 23%,  $p < 0.001$ ) and had a higher intake of medical drugs (4.6 vs 3.3,  $p < 0.001$ ). They also performed worse regarding gait speed, stair climbing and one leg stance ( $p < 0.001$ ), but there was no difference in grip strength.**Conclusion:** Older persons with dizziness are less physically active, have worse lower extremity function, are more often fallers and report lower self-rated health than persons without dizziness.**Key words:** Vertigo, unsteadiness, elderly person, dynamic balance

## OP11-5

Functional, Psychiatric, Autonomic Disorders and Others I

**CHRONIC DIZZINESS, HEADACHE AND ANXIETY IMPROVED BY TREATMENT OF VERTICAL HETEROPHORIA: A RETROSPECTIVE ANALYSIS****Mark S ROSNER<sup>1,2</sup>, Debby L FEINBERG<sup>2</sup>, Arthur J ROSNER<sup>3</sup>**<sup>1</sup>*Department of Emergency Medicine, St. Joseph Mercy Hospital, Ypsilanti, Michigan, USA*<sup>2</sup>*Department of Research And Education, Vision Specialists Institute, Bloomfield Hills, Michigan, USA*<sup>3</sup>*Department of Otorhinolaryngology, Oakland University William Beaumont School of Medicine, Rochester, Michigan, USA***Primary objective:** To assess the efficacy of neutralizing prismatic lenses to reduce the symptoms of dizziness, headache and anxiety in patients with vertical heterophoria (VH).**Background:** The diagnosis and treatment of dizziness, headache and anxiety is usually approached individually, as no single entity is routinely considered to be causative of all three symptoms. However, when the patient's symptoms are targeted individually, many are refractive to treatment. Vertical heterophoria (VH) is a form of binocular vision dysfunction (BVD) and can trigger all three groups of symptoms, yet it is rarely considered as a possible etiology and is rarely diagnosed or treated in these patients.**Design and method:** This retrospective analysis followed 126 patients who were diagnosed with VH by an optometric binocular vision subspecialist. Data was collected both before and after prism application and included validated survey instruments for dizziness, headache, anxiety and BVD symptom burden; subjective rating (0–10 scale) of dizziness, headache and anxiety severity; and a sub-analysis of the BVD survey instrument questions that pertain

specifically to dizziness, headache and anxiety. Upon conclusion of treatment subjective overall improvement of heterophoria symptoms was measured utilizing a 10 cm visual analogue scale.

**Outcomes:** All measures of dizziness, headache and anxiety were markedly reduced (22.3%–60.8%), as was the subjective overall assessment of VH symptoms by the patient (76.1%) with the application of prism to neutralize the VH.

**Conclusions:** Neutralizing prismatic lenses are an effective treatment of dizziness, headache and anxiety in VH patients, implicating VH in the etiology of all three symptoms.

#### OP11-6

Functional, Psychiatric, Autonomic Disorders and Others I

#### CLINICAL CHARACTERISTICS AND DIAGNOSTIC CLASSIFICATION OF DIZZINESS IN CHILDREN

Hyung Min LEE<sup>1</sup>, Jiwon CHANG<sup>1</sup>, Jihun PARK<sup>1</sup>, Sung Hoon RYU<sup>1</sup>, Hyung-Jong KIM<sup>2</sup>, Su Kyoung PARK<sup>1</sup>

<sup>1</sup>Department of Otolaryngology-head And Neck Surgery, Kangnam Sacred Heart Hospital, Hallym University College of Medicine, Korea

<sup>2</sup>Department of Otolaryngology-head And Neck Surgery, Hallym University College of Medicine, Korea

Vertigo and dizziness are less frequent symptoms in children than in the adult population. However, they are not rare and the prevalence of vestibular disorders in the pediatric population ranges between 5% and 18%. The purpose of this study is to analyze the clinical characteristics and the results of audiologic and vestibular evaluation, to classify the diagnostic causes of vertigo, and to provide the information about vertigo in children.

A total of 111 patients with vertigo or dizziness who visited Dizziness Clinic in the Department of Otolaryngology were included in this study. These patients were retrospectively reviewed based on clinical charts. The average age of the patients was 10.58 years (3–15 years). All patients performed questionnaires and were observed under frenzel nystagmography for spontaneous, positional, and head shaking nystagmus. Electrocotileography, caloric and VEMP tests were performed in 74, 38 and 45 patients respectively. In selective cases, magnetic resonance imaging, table tilt test, and hematologic test were performed.

Benign paroxysmal vertigo of childhood (BPVC) and vestibular migraine were both 18%, respectively. Other causes were orthostatic intolerance, Meniere's disease, vestibular neuritis, BPPV, head trauma, motion sickness, bilateral vestibulopathy and unknown causes were 16.2%. Caloric test, VEMP and electrocotileography showed abnormal findings in 11 cases (28.9%), 9 cases (20.5%) and 26 cases (36.1%), respectively.

Dizziness in children has different causes from adult, showing BPVC and vestibular migraine to be the most frequent causes. The evaluation of dizziness in children should include a complete history and physical examination, and vestibular function tests.

#### OP12-1

Animal Models and Molecular Approach

#### DOSE-DEPENDENT VESTIBULO-OCULAR REFLEX RESPONSES AND LATERAL CANAL ABNORMALITIES IN PENDRIN DEFICIENT MICE

Byung Yoon CHOI<sup>1,2,3</sup>, Yong-Hwi AN<sup>1,4</sup>, Min Young KIM<sup>2</sup>, Jiyeon LEE<sup>5</sup>, Seung Ha OH<sup>1,3</sup>, Jun Ho LEE<sup>1,3</sup>, Ja-Won KOO<sup>1,2,3</sup>, Jeong Hun JANG<sup>6</sup>, Sung Huhn KIM<sup>7</sup>, Andrew J GRIFFITH<sup>8</sup>, Gyu Cheol HAN<sup>5</sup>

<sup>1</sup>Department of Otorhinolaryngology-head And Neck Surgery, Seoul National University, Seoul, Korea

<sup>2</sup>Department of Otorhinolaryngology-head And Neck Surgery, Seoul National University Bundang Hospital, Seongnam, Korea

<sup>3</sup>Department of Sensory Organ Research Institute, Seoul National University Medical Research Center, Seoul, Korea

<sup>4</sup>Department of Otorhinolaryngology-head And Neck Surgery, Eulji Medical Center, Eulji University, Seoul, Korea

<sup>5</sup>Department of Otorhinolaryngology-head And Neck Surgery, Gachon University of Medicine And Science, Graduate School of Medicine, Incheon, Korea

<sup>6</sup>Department of Otolaryngology, Ajou University School of Medicine, Suwon, Korea

<sup>7</sup>Department of Otorhinolaryngology-head And Neck Surgery, Yonsei University College of Medicine, Seoul, Korea

<sup>8</sup>*Department of Otolaryngology Branch, National Institute On Deafness And Other Communication Disorders, National Institutes of Health, Bethesda, Maryland, USA*

Pendrin, encoded by SLC26A4 gene, is an anion exchanger protein expressed in the epithelial cells of inner ear. Anatomically, the absence of pendrin results in hearing loss associated with enlarged vestibular aqueduct is observed simultaneously with dizziness and postural imbalance. In this study, we report the quantitative responses of vestibulo-ocular reflex and anatomical abnormalities of the lateral semicircular canal in pendrin-deficient mice strain composed of three distinct genetic conditions: homozygous knockout mice, transgenic mice with doxycycline-inducible expression of Slc26a4, and heterozygotes. Hearing and balancing systems were evaluated by auditory brainstem response, sinusoidal harmonic acceleration test, behavioral observation, and histology of the lateral semicircular canal. All SLC26A4 homozygous knockout mice embodied total deafness whereas the remaining strains had normal hearing, indicating all-or-none phenotype of auditory function. Sinusoidal harmonic acceleration test exhibited minimal vestibulo-ocular reflex responses of homozygotes and intermediate responses of transgenic mice and heterozygotes compared to normal controls. This outcome implies a pendrin dose-dependent pattern of vestibular dysfunction. Vacuolar replacement and absence of calretinin expression of vestibular hair cells in the lateral semicircular canal were identified from homozygotes, but no apparent difference in inner ear architectures among wild-type, heterozygous and transgenic mice were identified. These results suggested that mutations of SLC26A4 gene in mouse models induce diverse functional deficits of the lateral semicircular canal and vestibular diseases with variable manifestations.

#### OP12-2

Animal Models and Molecular Approach

#### **PROTECTIVE EFFECT OF NANOPARTICLE ASTAXANTHIN AGAINST NEOMYCIN-INDUCED HAIR CELL DEATH IN ZEBRAFISH LATERAL LINE.**

**Hiroshi YAMASHITA<sup>1</sup>, Kazuma SUGAHARA<sup>1</sup>, Yoshinobu HIROSE<sup>1</sup>, Yousuke TAKEMOTO<sup>1</sup>, Makoto HASIMOTO<sup>1</sup>**

<sup>1</sup>*Department of Otolaryngology, Yamaguchi University Graduate School of Medicine, Japan*

The zebrafish lateral line is an efficient model system for the evaluation of chemicals that protect and damage hair cells. Located on the surface of the body, lateral line hair cells are accessible for manipulation and visualization. The zebrafish lateral line system allows rapid screens of large chemical libraries.

In the present study, several molecules known as the supplemental drugs were evaluated for protective effect on hair cells against aminoglycoside ototoxicity. Zebrafish larvae were exposed to the molecules (1–1000 µg/ml) for 1 hour before 200 µM neomycin to induce hair cell death for 1 hour. To label hair cells, immunohistochemistry was performed using anti-parvalbumin antibody after the fixation. The rate of survival hair cells was calculated with the fluorescence microscope.

In zebrafish lateral line, the survival rate of hair cells in Neomycin + Astaxanthin group was significantly more than that in Neomycin group.

Astaxanthin has the strong antioxidant activity. Therefore, the dietary supplement and cosmetics which contain astaxanthin were manufactured in many countries. The nanoparticle astaxanthin can diffuse into water and transit to the living tissue. Therefore, this drug showed the strong protective effect in the zebrafish lateral line hair cells. The nanoparticle astaxanthin may be used as the protective drug in the inner ear.

#### OP12-3

Animal Models and Molecular Approach

#### **CHARACTERISTICS OF THE VESTIBULAR APPARATUS AND TRAUMA-INDUCED OTOCIONIA DISLOCATION IN SPRAGUE-DAWLEY RATS**

**Chunjie TIAN<sup>1</sup>, Oak-Sung CHOO<sup>1</sup>, Yeon Ju KIM<sup>1</sup>, Young Sun KIM<sup>1</sup>, Beomyoung SHIN<sup>1</sup>, Yun-Hoon CHOUNG<sup>1</sup>**

<sup>1</sup>*Department of Otolaryngology, Ajou University School of Medicine, Korea*

Head injury is the most common cause of benign paroxysmal positional vertigo (BPPV). Based on clinical findings and hypotheses, the pathogenic mechanism of BPPV is speculated to be movement of dislocated otoconia. However,

few studies using in vivo animal models have attempted to validate this. The purpose of the current study was to characterize the vestibular apparatus of Sprague-Dawley (SD) rats, and then establish an animal model of trauma-induced BPPV to better understand the pathophysiology of BPPV. We induced trauma-related BPPV in SD rats by free-fall from a height of 1.5 m. A rotarod treadmill test and scanning electron microscopy were employed for analysis of vestibular function and morphology, respectively. We found that otoconia were significantly larger in the lateral region of the utricle than in the medial region and the saccule. Rats subjected to free-fall four times performed substantially worse in the rotarod test than the control or “two falls” group. Deficits persisted until 7 weeks after free-fall injury. Larger otoconia from the lateral region were the most substantially dislodged of all otoconia and became attached to the posterior crista ampullaris. A significantly reduced otoconial volume was detected following 2 months of dissolution in artificial endolymph. These results with SD rats may explain the pathogenesis and spontaneous resolution of trauma-induced BPPV typically seen in clinical cases.

#### OP12-5

Animal Models and Molecular Approach

#### **VESTIBULAR GRAVICEPTION BUILDS MOTOR, COGNITIVE AND EMOTIONAL POSTNATAL DEVELOPMENT IN MICE**

**Anne LEGALL<sup>1,2,3</sup>, Pascal HILBER<sup>4</sup>, Joseph TOULOUSE<sup>1,2,3</sup>, Marie-Laure MACHADO<sup>1,2</sup>, Bruno PHILOXENE<sup>1,2</sup>, Pierre DENISE<sup>1,2,3</sup>, Jan BULLA<sup>5</sup>, Christophe CHESNEAU<sup>6</sup>, Stephane BESNARD<sup>1,2,3</sup>**

<sup>1</sup>Department of U1075 Comete, Université De Normandie, France

<sup>2</sup>Department of U1075 Comete, Inserm, France

<sup>3</sup>Department of Explorations Fonctionnelles, Chu Caen, France

<sup>4</sup>Department of Ea 4700 Psy-nca, Université De Normandie, France

<sup>5</sup>Department of Department of Mathematics, University of Bergen, Norway

<sup>6</sup>Department of Laboratoire De Mathématiques Nicolas Oresme, Université De Caen, Cnrs Umr 6139, France

The vestibular system is functional early in individual's life: anatomical structures are almost completely developed at birth and maturation continues during postnatal period. Recent works strongly supported a role of the vestibular system in bodily self-consciousness and space cognition at adulthood but only few data has reported whether the vestibular system influences the development during childhood. Indeed, we hypothesized that Earth gravity might, through the vestibular system, build different aspects of cognition, emotion and social interaction.

We longitudinally evaluated performances of an original Het mouse model (B6Ei.GL-Nox3het/J) selectively devoid of otoconia within the inner ear (i.e. without gravitational vestibular perception) for the first time. Behavioral performances were assessed by a set of motor, cognitive and emotional tests from birth to adulthood. Compared to controls, we globally observed a developmental delay with a maximum at P7 in homozygote (HO) Het mice highlighting the crucial role of gravity perception during this period. Those observations are similar to symptoms observed in vestibulo-deficient children. At adulthood HO Het mice expressed both autism spectrum disorders and hyperactivity-like symptoms such as stereotyped behavior and repetitive tasks. Moreover HO mice appeared less anxious compared to heterozygote while social interaction seemed impaired. We demonstrated for the first time that gravity vestibular perception is involved in cognitive, emotional and social development. Our findings support that early screening of the vestibular function at childhood as well as early therapeutic care and psycho-behavioral follow-up have to be taken into account by clinicians.

#### OP12-6

Animal Models and Molecular Approach

#### **NEW TAIL HANGING METHOD FOR VESTIBULAR ANIMAL RESEARCH**

**Dongju LEE<sup>1</sup>, Jiyeon LEE<sup>2</sup>, Jeong-Hyeon BAK<sup>3</sup>, Nam Beom KIM<sup>4</sup>, Mi Joo KIM<sup>2</sup>, Gyu Cheol HAN<sup>1</sup>**

<sup>1</sup>Department of Otolaryngology-head And Neck Surgery, Gachon University of Medicine And Science, Graduate School of Medicine, Korea

<sup>2</sup>Department of Otorhinolaryngology, Catholic Kwandong University International St. Mary's Hospital, Korea

<sup>3</sup>Department of Mechanical Engineering, Hanyang University, Korea

<sup>4</sup>Department of Neuroscience Research Institute, Gachon University, Graduate School of Medicine, Korea

There is not a novel method to estimate vestibular function of small experimental animal. Traditionally, researchers have used a circling or behavior changing with head position or body posture in their vestibular functional documentation. However these tests have many error in the interpretation because these are influenced from various environmental conditions like emotion, locomotion, or memory rather than actual vestibular function.

We has designed the tail hanging test in small rodent for performing vestibular function test like human posturography. We blocked visual cue by putting ointment on the both eyes before the test and blocked proprioception by hanging a tail. And then we observed body sway angle among tail-rump-snout. In a previous study, this method showed significant difference of minimal body sway angle between normal and unilateral labyrinthectomized (ULx) mouse. In a new version of tail hanging test used a colored-high speed camera and be added an improved algorithm to differentiate the twist motion. Each distance between the measuring points and sway angle were combined to complete the measurement. To verify the usefulness this experimental tool, Slc26a4 transgenic mouse and ULx mouse were used. The difference of minimal body sway angle between two groups was significance ( $p < 0.000$ ), and it was also different between Slc26a4 $\Delta/+$  and Slc26a4 $\Delta/\Delta$  ( $p = 0.038$ ).

We expect this experiment can do easy, non-invasive and useful for mass screening of vestibular function, and it also will be able to measure perfectly more than previous version by adding algorithm of anterior bending according to bilateral vestibular function changes.

#### OP13-1

#### Meniere's Disease and Related Disorders II

#### DIAGNOSIS AND MANAGEMENT OF DROP ATTACKS IN MENIERE'S DISEASE

Pierre BERTHOLON<sup>1</sup>, Yann LELONGE<sup>2</sup>, Pierre REYNARD<sup>3</sup>, Victor COLIN<sup>4</sup>, Roland PEYRON<sup>5</sup>, Alexandre KARKAS<sup>6</sup>

<sup>1</sup>Department of ORL, Chu Saint Etienne, France

<sup>2</sup>Department of ORL, Chu Saint Etienne, France

<sup>3</sup>Department of ORL, Chu Saint Etienne, France

<sup>4</sup>Department of ORL, Chu Saint Etienne, France

<sup>5</sup>Department of Neurologie, Chu Saint Etienne, France

<sup>6</sup>Department of ORL, Chu Saint Etienne, France

**Introduction:** In 1936, Tumarkin first described sudden falls/drop attacks in patients with a peripheral vestibular syndrome and speculated that these falls resulted from a mechanical deformation of the otolith organs.

**Objectives:** To describe drop attacks and their management in 15 Menière's patients.

**Methods:** The criterion for inclusion were both:

- the occurrence of at least one sudden falls without loss of consciousness or associated neurological symptoms.
- and a definite Menière's disease according to the criteria of the American society.

**Results:** Fifteen patients had sudden falls in Menière's disease that could be complicated either by severe head trauma ( $n = 1$ ) or various fractures (nose, wrist...) ( $n = 4$ ). Interestingly, 8 patients complained of vertigo or dizziness after the fall, including one patient whose fall occurred in the waiting room without head trauma. This latter patient complained of a vertical illusion of movement immediately after the fall and videonystagmoscopy revealed an essentially downbeating nystagmus with a slight rotatory component. The follow up was favorable in fourteen patients, spontaneously ( $n = 7$ ), after chemical labyrinthectomy ( $n = 6$ ) 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 as well as the observation of one patient's nystagmus would suggest that the mechanism initially limited to the otolith system could spread to the semicircular system.

## OP13-2

Meniere's Disease and Related Disorders II

**COMPARISON OF NONINVASIVE EVALUATION OF ENDOLYMPHATIC SPACE IN HEALTHY VOLUNTEERS IN DIFFERENT AGE GROUPS USING MRI****Fang LIU<sup>1</sup>, Weining HUANG<sup>1</sup>, Qinghua CHEN<sup>2</sup>, Zhan GAO<sup>1</sup>**<sup>1</sup>*Department of Otolaryngology, Beijing Hospital, China*<sup>2</sup>*Department of Radiology, Beijing Tongren Hospital, China*

**Conclusions:** Noninvasive standard evaluation of normal endolymphatic space and endolymphatic hydrops using magnetic resonance imaging (MRI) in various age groups is reported for the first time.

**Objective:** To compare the standard evaluation of endolymphatic space in healthy volunteers in the cochlea and the vestibule among different age groups by applying noninvasive intratympanic gadolinium (Gd) perfusion through the Eustachian tube and three-dimensional fluid-attenuated inversion recovery MRI (3D-FLAIR MRI).

**Methods:** This was a prospective study. 3D-FLAIR MRI was performed with a 3 T unit 24 h after intratympanic administration of Gd through the Eustachian tube in 60 healthy volunteers aged 20–55 years. Pure-tone test and tympanometry were performed 24 h before and 1 week after Gd administration.

**Results:** There was no significant difference in the ratios of the area of the endolymphatic space to that of the fluid space in the cochlea and the vestibule between males and females, or among 20–30-, 31–44-, and 45–55-year-old healthy volunteers. In 20–55-year-old healthy volunteers, the normal value of the endolymphatic space in the cochlea ranged between 7% and 27%, and that in the vestibule was between 17% and 39%. No significant changes in pure-tone test or tympanometry were noted.

## OP13-3

Meniere's Disease and Related Disorders II

**A NOVEL VARIANT IN PRKCB SEGREGATES LOW-FREQUENCY HEARING LOSS IN A FAMILY WITH MENIERE'S DISEASE****Teresa REQUENA<sup>1</sup>, Carmen MARTIN-SIERRA<sup>1</sup>, Lidia FREJO<sup>1</sup>, Steve D. PRICE<sup>2</sup>, Angel BATUECAS<sup>3</sup>, Sofia SANTOS-PEREZ<sup>4</sup>, Andres SOTO-VARELA<sup>4</sup>, Anna LYSAKOWSKI<sup>2,5</sup>, Jose A. LOPEZ-ESCAmez<sup>1,6</sup>**<sup>1</sup>*Department of Genomic Medicine, Genyo – Centre For Genomics And Oncological Research – Pfizer/university of Granada/Junta De Andalucía, Pts., Spain*<sup>2</sup>*Department of Anatomy And Cell Biology, Univ. of Illinois At Chicago, USA*<sup>3</sup>*Department of Otoneurology, Hospital Universitario Salamanca, Spain*<sup>4</sup>*Department of Otoneurology, Complexo Hospitalario Universitario De Santiago De Compostela, Spain*<sup>5</sup>*Department of Otolaryngology-head And Neck Surgery, Univ. of Illinois At Chicago, USA*<sup>6</sup>*Department of Otoneurology, University Hospital De Granada, Spain*

**Introduction:** Familial Meniere's disease (FMD) is a rare autosomal dominant (AD) disorder characterized by recurrent attacks of spontaneous vertigo, sensorineural hearing loss (SNHL), and tinnitus with incomplete penetrance. MD is associated with an accumulation of endolymph in the membranous labyrinth. The SNHL usually starts at low and medium frequencies with a variable progression to high frequencies.

**Methods:** We have performed whole-exome sequencing in an AD-MD family consisting of 2 patients with MD and a third one with SNHL without vestibular symptoms. After alignment and annotation variants were filter by in-house control database and minor allelic frequency (MAF) < 0.001 and prioritized using different criteria. qPCR and immuno-labelling were performed to confirm the expression and to define which cell types express the candidate gene in the cochlea.

**Results:** We identified a novel missense variant in the PRKCB gene segregating low-to-middle frequency SNHL. Confocal imaging showed strong PKC II protein labelling in non-sensory cells, the tectal cells (TCs) and inner border cells (IBCs) of the rat organ of Corti with an expression gradient along the cochlea. PKC II signal was more pronounced in apical turn TCs of the cochlea compared with the middle and basal turns. It was also much higher in cochlear than in vestibular tissue.

**Conclusions:** PRKCB is a novel candidate gene for SNHL in FMD and the gradient of expression in TC along the cochlea may explain the onset of hearing loss at low frequencies in MD given the role of TCs in K<sup>+</sup> recycling within the endolymph.

## OP13-4

Meniere's Disease and Related Disorders II

**ELIMINATION OF A VISUAL-VESTIBULAR CONFLICT IN MENIERE'S DISEASE****Jelte BOS<sup>1,2</sup>, Astrid LUBECK<sup>2</sup>, Eric VENTE<sup>3</sup>**<sup>1</sup>*Department of Perceptual And Cognitive Systems, Tno, Netherlands*<sup>2</sup>*Department of Behavioural And Movement Sciences, Vrije Universiteit Amsterdam, Netherlands*<sup>3</sup>*Department of General Practitioner, Alphen A/d Rijn, Netherlands*

A considerable number of patients suffering from Ménière's disease (MD) in The Netherlands and Belgium seem to benefit from wearing weak asymmetric base-in prisms (WABIPs) as determined by the deviation from straight-ahead during walking with eyes closed after having imprinted an after-image of an Earth-fixed visual target. Despite a lack of proven effectiveness, there is yet some data in support of the assumption that these prisms are effective. Moreover, literature offers support for explaining why especially vertigo, as one of the most disabling symptoms of MD, then is reduced. This explanation is largely based on the oculogyric illusion, (vestibular) efference copies and (ocular) re-afferent signals. WABIPs can then be explained to both straighten the deviation while walking with an after-image, and to eliminate the vestibulo-ocular stress resulting in vertigo.

## OP13-5

Meniere's Disease and Related Disorders II

**THE ROLE OF MAGNETIC RESONANCE IMAGING IN THE DIAGNOSIS OF ENDOLYMPHATIC HYDROPS AND MENIÈRE'S DISEASE.****Robby VANSPAUWEN<sup>1</sup>, Bert DE FOER<sup>2</sup>, Youri MARYN<sup>1</sup>, Anja BERNAERTS<sup>2</sup>, Andrzej ZAROWSKI<sup>1</sup>, Joost VAN DINOTHER<sup>1</sup>, Thomas SOMERS<sup>1</sup>, Erwin Frans OFFECIERS<sup>1</sup>, Cathérine BLAIVIE<sup>1</sup>, Jan CASSELMAN<sup>2,3</sup>**<sup>1</sup>*Department of ENT, European Institute For Orl-hns, Gza Hospital Sint-augustinus, Antwerp, Belgium*<sup>2</sup>*Department of Radiology, Gza Hospital Sint-augustinus, Antwerp, Belgium*<sup>3</sup>*Department of Radiology, Az St-jan Av, Brugge, Belgium*

**Introduction:** A dedicated 3T magnetic resonance imaging (MRI) protocol of the inner ear was introduced to evaluate the presence and extent of endolymphatic hydrops (EH). In this pilot study, we assessed retrospectively the sensitivity and specificity of this MRI protocol in patients diagnosed with definite Menière's disease (MD) according to the new diagnostic criteria.

**Material and methods:** The study was performed on a 3-Tesla MRI machine using a three-dimensional-fluid-attenuated inversion recovery (3D-FLAIR) sequence performed 4 hours after an intravenous (iv) injection of a double dose of gadolinium. EH in the cochlea and/or vestibule was classified as either none, grade I or grade II (cfr. reported criteria in recent literature). Thirteen patients diagnosed with unilateral definite MD were included (mean age was 53,8 years). For ethical reasons (potential long-term side effects of gadolinium administration) no control group (healthy volunteers) could be included. Therefore, contralateral healthy ears (normal hearing level, normal caloric response and present cVEMP response) of the included patient population were used as normal control ears.

**Results:** The MRI was positive in 10 out of 13 definite MD suspected ears, resulting in a sensitivity of 77%. The MRI was negative in each ( $n = 13$ ) of the healthy ears, leading to a specificity of 100%.

**Conclusions:** This preliminary study confirms that 3T 3D-FLAIR MRI of the membranous labyrinth performed 4 hours after IV gadolinium administration can be a very helpful tool for diagnosing definite MD. Further studies in a larger patient population will be required to confirm these preliminary findings.

## OP13-6

Meniere's Disease and Related Disorders II

**TRIPLE SEMICIRCULAR CANAL PLUGGING: A NOVEL MODALITY FOR TREATMENT OF MENIERE'S DISEASE****Daogong ZHANG<sup>1</sup>, Zhaomin FAN<sup>1</sup>, Yuechen HAN<sup>1</sup>, Yafeng LV<sup>1</sup>, Yawei LI<sup>1</sup>, Haibo WANG<sup>1</sup>**<sup>1</sup>*Department of Otorhinolaryngology Head And Neck Surgery, Provincial Hospital Affiliated To Shandong University, China*

**Objective:** To explore the long-term efficacy and safety of triple semicircular canal plugging (TSCP) in the treatment of intractable Meniere's disease (MD) and delayed endolymphatic hydrops (DEH).

**Methods:** Seventy-nine patients diagnosed with unilateral MD and fifteen patients diagnosed with unilateral DEH, who referred to vertigo clinic of our hospital between Dec.2010 and Dec.2013, were enrolled in this study. Triple semicircular canal plugging (TSCP) was performed in the affected ear for each patient. Vertigo control and auditory function were measured. Pure tone audiometry, caloric test, and cervical vestibular evoked myogenic potential (cVEMP) and magnetic resonance hydrograph of labyrinth were performed. Thirty-six MD patients, who accepted endolymphatic sac decompression operation during the same period, were selected as a control group.

**Results:** The total control rate of vertigo in MD patients was 98.7% (78/79) in the two-year follow-up. The rate of hearing preservation was 70.9% (56/79). Vertigo control rate of 36 MD patients who were subjected to endolymphatic sac decompression operation was 72.2%. The vertigo control rate of TSCP was significantly higher than that of endolymphatic sac decompression operation ( $\chi^2 = 17.15$ ,  $p < 0.05$ ). Control rate of vertigo in DEH patients was 93.3% (14/15). The rate of hearing preservation was 66.7% (10/15). Twenty-four months after treatment, canal paresis was found in the operation side of all patients of TSCP by means of caloric test.

**Conclusions:** TSCP, which can reduce vertiginous symptoms in patients with intractable MD and DEH, represents an effective and safe therapy for these disorders.

## OP13-7

Meniere's Disease and Related Disorders II

**PROINFLAMMATORY CYTOKINE LEVELS DIFFER BETWEEN MENIERE'S DISEASE AND VESTIBULAR MIGRAINE****Lidia FREJO<sup>1</sup>, Julia JALDO<sup>1</sup>, Alvaro GALLEGOS-MARTINEZ<sup>1</sup>, Juan Carlos AMOR-DORADO<sup>2</sup>, Sofia SANTOS-PEREZ<sup>3</sup>, Andres SOTO-VARELA<sup>3</sup>, Angel BATUECAS-CALETRIO<sup>4</sup>, Juan Manuel ESPINOSA-SANCHEZ<sup>1,5</sup>, Eduardo MARTIN-SANZ<sup>6</sup>, Teresa REQUENA<sup>1</sup>, Jose Antonio LOPEZ-ESCAMEZ<sup>1,7</sup>**<sup>1</sup>*Department of Genomic Medicine, Otology & Neurotology Group. Genyo. Centre For Genomics And Oncological Research: Pfizer/University of Granada / Andalusian Regional Government, Spain*<sup>2</sup>*Department of Otolaryngology, Hospital Can Misses, Ibiza, Spain*<sup>3</sup>*Department of Otorhinolaryngology, Complexo Hospitalario Universitario, Santiago De Compostela, Spain*<sup>4</sup>*Department of Otolaryngology, Hospital Universitario Salamanca, Salamanca, Spain*<sup>5</sup>*Department of Otorhinolaryngology, Hospital San Agustin, Linares, Spain*<sup>6</sup>*Department of Otolaryngology, Hospital Universitario De Getafe, Getafe, Spain*<sup>7</sup>*Department of Otolaryngology, Complejo Hospitalario Universidad De Granada (chugra), Granada, Spain*

**Purpose of the study:** To characterize the cytokine profile in patients with Meniere's disease (MD) and vestibular migraine (VM).

**Methods:** Isolated peripheral blood mononuclear cells (PBMC) from 62 patients with MD, 29 patients with VM and 54 controls were incubated at 37°C, 7% CO<sub>2</sub> overnight. Supernatant was collected and RNA harvested. Basal levels of TNF $\alpha$ , IL-1 $\beta$ , and IL-6 were quantified in supernatant of PBMC with a bead-based multiplex assay. RNA expression levels were measured using the HumanHT-12 v4 Expression BeadChip. Limma R package was used for expression data analysis and normalization and for differential expression analysis. Data were analyzed using SPSS Software and cluster analyses were performed using the heatmap.2 function from gplots R package.

**Results:** Two different subgroups of patients with MD were observed according to their cytokines profile. Forty-two patients (68%) presented low levels of cytokines (IL-1 $\beta$  = 1.55 ± 1.53; IL-6 = 4.62 ± 4.99 and TNF $\alpha$  = 7.53 ±

6.17), while 20 (32%) exhibited high levels of cytokines ( $IL-1\beta = 28.86 \pm 12.84$ ;  $IL-6 = 153.26 \pm 115.26$  and  $TNF\alpha = 47.22 \pm 16.01$ ). All individuals with VM or controls showed low levels of cytokines.

**Conclusions:**

1. Proinflammatory cytokines profiles suggest two subgroups of patients with MD.
2. VM patients show low levels of proinflammatory cytokines.
3. Cytokine profile could be a potential marker to differentiate VM and MD.

**Funding:** This study was funded by EU-FEDER Funds for R+D+i by the Grant 2013-1242 from Instituto de Salud Carlos III.

OP13-8

Meniere's Disease and Related Disorders II

**ENDOLYMPH DYNAMICS IMAGED WITH LIGHT SHEET FLUORESCENCE MICROSCOPY**

**Daniel J. BROWN<sup>1</sup>, Lieke VAN ROON<sup>3</sup>, Christopher J. PASTRAS<sup>1</sup>, Ian S. CURTHOYS<sup>2</sup>, Cassandra SOUTHWELL<sup>1</sup>**

<sup>1</sup>*Department of Sydney Medical School, The University of Sydney, Australia*

<sup>2</sup>*Department of Psychology, The University of Sydney, Australia*

<sup>3</sup>*Department of Institute For Life Sciences And Chemistry, University of Utrecht, Netherlands*

**Purpose:** A clear understanding of where endolymph is absorbed in the inner ear is vital to our understanding of Meniere's Disease. Techniques for investigating endolymph dynamics have typically employed molecular markers, iontophoreses or injected into scala media. Here we aim to visualize endolymph movement with acute hydrops.

**Methods:** Fluorescein isothiocyanate (FITC)-dextran in artificial endolymph was injected into scala media of anaesthetized guinea pigs. Cochlear response thresholds were obtained throughout the injection. Temporal bones were harvested, fixed, decalcified, dehydrated, and immersed in dibenzyl ether to optically clear the tissue. Temporal bones were imaged on our custom-built scanning Light Sheet Fluorescence Microscope (sLSFM).

**Results:** A substantial amount of FITC-dextran was transported into the endolymphatic duct and sac when more than  $2.4 \mu\text{l}$  of endolymph had been injected. Moderate levels of FITC-dextran appeared in the utricle and semicircular canals, but not in the perilymphatic compartments.

**Conclusion:** This technique provides high-resolution 3D images of biomarker distribution. The remarkable uptake of FITC-dextran into the endolymphatic duct supports the theory that it plays a primary role in the absorption of endolymph during hydrops. The lack of FITC-dextran in perilymph following a  $> 150\%$  increase in endolymph volume, sufficient to induce a sudden recovery of a cochlear function, suggests that endolymph is forced through the utriculo-saccular duct rather than causing a rupture of the labyrinth.

OP13-9

Meniere's Disease and Related Disorders II

**NORMAL VIDEO HEAD IMPULSE TEST IN DEFINITE MENIERE'S DISEASE: A NEW DIAGNOSIS CRITERIA?**

Francois RUBIN<sup>1</sup>, Romain KANIA<sup>1</sup>, Philippe HERMAN<sup>1</sup>, Michel TOUPET<sup>1,2</sup>, **Charlotte HAUTEFORT<sup>1,2</sup>**

<sup>1</sup>*Department of Lariboisière University Hospital, Paris Diderot University, France*

<sup>2</sup>*Department of Iron, Paris/ Bruxelles, France*

Meniere's disease (MD) is diagnosed according to new diagnostic criteria jointly formulated by the Classification Committee of the Bárany Society, The Japan Society for Equilibrium Research, the European Academy of Otology and Neurotology, the Equilibrium Committee of the American Academy of Otolaryngology-Head and Neck Surgery and the Korean Balance Society. Using Video Head Impulse Test allows exploring the vestibulo-ocular reflex gain of the three semi-circular canals at physiological frequencies, offering more distinct data than caloric tests. This work aimed at studying VHIT on patients affected by definite MD.

From 2010 to 2013, a prospective study was conducted in a tertiary referral center for all consecutive adult patients admitted for a definite MD. VHIT and caloric tests were performed. The main outcome measurement was the percentage of normal VHIT compared with that of normal caloric testings using Student t-test.

**Results:** 37 patients were included, with a mean age of 56 years  $\pm$  12.7. Mean hearing loss was 59 dB HL = / – 18.3. Twelve patients experienced Tumarkin's attacks. All patients had normal VHIT. Four patients (11%) had normal caloric tests and 33 (89%) patients had abnormal caloric tests with a mean unilateral deficit of 45%. The percentage of normal VHIT was significantly higher than that of normal caloric tests ( $p < 0.05$ ). This study suggests that VHIT could be normal in patients with definite MD. Further studies are required in order to confirm these results with a larger group of patients.

#### OP14-1

Bilateral Vestibulopathy and Vestibular Prosthesis

#### VISUAL CORTEX ADAPTATION IN BILATERAL VESTIBULAR FAILURE

Hena AHMAD<sup>1</sup>, R Edward ROBERTS<sup>1</sup>, Mitesh PATEL<sup>1</sup>, Qadeer ARSHAD<sup>1</sup>, Barry SEEMUNGAL<sup>1</sup>, **Adolfo M BRONSTEIN**<sup>1</sup>

<sup>1</sup>Department of Neuro-otology, Division of Brain Sciences, Imperial College London, Charing Cross Hospital, United Kingdom

Patients with bilateral absence of the vestibulo-ocular reflex (VOR) experience intense oscillopsia during head movements as a result of retinal image slip. Although oscillopsia gradually subsides, the mechanisms underlying this adaptive process remain unexplained. Here, we explored whether this adaptation involved changes in visual cortical excitability, and investigated this directly by measuring primary visual cortex excitability (V1) using transcranial magnetic stimulation (TMS). Single pulse TMS was used to establish phosphene thresholds (a surrogate for cortical excitability) in 12 bilateral vestibular failure (BVF) patients and 12 healthy controls. Phosphene perception was measured during static, visual motion, and then repeated following a prolonged period of full field visual motion stimulation. The intensity of stimulation required to elicit phosphenes in BVF patients was significantly higher than in controls implying reduced V1 excitability. A significant decrease in the probability of phosphene perception was observed in patients when viewing visual motion compared to controls. A subset of patients exhibited markedly reduced V1 excitability, with strong or complete suppression of phosphenes during visual motion termed the “disappearing phosphene” phenomenon. In patients, phosphene thresholds were inversely correlated with oscillopsia scores, suggesting reduced visual cortical excitability associated with improved functional status. Our findings provide the first neurophysiological evidence that cortical adaptation mechanisms play a critical role in recovery from vestibular failure.

#### OP14-2

Bilateral Vestibulopathy and Vestibular Prosthesis

#### DISEASE-SPECIFIC SPARING OF THE ANTERIOR SEMICIRCULAR CANALS IN BILATERAL VESTIBULOPATHY

**Alexander Andrea TARNUTZER**<sup>1</sup>, Christopher J BOCKISCH<sup>1,2,4</sup>, Elena BUFFONE<sup>1</sup>, Lucas M BACHMANN<sup>3</sup>, Konrad P WEBER<sup>1,4</sup>

<sup>1</sup>Department of Neurology, University Hospital Zurich, Switzerland

<sup>2</sup>Department of Otorhinolaryngology, University Hospital Zurich, Switzerland

<sup>3</sup>Department of N/a, Medignition Inc, Research Consultants, Switzerland

<sup>4</sup>Department of Ophthalmology, University Hospital Zurich, Switzerland

Bilateral vestibular loss, causing gait imbalance and oscillopsia, is often diagnosed with great delay and an underlying cause is only identified in 50–80%. We measured horizontal and vertical semicircular canal function using the video-head-impulse test (vHIT) and hypothesized that specific vHIT-patterns may be linked to certain disorders. We retrospectively analyzed 109 bilateral vestibular loss patients linked to aminoglycoside vestibulotoxicity ( $n = 16$ ), Menière's disease ( $n = 10$ ), infectious inner-ear disorders ( $n = 11$ ), sensorineural hearing-loss ( $n = 11$ ), cerebellar-ataxia-neuropathy-vestibular-areflexia-syndrome (CANVAS,  $n = 5$ ), other causes ( $n = 19$ ) as well as those with unknown origin ( $n = 47$ ). Vestibulo-ocular reflex gains and cumulative saccade amplitudes were measured with vHIT, and the functional integrity of all semicircular canals was rated. Gains and saccade amplitudes showed a significant inverse correlation ( $R^2 = 0.43$ ,  $p < 0.001$ ). Overall, anterior semicircular canal hypofunction

( $n = 86/218$ ) was identified significantly ( $p < 0.001$ ) less often than horizontal ( $n = 186/218$ ) and posterior ( $n = 194/218$ ) hypofunction. Preserved anterior canal function was associated with aminoglycoside vestibulotoxicity, Menière's disease and bilateral vestibular loss of unknown origin, while no such sparing was found for inner-ear infections, CANVAS and sensorineural hearing loss as demonstrated by subgroup analyses and multivariate logistic regression analysis. Bilateral vestibular loss often results in patchy vestibular loss and shows significant sparing of anterior canal function in aminoglycoside vestibulotoxicity, Menière's disease and cases of unknown origin. These disease-specific dissociations may be related to reduced vulnerability or superior recovery of the anterior canals. In patients with suspected bilateral vestibular loss we recommend quantifying gains and saccade amplitudes for all semicircular canals as the pattern of canal hypofunction may help identifying the underlying disorder.

## OP14-3

Bilateral Vestibulopathy and Vestibular Prosthesis

**AMIODARONE-INDUCED “ATAxia” IS REVEALED AS BILATERAL VESTIBULOPATHY**

**Robert GÜRKOV<sup>1</sup>, Maxine RÜHL<sup>2</sup>**

<sup>1</sup>Department of Otorhinolaryngology, University of Munich, Germany

<sup>2</sup>Department of German Centre For Vertigo And Balance Disorders, University of Munich, Germany

**Introduction:** Amiodarone is a benzofuran derivative and is now commonly used in refractory ventricular tachycardia and paroxysmal atrial fibrillation. Neurologic adverse effects like tremor, peripheral sensorimotor neuropathy, proximal weakness and ataxia have been described. However, the mechanism of the ataxic symptoms is not clear.

**Case report:** We report a 73-year-old patient who presented with progressive gait insecurity for several years. No further auditory or neurological symptoms. No history of ototoxic drug exposure or audiovestibular disorders. The symptoms started several months after the initiation of Amiodarone treatment for paroxysmal atrial fibrillation. Clinical examination showed a bilaterally pathologic head impulse test, a widened and ataxic gait pattern, positive Romberg test, bimalleolar pallhypesthesia. No further abnormalities, no clinical cerebellar signs. Caloric irrigation revealed bilateral areflexia. Video-Head Impulse test revealed bilaterally corrective saccades and gain values (at 60 ms) of 0.01 and 0.07. In this patient, clearly the bilateral vestibulopathy is the cause for his balance disorder. The association with Amiodarone intake is highly suggestive of an adverse drug reaction.

**Literature review:** Previous reports on Amiodarone-induced “ataxia” are critically reviewed. It is revealed that these cases show clinical features in good accordance with bilateral vestibulopathy, despite their lack of thorough vestibular examination.

**Conclusion:** The evidence presented herein clearly suggests that Amiodarone may induce peripheral vestibulopathy. This warrants further prospective clinical trials in patients who are taking Amiodarone. Furthermore, its potential as a selective vestibulotoxic agent e.g. in the ablative treatment of Menière's disease should be evaluated in animal studies.

## OP14-4

Bilateral Vestibulopathy and Vestibular Prosthesis

**VESTIBULAR IMPAIRMENT IN CHRONIC INFLAMMATORY DEMYELINATING PERIPHERAL NEUROPATHY**

**Gülden AKDAL<sup>1</sup>, Tural TANRIVERDIVAZDE<sup>2</sup>, Hamish MCDOUGALL<sup>3</sup>, Fikret BADEMKIAN<sup>4</sup>, Hatice KARASOY<sup>4</sup>, Nur YÜCEYAR<sup>4</sup>, Ihsan Şülrü ŞENGÜN<sup>1</sup>**

<sup>1</sup>Department of Neurology, Dokuz Eylül University, Turkey

<sup>2</sup>Department of Neuroscience, Dokuz Eylül University School of Medicine Health Institute, Turkey

<sup>3</sup>Department of Vestibular Research Unit, School of Psychology, University of Sydney, Australia

<sup>4</sup>Department of Neurology, Ege University Hospital, Turkey

Vestibular loss has been associated with peripheral neuropathy from many different hereditary and acquired causes. Chronic inflammatory demyelinating peripheral neuropathy (CIDP) is a common and disabling condition causing mainly motor but also sensory loss. We were interested to find out if patients with CIDP also have peripheral vestibular loss. We studied 20 patients [14M:6F; mean age  $54.8 \pm 14.8$  (26–83)] with CIDP, after onset of disease

from 40 to 0.5 years, using video Head-Impulse testing (GN Otometrics). We found some patients had normal and others had impaired VOR gain, affecting one or more of the semicircular canals.

(L) Lateral mean gain = 0.82 (SD ± 0.23) (min = 0.28, max = 1.23);

(R) Lateral mean gain = 0.92 (SD ± 0.14) (min = 0.49, max = 1.08);

(L+R) Lateral mean gain = 0.87 (SD ± 0.16);

(L/R) Lateral mean gain asymmetry = 12.4 (SD ± 18.9) (Min = 0, Max = 71);

(L) Anterior mean gain = 0.81 (SD ± 0.21) (min = 0.29; max = 1.17);

(R) Anterior mean gain = 0.77 (SD ± 0.14) (min = 0.52; max = 0.96);

(L+R) Anterior mean gain = 0.79 (SD ± 0.15);

(L/R) Anterior mean gain asymmetry = 14.80 (SD ± 15.00) (min = 0; max = 52);

(L) Posterior mean gain = 0.84 (SD ± 0.21) (min = 0.43; max = 1.17);

(R) Posterior mean gain = 0.82 (SD ± 0.23) (min = 0.13; max = 1.02);

(L+R) Posterior mean gain = 0.83 (SD ± 0.16);

(L/R) Posterior mean gain asymmetry = 16.90 (SD ± 14.36) (min = 0; max = 46).

Based on our findings we conclude that further studies with a larger group of CIDP patients studied at various stages of the disease and treated with various regimes is warranted.

#### OP14-5

Bilateral Vestibulopathy and Vestibular Prosthesis

#### COCHLEOVESTIBULAR SIMULTANEITY

**Nils GUINAND<sup>1</sup>**, Jelena TODIC<sup>1</sup>, Jean-Philippe GUYOT<sup>1</sup>, Angelica PEREZ FORNOS<sup>1</sup>, Samuel CAVUSCENS<sup>1</sup>, Maurizio RANIERI<sup>1</sup>, Raymond VAN DE BERG<sup>2</sup>, Herman KINGMA<sup>2</sup>, Daniel MERFELD<sup>3,4</sup>, Richard LEWIS<sup>3,4</sup>

<sup>1</sup>Department of ENT, University Hospitals of Geneva, Switzerland

<sup>2</sup>Department of ENT, Maastricht University Medical Center, Netherlands

<sup>3</sup>Department of Otolaryngology & Laryngology, Harvard Medical School, USA

<sup>4</sup>Department of Jenkins Vestibular Physiology Laboratory, Massachusetts Eye And Ear Infirmary, Harvard Medical School, USA

**Introduction:** The vestibular implant offers a unique opportunity to activate selectively the vestibular organ. The aim of this study was to determine how the brain binds cochlear and vestibular cues in time and how adaptable this process is.

**Methods:** In a patient with a bilateral vestibular loss, fitted with a custom modified cochlear implant (Medel, Austria) in his deaf ear, the cochlear and the vestibular (superior canal) nerves were stimulated during 10ms with biphasic, charge balanced pulses (rate: 1000pps, phase: 75 µs, amplitudes: cochlear: 350 µA, vestibular: 650 µA). We measured: 1) the reaction times for both percepts; 2) the point of subjective simultaneity (PSS) and the temporal binding window (TBW) by varying randomly the time onset between both stimuli between ± 400 ms, in 50 ms steps; 3) the PSS adaptation by providing a repetitive series of cochlear-vestibular stimuli with a fixed time lag (220 ms).

**Results:** The vestibular reaction time was 114(± 53) ms and the cochlear was 110(± 35) ms. The PSS was essentially zero with a TBW of 111 ms. Finally, the PSS was sensitive to the adaptation paradigm, shifting by about 100 ms towards the sound-first pattern.

**Conclusion:** Electrical cochlear and vestibular activation results in percepts with nearly identical latency and are perceived as simultaneous when they are simultaneous. The PSS is sensitive to adaptation, more than previously reported for auditory-visual pairs. It provides a fascinating and unique exploration of temporal processing in the brain, and can serve as the groundwork for identifying the optimal temporal coding of vestibular signals relative to the other senses.

## OP14-6

Bilateral Vestibulopathy and Vestibular Prosthesis

**RESTORATION OF THE VESTIBULO-COLIC REFLEX WITH A VESTIBULAR IMPLANT**

**Nils GUINAND<sup>1</sup>, Samuel CAVUSCENS<sup>1</sup>, Maurizio RANIERI<sup>1</sup>, Raymond VAN DE BERG<sup>2</sup>, Robert STOKROOS<sup>2</sup>, Herman KINGMA<sup>2</sup>, Jean-Philippe GUYOT<sup>1</sup>, Angelica PEREZ FORNOS<sup>1</sup>**

<sup>1</sup>Department of ENT, University Hospitals of Geneva, Switzerland

<sup>2</sup>Department of ENT, Maastricht University Medical Center, Netherlands

**Introduction:** The vestibulo-collic reflex(VCR) is important for postural control. It can be assessed by recording cervical vestibular evoked myogenic potentials(cVEMPs), which are thought to reflect the functionality of the saccule. In patients with a bilateral vestibular loss(BVL), artificial restoration of the VCR using electrical stimulation of the vestibular organ would indicate the potential of the vestibular implant to control posture.

**Methods:** In 3 BVL patients, fitted with a custom modified cochlear implant (Medel, Austria), cVEMPs were recorded according to a standard protocol, except for the stimulus, which consisted of 100 trials of single biphasic, charge balanced pulses delivered at 5pps to the vestibular nerve using intralabyrinthine electrodes located close to the ampullas of the superior (SAN) and lateral (LAN) canals in 2 patients and using an extralabyrinthine electrode located in the vicinity of the posterior ampullary nerve (PAN) in the third patient. In a previous study we could show that the selected electrodes could elicit a robust vestibulo-ocular reflex.

**Results:** cVEMPs with its classical characteristics could be elicited with the intralabyrinthine SAN and LAN electrodes in 2 patients and with the extralabyrinthine PAN electrode in the third patient. There was a positive correlation between the stimulus and the cVEMPs amplitudes.

**Conclusion:** Artificial restoration of the VCR in BVL patients is possible. This indicates that functionally useful motion information could be delivered via the vestibulo-spinal pathways. Due to possible current spread, it remains unclear if it results from activation of the canal or of the otolithic system, or a combination.

## OP14-7

Bilateral Vestibulopathy and Vestibular Prosthesis

**SLOW EYE MOVEMENTS WITH HEAD IMPULSES: AN EXTRA-VESTIBULAR CONTRIBUTION IN BVL?**

**Leonor LUIS<sup>1,2,3</sup>, Tiago COSTA<sup>3</sup>, Eduardo FERREIRA<sup>3</sup>, Maria HEUBERGER<sup>4,5</sup>, Nadine LEHNEN<sup>4,5</sup>, Erich SCHNEIDER<sup>6</sup>**

<sup>1</sup>Department of Clinical Physiology Translational Unit, Institute of Molecular Medicine, Faculty of Medicine, University of Lisbon, Portugal

<sup>2</sup>Department of Otolaryngology, Hospital De Cascais, Portugal

<sup>3</sup>Department of Otolaryngology, Hospital De Santa Maria, Portugal

<sup>4</sup>Department of German Center For Vertigo And Balance Disorders, German Center For Vertigo And Balance Disorders, Germany

<sup>5</sup>Department of Neurology, Ludwig-maximilians University of Munich, Germany

<sup>6</sup>Department of Institute of Medical Technology, Brandenburg University of Technology, Germany

Horizontal rotations of the head generate conjugate eye movements, of equal magnitude and opposite direction, known as the vestibulo-ocular reflex (VOR). Patients with bilateral vestibular dysfunction cannot produce compensatory responses. In order to compensate for their deficient slow phases re-fixation saccades may be triggered. Slow eye movements may also be pre-programmed in anticipation of active head movements.

We report on a 61-year-old woman with a bilateral vestibular lesion after gentamycin vestibulotoxicity. The video-HIT (vHIT) quantified bilaterally non-compensatory slow phases (VOR instantaneous gain at 60 ms after head impulse start was 0,42 on the right and 0,49 on the left) with frequent overt saccades with right and covert and overt saccades with left head impulses. While directed to stare blankly ahead into the darkened room the VOR gain was markedly reduced (0,11 on the right and 0,17 on the left) and refixation saccades were less frequent. Using a visual stimulus simulating the visual motion during the HIT (Optokinetic-IT) there was no response.

These observations challenge the belief that slow eye movements with passive, unexpected head impulses are vestibular only responses in bilateral vestibular lesion patients. While optokinetic-IT could not generate neither

slow nor rapid eye movements a visual input was necessary for higher gain slow phase and more frequent catch-up saccade generation.

#### OP14-8

Bilateral Vestibulopathy and Vestibular Prosthesis

#### DIVERSE CLINICAL AND LABORATORY MANIFESTATIONS OF BILATERAL VESTIBULOPATHY

Min-Beom KIM<sup>1</sup>, Myunggi MOON<sup>1</sup>

<sup>1</sup>Department of Otolaryngology Head And Neck Surgery, Kangbuk Samsung Hospital, Sungkyunkwan University, Korea

**Objective:** To identify the clinical and laboratory characteristics of bilateral vestibulopathy(BVP) on the video head impulse test(vHIT).

**Methods:** During 23 months, 1789 patients with dizziness underwent vHIT in our tertiary referral hospital. Of these patients, 65(3.6%) patients had bilaterally positive catch up saccades. Based on the caloric test, 15 (group1) had bilateral caloric weakness, 13 (group2) had unilateral caloric weakness, and 37 (group3) had normal caloric responses on both ears. We collected data on these patients, regarding demographics, gain and type of saccade on vHIT, and gain and time constant on velocity step test.

**Results:** The average age of group2 ( $70.38 \pm 11.96$  years) and group3 ( $69.03 \pm 11.01$  years) was significantly older than group1 ( $54.80 \pm 11.96$  years). ( $P = 0.029$ ,  $P = 0.003$  respectively) While all patients had bilaterally positive vHIT, nine of 15 in group1 were finally diagnosed as classical BVP by clinical features. On comparison of average gain on bilateral horizontal vHIT, groups 2 ( $0.71 \pm 0.17$ ) and 3 ( $0.80 \pm 0.14$ ) had higher gain compared to group1 ( $0.45 \pm 0.22$ ) ( $P = 0.001$ ,  $P = 0.000$  respectively). On velocity step test, time constant and gain of group3 was significantly higher than those of group1 ( $P = 0.000$ ,  $P = 0.004$ , respectively). In the ROC curve analysis, vHIT alone seemed to be discordant method for diagnosis of BVP compared to the caloric and step velocity test.

**Conclusions:** About 3.6% patients with dizziness showed bilateral vestibular ocular reflex deficit during high frequency acceleration, and was prevalent especially in elderly patients. Also, positive bilateral vHIT does not always correlate with caloric or rotatory chair test results. This may imply that a diverse spectrum of vestibulopathies exist according to the stimulation frequency of deficit.

#### OP14-9

Bilateral Vestibulopathy and Vestibular Prosthesis

#### THE VESTIBULAR IMPLANT: “MORE THAN THE VOR”

R. VAN DE BERG<sup>1,3</sup>, N. GUINAND<sup>2</sup>, R. STOKROOS<sup>1</sup>, Jp. GUYOT<sup>2</sup>, H. KINGMA<sup>1,3</sup>, A. PEREZ-FORNOS<sup>2</sup>

<sup>1</sup>Department of Otorhinolaryngology And Head & Neck Surgery, Division of Balance Disorders, Maastricht University Medical Center, Maastricht, Netherlands

<sup>2</sup>Department of Otorhinolaryngology And Head & Neck Surgery, University Hospitals Geneva, Geneva, Switzerland

<sup>3</sup>Department of Physics, Tomsk State University, Tomsk, Russia

**Introduction:** The vestibular implant (VI) is currently mainly investigated by evaluation of the vestibulo-ocular reflex (VOR). However, the vestibular system involves more neural pathways than the VOR.

**Objective:** To show that the vestibular implant (VI) activates more neural pathways than only the vestibulo-ocular reflex (VOR).

**Methods:** In our pool of patients with a bilateral vestibular loss and fitted with a vestibular implant, the VOR, perception and head movements were recorded during sinusoidal electrical stimulation of the vestibular nerve. Patients were also asked to describe their percept.

**Results:** Thresholds of the VOR were generally higher than thresholds of perception. The reported percepts were heterogeneous and only a minority of patients reported a rotatory sensation in response to electrical stimulation of the vestibular nerve. Sinusoidal modulation activated head movements not present without modulation. These findings indicate that other neural pathways than those of the VOR are activated.

**Conclusion:** These findings show that probably multiple neural pathways are stimulated by the VI, with different thresholds. Evaluation of the effect or benefit of the vestibular implant cannot be limited to VOR assessment. There are a variety of parameters to be taken into account.

OP15-1

Meniere's Disease and Related Disorders III

### HIGH FREQUENCY SENSORINEURAL HEARING LOSS ASSOCIATED WITH VESTIBULAR EPISODIC SYNDROME (HIVES)

**Eduardo MARTIN-SANZ<sup>1</sup>, Joaquin YANES<sup>1</sup>, Jonathan ESTEBAN<sup>1</sup>, Ricardo SANZ<sup>1</sup>**

<sup>1</sup>*Department of Otolaryngology, University Hospital of Getafe, Spain*

**Objectives:** 1) To describe the clinical features of patients with high frequency sensorineural hearing loss (SNHL) and vestibular episodic syndrome (HIVES) fulfilling criteria for definite Meniere's disease (MD). 2) To compare the results of clinical and vestibular tests between patients with HIVES vs patients with MD.

**Study design:** A retrospective study.

**Methods:** A total of 388 clinical records from patients with vestibular episodic syndrome were assessed. Clinical, hearing and vestibular tests results were revised and patients fulfilling criteria for definite MD were classified according to the hearing profile in two categories: a) low-to-medium frequencies SNHL ( $N = 48$ ) and b) high frequency SNHL ( $N = 20$ ). Patients underwent a complete neuro-otologic examination including audiometry, cVEMPs and extratympanic Electrocochleography.

**Results:** No statistical differences were observed in the distribution of sex, age, familial history, vertigo spells per month and time since the onset of the disease or affected side between both cohorts. Auditory differences were observed between both MD and HIVES groups, with higher thresholds in the 4 to 8 kHz frequency range analyzed in the HIVES group.

Both cVEMPs and ECoG profiles were similar without significant differences between both groups.

**Conclusions:** Patients with MD and HIVES has identical phenotype, being the hearing profile the only difference found between both groups.

OP15-2

Meniere's Disease and Related Disorders III

### VEMP TESTING IN PATIENTS WITH MENIERE'S DISEASE ACCORDING TO CALORIC AND VHIT RESULTS

**Nicolas PEREZ<sup>1</sup>, Raquel MANRIQUE<sup>1</sup>, Lorea ARBIZU<sup>2</sup>, Maria Victoria UCAR<sup>2</sup>**

<sup>1</sup>*Department of Otorhinolaryngology, University of Navarra, Spain*

<sup>2</sup>*Department of Otorhinolaryngology, Complejo Hospitalario De Navarra, Spain*

It has been recently hypothesized that in patients with Ménière's disease (MD) the disparity in test results (between the calorimetric test, CAL, and the video head-impulse test, vHIT) is indicative of an endolymphatic hydrops in the horizontal semicircular canal. In this work we were interested in the evaluation of the Vestibular Evoked Myogenic Potential results (VEMP) in patients with MD classified according to the results in the CAL and vHIT.

We have included patients diagnosed of unilateral definite Menière's disease. In all of them vHIT was normal for impulses towards the affected ear and unaffected ear. Group 1 was made of patients with a normal calorimetric response (canal paresis < 20%) and Group 2 of patients with an abnormal canal paresis; in this case only patients in which the side of the canal paresis was coincident with the side with auditory symptoms were selected. In our patients, 30% belong to group 1 and 70% to group 2.

The only significant finding (U Mann-Whitney,  $p = 0.02$ ) was the interaural asymmetry rate for n10-p16 in the oVEMP; this was much lower for patients in group 2 ( $11\% \pm 6\%$ ) than in patients in group 1 ( $30\% \pm 7\%$ ). There were no differences in latencies for n10 neither p16.

Based on these findings we think that there is rationale to consider the possibility of a differential degree in hydrops in both groups of patients. Results will be discussed regarding other characteristics of the disease: degree of hearing loss, disease duration, time since last vertigo attack and presence of Tumarkin spells.

## OP15-3

Meniere's Disease and Related Disorders III

**THE DISSOCIATION BETWEEN VIDEO HEAD IMPULSE AND CALORIC RESULTS IN MÉNIÈRE'S DISEASE SUGGESTS THE MECHANISM**Leigh Andrew MCGARVIE<sup>1</sup>, Hamish Gavin MACDOUGALL<sup>2</sup>, Gabor Michael HALMAGYI<sup>1</sup>, Ian Stewart CURTHOYS<sup>2</sup><sup>1</sup>*Department of Neurology, Royal Prince Alfred Hospital, Australia*<sup>2</sup>*Department of Psychology, University of Sydney, Australia*

Since the introduction of the video head impulse test (vHIT) as a standard clinical screening test, it has been noted that in patients with Ménière's Disease (MD) there is generally a dissociation between the results of the caloric test and the responses to horizontal vHIT.

This retrospective study at a tertiary referral hospital examined this disagreement.

We reviewed the data of 22 patients who met the AAO-HNS criteria for MD and who had both caloric and vHIT testing in the interictal period of the disease. There was a clear dissociation in the results, with a reduced or absent response to caloric stimulation of their affected ear, whilst their VOR gain response to vHIT towards the affected ear was in the normal range.

Taking into account the accepted Gentine model of the mechanism of caloric stimulation and recent imaging and hair cell studies in Ménière's patients, we suggest that this dissociation is more likely to be due to the effect of hydrops on the caloric results, rather than a reduction in canal function. In this situation, the increased cross section of the horizontal semicircular duct in hydropic labyrinths enables endolymph circulation within the arm of the duct itself and thus a smaller thermally induced pressure across the cupula. The increased duct cross section will, however, have little effect on responses to rotation as the overall curvature diameter of the canal is maintained, and hence, the inertial endolymph drive is maintained.

## OP15-4

Meniere's Disease and Related Disorders III

**CERVICAL SPECIFIC PROTOCOL AND RESULTS FOR 300 MENIERES PATIENTS FOLLOWED FOR A MINIMUM OF 6 YEARS****Michael T BURCON***Department of Meniere's Research Institute, Burcon Chiropractic, USA*

Testing efficacy of cervical specific care to control vertigo in 300 consecutive Meniere's patients.

Pattern established utilizing thermography, cervical syndrome and modified Prill leg length inequality tests, determining when and where to adjust. One of four possible adjustment listings obtained by Blair x-ray analysis. Ninety percent of patients' atlas listings were posterior and inferior on the opposite side of involved ear. When patients were in pattern, Palmer toggle recoil and/or Pierce Results knife-edge adjustments were performed.

Upper cervical subluxation complex resulting from whiplash can cause chronic Eustachian tube dysfunction from a combination of torqueing CN V, which supplies tensor veli palatine muscle, and swelling from facet friction imposing pressure on the auditory tube in the nasopharynx. This edema can over stimulate the sympathetic innervation of endolymphatic sac via the superior cervical ganglion, creating endolymphatic hydrops. The misalignment tractions CN VIII, kinking the vertebral artery, which supplies blood to inner ear via the basilar artery. The cranial vault is a closed hydraulic system; lowered blood pressure will increase craniocervical fluid pressure via the cochlear aqueduct. Vertigo intensity rated by patients on a scale of 0 to 10, with 10 being the worst imaginable. Prior to treatment mean score was 8.5, six weeks post treatment average was down to 3.0, after one year 2.0, two years 1.4, three years 0.9, four, five and six years 0.8, an improvement of over 90%.

Meniere's can be caused by whiplash, with an average of fifteen years from the time of trauma to onset of symptoms.

## OP15-5

Meniere's Disease and Related Disorders III

**GENETICS OF ION HOMEOSTASIS IN MENIÈRE'S DISEASE****Roberto TEGGI<sup>1</sup>, Laura ZAGATO<sup>2</sup>, Simona DELLI CARPINI<sup>2</sup>, Roberto ALBERA<sup>3</sup>, Chiara LANZANI<sup>2</sup>**<sup>1</sup>*Department of ENT, San Raffaele Scientific Institute Milano, Italy*<sup>2</sup>*Department of Genetics of Hypertension, San Raffaele Scientific Institute Milano, Italy*<sup>3</sup>*Department of ENT, Ospedale Le Molinette Torino, Italy*

**Objective:** To assess the role of genetic polymorphisms of different genes involved in essential hypertension in Meniere's Disease patients.

**Materials and methods:** We included 155 Caucasian subjects with definite MD and 137 control subjects without a lifetime history of vertigo. Patients were recruited in the Vertigo Centers of two University Hospitals. Both patients and controls performed a blood withdrawal for genotyping. A clinical history of MD patients and controls was also collected, above all for migraine, hypertension and familiarity for MD. Main outcome measure was the genetic variance of 36 genes encoding proteins involved in ionic transport and previously studied in hypertension.

**Results:** Four different genes demonstrated a significant increase in frequency of specific allele and genotype in MD patients compared to controls: SLC8A1 (rs487119), CYP11B2 (rs1799998), SIK1 (rs2838301 and rs3746951). Significance of chi square test for genotype and allele frequency are respectively the followings: SLC8A1 ( $p = 0.01$ ;  $p = 0.006$ ), CYP11B2 ( $p = 0.028$ ;  $p = 0.009$ ), SIK1 rs2838301 ( $p = 0.009$ ;  $p = 0.016$ ), SIK1 rs3746951 ( $p = 0.024$ ;  $p = 0.01$ ). The presence of all four risk variant increases of 5 folders the probability of MD disease compared to wild type.

**Conclusions:** SLC8A1 gene encodes a Na+-Ca++ exchanger (NCX1 protein); CYP11B2 encodes Aldosterone Synthase, acting with a rate limiting function in Aldosterone production; SIK genes are involved in the production of Salt Inducible Kinase, which has been associated with changes in Na+-K+ATPase function. In our opinion these data support the hypothesis that a genetically induced dysfunction of ionic transport may act as a predisposing factor to develop MD.

## OP15-6

Meniere's Disease and Related Disorders III

**ANALYSIS OF AUDIO-VESTIBULAR ASSESSMENT IN ACUTE LOW-TONE HEARING LOSS****Gi Jung IM<sup>1</sup>, Sung Kyun KIM<sup>1</sup>, June CHOI<sup>1</sup>, Jae Jun SONG<sup>1</sup>, Sung Won CHAE<sup>1</sup>, Hak Hyun JUNG<sup>1</sup>**<sup>1</sup>*Department of Otolaryngology-head And Neck Surgery, Korea University College of Medicine, Korea*

**Conclusion:** This study demonstrated excellent hearing recovery following the combined treatment of diuretic and oral steroid, and electrocochleography(ECoG) was significantly higher than normal side. We report characteristics of acute low-tone hearing loss(ALHL) that the greater low-tone hearing loss, the higher ECoG, and excellent recovery even-though low-tone hearing loss is worse, which can be different compared with sudden deafness.

**Objective:** To analyze ALHL without vertigo, we compared the ALHL group with all patients exhibiting low-tone hearing loss and ear fullness. Hearing changes and vestibular functions were analyzed.

**Materials and methods:** ALHL was defined as a mean hearing loss of  $\geq 30$  dB at 125, 250, and 500 Hz, and  $\leq 20$  dB at 2, 4, and 8 kHz. From 156 low-tone hearing loss more than 10 dB without vertigo, 31 met the ALHL criteria and subjected to audio-vestibular assessments including PTA, ECoG, vestibular evoked myogenic potential (VEMP) testing, and caloric testing.

**Results:** In ALHL, low-tone hearing loss was  $42.7 \pm 9.5$  dB, and 83.9% of ALHL significantly recovered by more than 10 dB. The ECoG in ALHL was  $0.334 \pm 0.11$  (higher than  $0.25 \pm 0.08$  on normal side) and ECoG abnormality was 35.5%(the greater low-tone hearing loss, the higher ECoG value).

## OP16-1

Vestibular Neuritis

**PREVALENCE AND FEATURES OF INFERIOR VESTIBULAR NEURITIS**

Romain GLATRE<sup>1</sup>, Romain KANIA<sup>1</sup>, Benjamin VERILLAUD<sup>1</sup>, Christelle DOMANGE<sup>1</sup>, Philippe HERMAN<sup>1</sup>, Charlotte HAUTEFORT<sup>1,2</sup>

<sup>1</sup>Department of Lariboisière University Hospital, Paris Diderot University, University Paris Sorbonne Cité, France

<sup>2</sup>Department of Iron, Paris/ Bruxelles, France

Vestibular neuritis (VN) is an acute unilateral vestibulopathy that commonly affects the superior vestibular nerve. The video head impulse test (VHIT) can help to diagnose inferior vestibular neuritis (IVN) by showing an isolated deficit on the posterior semicircular canal (SCC). The aim of this study was to evaluate the prevalence of IVN when managing acute vertigo, which could be higher when using VHIT in emergency.

From 2010 to 2013, a prospective study was conducted in a tertiary referal center for all consecutive adult patients admitted for a first isolated vestibular syndrome mimicking VN with unilateral abnormal VHIT. IVN was diagnosed by isolated posterior SCC deficit on VHIT, normal caloric tests and spontaneous unilateral nystagmus.

Among the 46 patients, VN was considered to be IVN for 14 patients (30%), superior for 24 (52%) patients and both for 8 patients (18%). Caloric tests were normal for all patients with IVN whereas they were always abnormal when involving the superior vestibular nerve. None of them had neurological or cochlear disorder and MRI was normal for all patients.

This study confirmed the importance of VHIT when managing acute vertigo in order to differentiate central and peripheral disorder and to diagnose inferior VN.

## OP16-2

Vestibular Neuritis

**ADDITIONAL EFFICACY OF METHYLPREDNISOLONE FOR THE TREATMENT OF VESTIBULAR NEURITIS BY THE VIDEO HEAD IMPULSE TEST**

Myung Hoon YOO<sup>1</sup>, Chan Joo YANG<sup>2</sup>, Shin Ae KIM<sup>2</sup>, Je Yeon LEE<sup>2</sup>, Joong Ho AHN<sup>2</sup>, Jong Woo CHUNG<sup>2</sup>, Hong Ju PARK<sup>2</sup>

<sup>1</sup>Department of Otolaryngology, College of Medicine, Kyungpook National University, Daegu, Korea

<sup>2</sup>Department of Otolaryngology, Asan Medical Center, University of Ulsan, College of Medicine, Seoul, Korea

**Background:** The efficacy of steroid in vestibular neuritis (VN) is controversial. The aim of this study is to examine the additional effectiveness of methylprednisolone for VN by using video head impulse test (vHIT).

**Methods:** This prospective controlled randomized study was conducted at one tertiary hospital. The 29 VN patients were randomized to either group (14 control and 15 steroid group). Control group received ginkgo biloba and steroid group received both ginkgo biloba and methylprednisolone for 2 weeks. After the initial tests including caloric, VEMP, vHIT, sensory organization test (SOT), dizziness handicap index (DHI), tests were repeated 1, 6 months later.

**Results:** At 1 and 6 months after treatment, both group showed statistically significant improvement in canal paresis and LSCC gain, but there was no significant difference between them. The incidence of normalized canal paresis at 1, 6 month was 50%, 71.4% in control group, and 40%, 60% in steroid group, which was also not significant ( $p = 0.715$ ,  $p = 1.000$ , respectively). The incidence of normalized vHIT gains at 1, 6 month was 57%, 78% in control group, and 53%, 87% in steroid group, which was also not significant ( $p = 1.000$ ,  $p = 0.651$ , respectively). And there were no significant differences in improvement and normalized ratio in ocular and cervical VEMP, SOT, and DHI score between 2 groups at 1 and 6 months.

**Conclusions:** When 1 and 6 months post-treatment VFT result was compared with pretreatment VFT, methylprednisolone didn't have any additional benefit in the improvement of symptoms and objective parameters in VN.

## OP16-3

Vestibular Neuritis

**DIAGNOSTIC ACCURACY OF VESTIBULAR NEURITIS IN THE EMERGENCY DEPARTMENT****Stuart Scott MOSSMAN<sup>1,2</sup>, Eloise WATSON<sup>2</sup>, Philip BROWN<sup>2</sup>**<sup>1</sup>*Department of Neurology, University of Otago Medical School, Wellington, New Zealand*<sup>2</sup>*Department of Neurology, Wellington Hospital, New Zealand***Introduction:** Vertigo and dizziness admissions to US Emergency Departments costs \$US4 billion/year.

The aim of our study was to assess the accuracy of the diagnosis of vestibular neuritis in the Emergency Department at Wellington Regional Hospital, New Zealand, pre and post increased input by the Neurology service.

Our hypothesis was that Neurology service input, and objective recording of the horizontal vestibular ocular reflex (HVOR) velocity gain of the head impulse test by EyeSeeCam video-oculography would improve diagnostic accuracy of vestibular neuritis, rationalise diagnostic neuroimaging and reduce the length of hospital stay.

**Methods:** Acute admissions with a primary diagnosis of vestibular neuritis were identified using vestibular ICD-10 codes. Clinical records were reviewed for the 18 month time intervals pre and post Neurology service involvement.**Results:** Thirty five admissions over 3 years were identified with vestibular neuritis. Diagnostic accuracy of vestibular neuritis was best in those patients assessed by the Neurology service with recording of the HVOR velocity gain of the head impulse test by video-oculography.**Conclusion:** The clinical head impulse test is underutilised by Emergency Department staff in the assessment of the acute vestibular syndrome but its interpretation even by Neurology staff is imperfect. Objective recording of the HVOR velocity gain by video-oculography in all patients with an acute vestibular syndrome can be regarded as best practise. Increased neurological input did not demonstrate a decrease in length of hospital stay, and saw an increase in neuro-imaging requests,

## OP16-4

Vestibular Neuritis

**CLINICAL FEATURES OF MINIMAL CANAL PARESIS ON CALORIC TEST IN VESTIBULAR NEURITIS****Hyun Ji KIM<sup>1</sup>, Dae-Young KIM<sup>1</sup>, Kyu-Sung KIM<sup>1</sup>**<sup>1</sup>*Department of Otorhinolaryngology, Inha University College of Medicine, Korea***Objective:** This study aimed to evaluate the clinical features of vestibular neuritis patients with minimal canal paresis (< 25%).**Study design:** The study design was retrospective and cross-sectional.**Methods:** Patients diagnosed as vestibular neuritis and treated at our institute in 2008–2013 completed otoneurologic examination and vestibular function test. Patients were categorized according to their results of caloric test(canal paresis < 25%, n = 58; canal paresis ≥ 25%, n = 143). Clinical characteristics and vestibular laboratory outcomes were compared between the groups.**Results:** Existence of underlying diseases, preceding symptoms and direction of spontaneous nystagmus were not different between the groups. Mean duration of spontaneous nystagmus was shorter in minimal canal paresis group ( $p < 0.001$ ). During the hospitalization period, direction of spontaneous nystagmus was changed more frequently in minimal canal paresis group ( $p < 0.001$ ). Among the subgroup with minimal canal paresis, only 29.5% had an abnormal finding on rotatory chair test, whereas 81.5% of the canal paresis group. Minimal canal paresis group patients showed higher sensory organization test scores in computerized dynamic posturography.**Conclusion:** Patients with minimal canal paresis (< 25%) show similar clinical manifestations with conventional vestibular neuritis but faster recovery of symptoms and higher incidence of recovery nystagmus.

## OP16-5

Vestibular Neuritis

**FREQUENCY AND POSITION CHARACTERISTICS OF THE VESTIBULAR DYSFUNCTION IN VESTIBULAR NEURITIS PATIENTS**Yafeng LV<sup>1</sup>, Daogong ZHANG<sup>1</sup>, Zhaomin FAN<sup>1</sup>, Yawei LI<sup>1</sup>, Jiliang XU<sup>1</sup>, Xianfeng LIU<sup>1</sup>, Yuanling LI<sup>1</sup>, Haibo WANG<sup>1</sup><sup>1</sup>*Department of Otolaryngology Head And Neck Surgery, Provincial Hospital Affiliated To Shandong University, jinan, China***Objective:** To investigate frequency and position characteristics of the vestibular dysfunction in vestibular neuritis patients.**Method:** Caloric test (CT), head impulse test(HIT),cervical vestibular evoked myogenic potential (cVEMP) and ocular vestibular evoked myogenic potential (oVEMP) were applied in 43 vestibular neuritis patients to assess their vestibular dysfunction. Superior vestibular nerve (S-VN), inferior vestibular nerve (I-VN) and each vestibular end organ incidence rate were calculated and statistically analyzed.**Result:** CT incidence rate (93.0%) was statistically higher than that of HIT (72.1%) ( $P < 0.01$ ). Total frequency incidence rate (72.1%) was statistically higher than that of low frequency (20.9%) ( $P < 0.01$ ). No high frequency only case was observed. The incidence rate of S-VN only, I-VN only and T-VN was 44.2%, 4.7% and 51.2% respectively. Among them, the incidence rate of I-VN was significantly lower than the others ( $P < 0.01$ ). the incidence rate of vestibular end organs was 17.4% (S-SCC), 44.2% (H-SCC), 20.9% (P-SCC), 39.5% (utricle) and 26.7% (saccule) respectively. The incidence rate of H-SCC was remarkably higher than the other semicircular canals ( $P < 0.01$ ). The difference between utricle and saccule was not statistically significant.**Conclusion:** The semicircular canal dysfunction in vestibular neuritis patients mainly involves total frequency of vestibular function, low frequency is more common than high frequency. Total vestibular nerve and single S-VN are mostly involved in vestibular neuritis.

## OP16-6

Vestibular Neuritis

**THE CLINICAL SIGNIFICANCE OF ARTERIAL STIFFNESS AND CARDIOVASCULAR RISK FACTORS IN VESTIBULAR NEURITIS.**Jae Ho CHUNG<sup>1</sup>, Han Seok YOO<sup>1</sup>, Seung Hwan LEE<sup>1</sup>, Chul Won PARK<sup>1</sup>, Jeong Hun SHIN<sup>2</sup><sup>1</sup>*Department of Otolaryngology-head And Neck Surgery, School of Medicine, Hanyang University, Korea*<sup>2</sup>*Department of Internal Medicine, Cardiology, School of Medicine, Hanyang University, Korea***Objectives:** To investigate the clinical significance of cardiovascular factors, including arterial stiffness and metabolic syndrome score in the development of vestibular neuritis.**Study design:** A prospective, case-control study.**Methods:** Forty-five adult patients with vestibular neuritis and 45 age- and sex-matched controls were evaluated between January 2015 and January 2016. Arterial stiffness was assessed from brachial-ankle pulse wave velocity (baPWV), and other cardiovascular markers including metabolic syndrome scores, blood pressure, body mass index, and lipid profiles were determined. Patients completed the dizziness handicap inventory (DHI) and underwent vestibular function tests such as caloric test and video head impulse test. The correlation between cardiovascular factors and clinical parameters had been assessed.**Results:** BaPWV, metabolic syndrome scores and blood pressure were higher in the vestibular neuritis group than in the control group ( $p = 0.002$ ,  $p = 0.001$ ,  $p = 0.001$ ), whereas comorbidity, anthropometric characteristics, and lipid profiles did not show the significant difference. In addition, baPWV or metabolic syndrome score were not correlated with clinical parameters including DHI scores, canal paresis and spontaneous nystagmus duration.**Conclusions:** Higher baPWV, representative of arterial stiffness and higher metabolic syndrome score were associated with the development of vestibular neuritis, which explains the hypothesis of a vascular etiology of this disease. However, cardiovascular risk factors had limited value in predicting the clinical course of vestibular neuritis.

## OP17-1

Anatomy and Physiology

**SINGLE MOTOR UNIT RECORDINGS REVEAL VESTIBULAR PROJECTIONS TO THE SPLENIUS CAPITIS NECK MUSCLES IN HUMANS****Sally M ROSENGREN<sup>1,3</sup>, Konrad P WEBER<sup>4</sup>, Danielle L DENNIS<sup>5</sup>, Sendhil GOVENDER<sup>5</sup>, Miriam S WELGAMPOLA<sup>2,3</sup>, James G COLEBATCH<sup>5</sup>**<sup>1</sup>*Department of Neurology, Royal Prince Alfred Hospital, Australia*<sup>2</sup>*Department of Institute of Clinical Neurosciences, Royal Prince Alfred Hospital, Australia*<sup>3</sup>*Department of Central Clinical School, University of Sydney, Australia*<sup>4</sup>*Department of Ophthalmology And Neurology, University Hospital Zurich, Switzerland*<sup>5</sup>*Department of Prince of Wales Clinical School And Neuroscience Research Australia, University of New South Wales, Australia*

The vestibulo-collic reflex (VCR) in humans is well-defined for only the sternocleidomastoid (SCM) neck muscle. However, other neck muscles also receive input from the balance organs and participate in neck stabilization. We therefore investigated the sound-evoked VCR projection to the splenius capititis (SC) muscles using 2 ms, 500 Hz tone bursts. We compared surface and single motor unit responses in the SCM and SC muscles in 10 normal volunteers. The strongest responses were recorded in the ipsilateral SCM and contralateral SC. In both cases there was a significant decrease or gap in single motor unit activity: in SCM at approximately 13 ms for 36/41 motor units, and in SC at 14 ms for 40/61 units. There were very few significant responses in the contralateral SCM and ipsilateral SC muscles, and they tended to be increases in activity. Surface responses in ipsilateral SCM consistently showed a biphasic positive-negative wave, while there were occasional/smaller negative-positive responses on the contralateral side. Surface responses over the ipsilateral SC were inconsistent, while those over the contralateral SC were positive-negative during neck rotation and negative-positive during neck extension. An initial decrease in single motor unit activity suggests an inhibitory projection, while an increase indicates an excitatory projection. The results thus confirm an uncrossed inhibitory vestibular projection to the ipsilateral SCM and reveal a crossed inhibitory projection to the contralateral SC (with a weak excitatory projection to the complementary muscle pair). This pattern is consistent with the agonist relationship between these muscles.

## OP17-2

Anatomy and Physiology

**DISTRIBUTION OF ION CHANNELS AND TRANSPORTER PROTEINS IN THE LATERAL WALL OF THE HUMAN COCHLEA****Wei LIU<sup>1</sup>, Fredrik EDIN<sup>1</sup>, Göran LAURELL<sup>1</sup>, Hao LI<sup>1</sup>, Helge RASK-ANDERSEN<sup>1</sup>, Annelies SCHROTT-FISCHER<sup>2</sup>, Rudolf GLUECKERT<sup>2</sup>**<sup>1</sup>*Department of Department of Surgical Sciences, Section of Otolaryngology, Uppsala University Hospital, Sweden*<sup>2</sup>*Department of Department of Otolaryngology, Medical University of Innsbruck, Austria*

**Introduction:** Stria vascularis (SV) as well as other inner ear tissue components are rich in ion and water channel/transporter proteins. In the SV they are essential for maintaining the chemical composition of cochlear endolymph and endo-cochlear potential (EP) critical for hair cell function and hearing.

**Material and methods:** By using immunohistochemistry combined with confocal and super-resolution microscopy (SR-SIM), we analyzed directly fixed human cochleae for proteins related to transportation of ions (ion transporters and ion channels) such as Kir4.1 (KCNJ10) and voltage-gated potassium channel proteins Kv7.1 (KCNQ1/KCNE1) in SV. Furthermore, we examined the expression of connexin 30/26 (Cx30/Cx26), ion transporters NKCC1 and Na<sup>+</sup>-K<sup>+</sup>-ATPase. Water channel proteins aquaporin2/4/5 and tight junction protein claudin and occluding 11 in human cochlea were also investigated.

**Results and conclusions:** The human SV was marginated apically and basally by marginal cells and basal cells bound by tight junction (TJ) rich in protein occludin and claudin 11. TJs also constitute an integral part of the blood-labyrinth barrier. The K<sup>+</sup> channel Kir 4.1 (encoded by KCNJ10) was expressed both in the intermediate and basal cells; in the latter, Kir 4.1 associated with Cx26 and Cx30. NKCC1 (Na<sup>+</sup>/K<sup>+</sup>/2Cl<sup>-</sup> co-transporter) was found

in the marginal cells and co-localized with Na<sup>+</sup>-K<sup>+</sup>-ATPase. The KCNQ1 gene, which encodes the voltage-gated potassium channel Kv7.1 (KvLQT1) was expressed in the apical cell membrane of the marginal cells. The observed highly organized channels/transporters in human SV explains where ion-recycling will be hindered in certain protein mutation.

**Correspondence to:** Wei Liu, lwoo24@gmail.com; Helge Rask-Andersen, helge.rask-andersen@akademiska.se

#### OP17-3

Anatomy and Physiology

#### EFFERENT VESTIBULAR NEURONS SHOW HOMOGENOUS DISCHARGE BUT HETEROGENEOUS SYNAPTIC INPUTS FROM MULTIPLE SOURCES

Miranda A MATHEWS<sup>1</sup>, Andrew MURRAY<sup>2</sup>, Rajiv WIJESINGHE<sup>1</sup>, Karen CULLEN<sup>3</sup>, Victoria W K TUNG<sup>1</sup>, Aaron J CAMP<sup>1</sup>

<sup>1</sup>Department of Biomedical Science, Bosch Institute, The University of Sydney, Australia

<sup>2</sup>Department of Biochemistry And Molecular Biophysics, Howard Hughes Medical Institute, Columbia University, USA

<sup>3</sup>Department of Anatomy And Histology, Bosch Institute, The University of Sydney, Australia

While previous work has shown that activation of the efferent vestibular system results in modulation of afferent vestibular neuron discharge, the intrinsic and synaptic properties of efferent neurons themselves are largely unknown.

**Purpose:** Here we substantiate the location of the efferent vestibular nucleus (EVN) in the mouse, before characterizing the input and output properties of EVN neurons *in vitro*.

**Methods:** We made transverse serial sections through the brainstem of 4-week-old mice, and performed immunohistochemistry for calcitonin gene-related peptide (CGRP) and choline acetyltransferase (ChAT). We then made whole-cell current-, and voltage-clamp recordings from visually identified EVN neurons. Finally we introduce a method for mapping direct monosynaptic inputs onto vestibular efferent neurons, by injecting RABVΔG into peripheral vestibular end organs of ChAT-Cre mice expressing rabies G and GFP in the EVN.

**Results:** As expected the EVN lies dorsolateral to the genu of the facial nerve (CNVII). In current-clamp, EVN neurons display a homogeneous discharge pattern characterized by a burst of action potentials at the onset of a depolarizing stimulus and the offset of a hyperpolarizing stimulus. In voltage-clamp, EVN neurons receive either exclusively excitatory or inhibitory inputs, or a combination of both. We show that synaptic inputs onto EVN neurons are predominantly excitatory, and that direct monosynaptic inputs come from a variety of sources including the medial vestibular nucleus, cerebellar purkinje cells, and neurons of the reticular formation.

**Conclusion:** These findings suggest that the inputs onto EVN neurons, and more specifically the origin of these inputs may underlie EVN neuron function.

#### OP17-4

Anatomy and Physiology

#### PREDICTING THE FACIAL NERVE RECOVERY IN HERPES ZOSTER OTICUS

Yun-Chen HUANG<sup>2</sup>, Yi-Ho YOUNG<sup>1</sup>

<sup>1</sup>Department of Otolaryngology, National Taiwan University Hospital, Taiwan

<sup>2</sup>Department of Otolaryngology, Catholic Cardinal Tien Hospital, Fu-jen Catholic University, Taiwan

**Objective:** This study adopted a test battery of cranial nerves (CNs) VII and VIII comprising a facial nerve function test, audiometry, a caloric test, and ocular and cervical vestibular evoked myogenic potential (oVEMP and cVEMP, respectively) tests to assess the function of CNs VII and VIII comprehensively so as to predict facial nerve recovery in patients with herpes zoster oticus (HZO).

**Methods:** A total of 20 patients with HZO underwent a test battery of CNs VII and VIII. Registering the unaffected nerve bundles in the internal auditory canal was based on the number of normal results in the test battery of CNs VII and VIII. Fair facial nerve recovery is defined as the improvement of facial paresis to facial nerve grades I to II/VI.

**Results:** In 20 patients with HZO, 6, 7, 3, and 4 patients had 0, 1, 2, and 3 unaffected nerve bundles, respectively. A significantly positive correlation was identified between the number of unaffected nerve bundles and fair facial

nerve recovery. Similarly, a statistically significant predictor of fair facial nerve recovery was noted for unaffected nerve bundles (odds ratio, 15.42) but not for grading of the facial nerve (odds ratio, 0.49).

**Conclusion:** Grading of the facial nerve alone fails to predict the outcome of facial paresis in patients with HZO mainly because it overlooks the involvement of CN VIII. Alternatively, a combined test battery of CNs VII and VIII may serve as a strong predictor for facial nerve recovery.

#### OP17-5

Anatomy and Physiology

#### WHY DOES DISTRACTION SEEM TO HELP REDUCE THE SYMPTOMS OF MOTION SICKNESS?

**Philippe PERRIN**<sup>1,2</sup>, Art I. MALLINSON<sup>3,4</sup>, Gilles BOSSER<sup>5</sup>, Gaëlle QUARCK<sup>6</sup>, Neil S. LONGRIDGE<sup>3,4</sup>, Pierre DENISE<sup>6</sup>

<sup>1</sup>Laboratory Development, Adaptation And Disadvantage, University of Lorraine, France

<sup>2</sup>Department of Pediatric Otolaryngology, University Hospital of Nancy, France

<sup>3</sup>Department of Neuro-otology, Vancouver General Hospital, Canada

<sup>4</sup>Department of Surgery, University of British Columbia, Canada

<sup>5</sup>Department of Pediatric Cardiology, University Hospital of Nancy, France

<sup>6</sup>Laboratory Comete, Inserm & Normandie University, France

Motion sickness (MS) is a poorly understood set of symptoms that affects children, ocean seamen, rally car drivers and fishermen. Some people are extremely susceptible to this symptom set, and some people are not bothered at all. MS needs an intact vestibular system and newly developed symptoms suggest an otolithic contribution.

Theories for MS have long been based on “sensory conflict”. Reading a book or an electronic reader in a car will increase the conflict and invoke the related symptoms of MS. However some recent investigations have revealed that engaging in interactive video games in a car can serve to reduce MS symptoms. An international collaboration is investigating this, as there are a number of factors which may be affecting symptoms. A questionnaire has been developed and given to children to ask them about their habits in the car. Questions asked will include the type and size of vehicle, area of the windows, activities in the car, use of electronic or interactive games, and where the device is held and/or mounted in the car. Questions will also be asked about travel (types of road, duration of trip, time of day) and about many other factors already known to influence MS (age, sex, physical activities).

This is to be a long term study carried out in Europe and North America and we will be reporting the first phase of our findings, in an attempt to understand this set of symptoms arising from the balance system.

#### OP17-6

Anatomy and Physiology

#### CAN HORIZONTAL SEMICIRCULAR CANAL BPPV BE USED AS A PHYSIOLOGICAL STIMULUS EFFECT MODEL?

**Taisheng CHEN**<sup>1</sup>, Honghua LU<sup>1</sup>, Xi HAN<sup>1</sup>, Wei WANG<sup>1</sup>, Taisheng CHEN<sup>1</sup>, Peng LIN<sup>1</sup>, Shanshan LI<sup>1</sup>, Chao WEN<sup>1</sup>, Qiang LIU<sup>1</sup>

<sup>1</sup>Department of Otolaryngology Head And Neck Surgery, Tianjin First Central Hospital, China

**Objective:** To evaluate the objective characteristics, mechanism, and clinical usage of direction, magnitude, and latency of the nystagmus induced in subjects with HSC-Can BPPV.

**Methods:** In Supine Roll test, the induced nystagmus of 72 HSC-Can subjects and 35 healthy volunteers is recorded using a 2-dimentional video nystagmography (2-D VNG).

**Results:** In Supine Roll test on HSC-Can subjects, horizontal nystagmus at turned position and in-turning are both induced. The direction of the induced nystagmus is same as the head turning. Before or after HSC-Can subjects successful canalith repositioning maneuvers, the magnitude of nystagmus in head turning showed no significant difference whether to the lesion side or normal side. But after the head turn to the lesion side, the nystagmus intensity was significantly higher than turn to the normal side. The ratio (to the lesion side vs. normal side) is approximately 2.5:1. We also observed that the induced nystagmus intensity of normal turned position is weaker than in turning process. Lesion turned nystagmus intensity is higher than turning nystagmus. In health group, there

is no statistically significant differences in induced nystagmus intensity when turning to right or left side. But these nystagmus intensity are differences with HSC-Can group in turning process.

**Conclusions:** There is a novel found in benign paroxysmal positional vertigo subjects patients with horizontal semicircular canalithiasis. The direction and magnitude of induced nystagmus follows Ewald's laws just like physiological nystagmus induced through horizontal semicircular canal. The nystagmus induced by Supine Roll test reflects physiological characteristics of nystagmus induced by stimulation on horizontal semicircular canal.

#### OP18-1

Clinical Tests for Vestibular Function II

#### CAPTURING VERTIGO IN THE EMERGENCY ROOM

**Nicole REID**<sup>1</sup>, Druvinka BANDARANAYAKE<sup>1</sup>, Andrew P BRADSHAW<sup>1</sup>, Kendall BEIN<sup>2</sup>, Jon HAYMAN<sup>2</sup>, Miriam S WELGAMPOLA<sup>1</sup>

<sup>1</sup>Department of Neurology, Royal Prince Alfred Hospital, Australia

<sup>2</sup>Department of Emergency Medicine, Royal Prince Alfred Hospital, Australia

**Background:** Acute vestibular-vertigo is associated with spontaneous or positional-nystagmus that could be of diagnostic value.

**Aim:** To record ictal video-nystagmography within the emergency-room.

**Method:** 60 patients with acute vertigo were administered a 6-point questionnaire and underwent monocular video-oculography in the emergency-room by emergency physicians. Spontaneous and positional-nystagmus were recorded.

**Results:** Fifteen subjects presented with acute vestibular syndrome. Thirteen subjects diagnosed with vestibular neuritis had spontaneous horizontal unidirectional-nystagmus which suppressed with visual fixation (average nystagmus Slow-Phase Velocity (SPV) 15.1 deg/s) and a positive bedside head-impulse. One subject who had no spontaneous-nystagmus and horizontal positional-nystagmus was found to have a cerebellar stroke. One was diagnosed with Vestibular Migraine.

Forty-two subjects reported spontaneous-vertigo lasting minutes ( $n = 22$ ) or hours ( $n = 15$ ) while eight reported exclusively positional-vertigo lasting seconds. Five had lightheadedness. Eleven subjects were diagnosed with clinically probable Vestibular Migraine; all had persistent positional-nystagmus, while six had additional spontaneous-horizontal ( $n = 3$ ) or vertical-downbeat ( $n = 3$ ) nystagmus. One subject had violent spontaneous-horizontal irritative-nystagmus (SPV 84.5 d/s) and was diagnosed with clinically probable Menieres Disease, based upon fluctuating hearing and vertigo lasting hours.

Twenty-two patients were diagnosed with BPV. Twelve were diagnosed in the emergency-room. They had no spontaneous-nystagmus but paroxysmal upbeat torsional-nystagmus ( $n = 8$ ), horizontal geotropic-nystagmus ( $n = 2$ ) or horizontal apogeotropic-nystagmus ( $n = 1$ ) on positional testing (peak SPV 12.9–346 deg/s). Ten were subsequently diagnosed with BPV in the neuro-otology clinic.

Sixty percent of all patients received a diagnosis in the emergency-room.

**Summary:** Ictal Video Nystagmography is feasible within the emergency-room and could facilitate early diagnosis and treatment of vestibular disorders.

#### OP18-2

Clinical Tests for Vestibular Function II

#### RELATING VESTIBULAR NEURAL RESPONSES BEFORE AND AFTER SEMICIRCULAR CANAL DEHISCENCE TO HUMAN PATIENT RESPONSES

**Julia DLUGAICZYK**<sup>1</sup>, Ann M BURGESS<sup>2</sup>, Samanthi GOONETILEKE<sup>2</sup>, Ljiljana SOKOLIC<sup>2</sup>, Leonardo MANZARI<sup>3</sup>, Ian S CURTHOYS<sup>2</sup>

<sup>1</sup>Department of Otorhinolaryngology, Saarland University Medical Center, Homburg/Saar, Germany

<sup>2</sup>Department of Psychology, Vestibular Research Lab, The University of Sydney, Australia

<sup>3</sup>Department of Neurotology, Msa Ent Academy Center, Cassino, Italy

Patients with superior canal dehiscence (SCD) display sound- and vibration-induced nystagmus, increased VEMP amplitudes and reduced VEMP thresholds. The aim of the present study was to correlate these clinical findings to neural data recorded from a guinea pig model of SCD.

A small opening (0.1 mm) in the bony anterior canal (AC) of an anesthetized guinea pig was created while recording from the same primary vestibular neuron before and during SCD.

Irregular AC neurons not responding to sound and vibration before SCD showed a strong reaction afterwards. Basically, two response patterns were observed: 1.) quick on- and offset with phase-locking to individual stimulus cycles, 2.) a tonic response with delayed on- and offset. Some neurons showed a combination of both. Similar patterns were found for sound- and vibration-induced nystagmus in SCD patients. We suggest that the first response is caused by a direct deflection of hair cell stereocilia during endolymph flow in the AC, whereas the second response is due to cupula deflection. The dynamics of the nystagmus response at stimulus on- and offset are likely to reflect the underlying receptor mechanism.

Furthermore, otolithic neurons displayed a lower threshold to sound and vibration after opening the AC in the guinea pig, which explains the reduced VEMP thresholds in SCD patients.

Finally, it has to be considered that the AC neurons activated by sound and vibration project to the contralateral inferior oblique and ipsilateral sternocleidomastoid muscles, which would account for the enhanced contralateral oVEMP and ipsilateral cVEMP amplitudes in SCD.

#### OP18-3

#### Clinical Tests for Vestibular Function II

#### A CLOSER LOOK AT SUBJECTIVE CALORIC SENSATIONS: IS THERE MORE TO VERTIGO THAN SPINNING?

Tamara MIJOVIC<sup>1</sup>, Andrew REMILLARD<sup>2</sup>, Jolene HARRINGTON<sup>3</sup>, Yvette REID<sup>3</sup>, Erica ZAIA<sup>3</sup>, Jane LEA<sup>2</sup>

<sup>1</sup>Department of Otolaryngology Head And Neck Surgery, McGill University, Canada

<sup>2</sup>Department of Surgery – Division of Otolaryngology Head And Neck Surgery, University of British Columbia, Canada

<sup>3</sup>Department of Audiology, University of British Columbia, Canada

**Background:** There is a prevailing opinion among physicians that a spinning sensation is the hallmark of peripheral vestibular pathology. Patients that report non-spinning type vertigo are often dismissed and inappropriately deemed to be non-vestibular in etiology.

**Objectives:** 1) To characterize the range of subjective sensations reported by patients during caloric vestibular stimulation. 2) To assess if the sensation can be correlated with the peak slow phase velocity (SPV).

**Methods:** Consecutive patients undergoing caloric testing were asked to subjectively report sensations experienced with each caloric irrigation. The reported sensations were grouped into categories and their prevalence assessed. The peak SPV associated with each irrigation was recorded. The mean SPV across sensation categories were compared using the Student t test.

**Results:** A total of 167 patients were included, 122 had normal calorics and 45 demonstrated unilateral weakness. Spinning/rotatory movements were the most common sensations reported. No sensation was reported among 10–20% of patients. Non-rotatory sensations (floating/falling, repetitive opposing movements, linear motions and vague spatial disorientation) were reported 20–25% of the time. Both lack of sensation and non-rotatory sensations were more likely to be correlated with SPVs that were significantly lower than those associated with spinning/rotating sensations.

**Conclusions:** During caloric irrigation, subjective sensations other than spinning and rotating are reported 20–25% of the time and these are usually associated with significantly lower peak SPV. Non-spinning vertigo is not uncommon as a subjective description of vestibular pathology.

## OP18-4

Clinical Tests for Vestibular Function II

**THE CLINICAL VALUE OF VESTIBULAR AUTOROTATION TEST IN THE DIAGNOSIS OF OTOGENIC VERTIGO**Aiping YANG<sup>1</sup>, Daogong ZHANG<sup>2</sup>, Yafeng LV<sup>2</sup>, Yawei LI<sup>2</sup>, Jiliang XU<sup>2</sup>, Xianfeng LIU<sup>2</sup>, Yuanling LI<sup>2</sup>, **Zhaomin FAN<sup>2</sup>**<sup>1</sup>*Department of Otolaryngology Head And Neck Surgery, The Third Hospital of Jinan, shandong, China*<sup>2</sup>*Department of Otolaryngology Head And Neck Surgery, Provincial Hospital Affiliated To Shandong University, jinan, China*

**Objective:** To explore the clinical value of vestibular autorotation test(VAT) in the treatment for otogenic vertigo patients. Method: 129 definite otogenic vertigo patients were included. All patients underwent the VAT and calorific test(CT). The results were analyzed statistically.

**Result:** In VAT examination, 89 (69.0%) cases were abnormal. In CT examination, 56(43.4%)cases were abnormal. In the contrast test of VAT and CT, VAT results were abnormal in 47(36.4%) patients and CT results were abnormal in 14(10.9%) patients. The number of patients whose both VAT and CT results were abnormal was 42(32.6%). The total number of patients with various abnormal results was 103(79.8%). According to statistical analysis, the abnormal result rate of VAT was higher than that of CT. The abnormal result rate of both VAT and CT was higher than that of each single test. There was statistical significance in the difference ( $\chi^2 = 1.670, p < 0.05$ ).

**Conclusion:** for otogenic vertigo patients, their abnormal result rate of VAT is higher than that of CT. VAT and CT can be mutually complementary. The combination of VAT and CT can help to understand the function of semicircular canal in the general and provide reference for the treatment for otogenic vertigo diseases.

## OP18-5

Clinical Tests for Vestibular Function II

**EVALUATION OF GRAVITY PERCEPTION USING LISTING'S PLANE ANALYSIS.****Takeshi TSUTSUMI<sup>1</sup>, Takamori TAKEDA<sup>1</sup>, Takuo IKEDA<sup>2</sup>, Yutaka FUKUOKA<sup>3</sup>**<sup>1</sup>*Department of Otorhinolaryngology, Tokyo Medical And Dental University, Japan*<sup>2</sup>*Department of Otorhinolaryngology, Tsudumigaura Medical Center For Children With Disabilities, Japan*<sup>3</sup>*Department of Engineering, Kogakuin University, Japan*

3-dimensional eye position of human being is restricted to be located on one's Listing's plane, when it is expressed by rotation vector method. This plane is peculiar to each personal, and is moved according to gravity direction. It means the plane can be a parameter representing otolithic function, as well as central integration and modification of gravity perception. Recently, we have made up and been modifying an algorithm to describe one's Listing's plane from video recordings of eye position using infrared CCD-mounted goggle, low-priced commercial products of clinical use. Healthy subjects and vestibular patients have been tested to describe one's Listing's plane during 9 point gaze paradigm. In vestibular schwannoma patients, affected-side-down head position was revealed to degrade the accuracy of Listing's plane. In addition, certain case with cerebellar deficit was found to exhibit thickened plane, which has been thinning along with improvement of cerebellar ataxia. On the other hand, pseudo-inclination, delivered by optokinetic stimulation, was also found to worsen the accuracy of Listing's plane. Precise measurement of Listing's plane may open up a path to a spread of handy evaluation of gravity perception.

## OP18-6

Clinical Tests for Vestibular Function II

**CLINICAL SIGNIFICANCE OF MILD-FREQUENCY ROTATIONAL CHAIR TEST RESULT IN VESTIBULAR NEURITIS PATIENTS****Jeonghui JOO<sup>1</sup>, Mi Joo KIM<sup>2</sup>, Nam Beom KIM<sup>3</sup>, Gyu Cheol HAN<sup>1</sup>**<sup>1</sup>*Department of Otolaryngology-head And Neck Surgery, Gachon University of Medicine And Science, Graduate School of Medicine, Korea*<sup>2</sup>*Department of Otorhinolaryngology, Catholic Kwandong University International St. Mary's Hospital, Korea*<sup>3</sup>*Department of Neuroscience Research Institute, Gachon University, Graduate School of Medicine, Korea*

**Introduction:** The stimulation range of traditional rotation chair test (0.01–0.064 Hz) is in the linear response range like as caloric test. Recent rotation chair test method extended the mechanical limitation up to the mid-frequency range (1.28–1.75 Hz). This rotation stimulation is a non-linear response section. Thus, the authors have looked characteristic of the mid-frequency rotational chair.

**Method:** Only 12 patients completed the DHI, caloric test (CP, %), posturography, and the full range-frequency rotational chair test among 45 acute vestibular neuritis diagnosed patients, who visited the emergency from September 2014 to February 2015. Correlation efficiency in 12 patients' ( $\sigma^2: \varphi = 4:8$ ,  $56.2 \pm 15.2$  yo) tests was analyzed.

**Result:** The correlation coefficient between the CPs and DHI was  $r^2 = 0.0642$ ; between CP and step velocity time constant (CW, sec) was  $r^2 = 0.4444$ ; between the gain of rotational 0.02, 0.08, 0.32, 1.28 Hz stimulus and step velocity time constant (CW, sec) was  $r^2 = 0.1893$ ; between 1.29 Hz of rotational chair test and CP (%) was  $r^2 = 0.3005$ . Thus  $r^2 = 0.3005$  showed higher negative correlation than  $r^2 = 0.0352, 0.216, 0.1197$ , which is the coefficient between 0.02–0.32 Hz of rotational chair test and CP (%).

**Conclusion:** Evaluation of a traditional low-frequency stimulation on vestibular function is not fully reflected the degree of patient's subjective symptom; however, assessment of caloric stimulation is fitted well with the time constant of the unilateral step velocity rotation chair. 1.28Hz rotational stimulus corresponding to mid-frequency is shown possibility as an ancillary test for classifying the clinical symptoms because 1.28 Hz showed a negative correlation to the caloric, unlike the other low-frequency stimulus.

#### OP19-1

Gait, Posture, and Spatial Orientation I

#### STATIC POSTUROGRAPHY: RESULTS WITH DIZZINESS PATIENTS

**Bernard COHEN**

*Department of Ent, Saint-antoine Hospital, Paris, France*

The purpose of this study was to identify the relevant descriptors among dizzy patients for quantification of instability and its evolution.

**Methods:** We used a twin platforms and studied the statokinesigram eyes open and eyes closed (E.O /E.C), with several descriptors:

- surface (S) of the confidence ellipse containing 90% of statokinesigram points, which reflects the oscillation amplitudes,
- the length as a function of the surface (LFS),
- the Romberg's quotient (100\*S (E.C/S(E.O)),
- the distributions of forces on the four supports (Total Balance),
- variance of the velocity (VV) which reflects the stiffness of the ankle,

We included 50 patients and 20 healthy subjects (HS).

We compared the results in stable patients, unstable and HS, and according to the etiologies and finally after vestibular réhabilitation

**Results:** The mean age was  $54 \pm 20$  and the sex ratio of 52%/48%.

The most common etiologies were neuritis (28%), isolated instability (22%) recurrent vertigo (12%).

Several parameters were relevant to define unstable patients: LFS (EC) (46% of unstable patients were above normal against 8% for the stable patients), LFS (EO) (35% against 8%), and velocity variance EO/EC (31% against 8%).

These parameters were disrupted in all disease groups except Meniere disease, recurrent vertigo, and space discomfort.

Reversing of the Romberg ratio (23%) helped to reorient the investigations to the study of vision and corrective lenses.

**Conclusion:** Static posturography remains a good tool to assess instability and compensation of dizziness patients. It can also detect extravestibular problems as a poor vision correction.

## OP19-2

Gait, Posture, and Spatial Orientation I

**IS THE TUNING FORK TEST REALLY USEFUL WHEN ASSESSING SOMATOSENSATION IN ELDERLY?****Anna HAFSTROM**<sup>1</sup>, Eva-Maj MÅLSTRÖM<sup>1</sup>, Måns MAGNUSSON<sup>1</sup><sup>1</sup>*Department of Otorhinolaryngology, Head And Neck Surgery, Clinical Sciences, Lund University,, Sweden*

**Background:** Diminished somatosensation in the feet contribute to balance deficits and increased risk of falls in the elderly. Somatosensation is usually tested with tuning forks, but since the efficacy is unclear, have we interpreted the importance of somatosensation in our patients correctly?

**Methods:** Three different somatosensory tests were compared and related to balance performance in 34 relatively healthy elderly subjects (mean 69.4 years). Tactile pressure sensation thresholds (TPSTs) were determined using Semmes – Weinstein monofilaments. Vibration sensation was assessed with a tuning fork and vibration perception thresholds (VPTs) with biothesiometry. Balance performance was assessed with one-leg standing time (OLST) and posturography; on firm and compliant surfaces with either eyes open (EO) or eyes closed (EC). Other tests included walking speed, Timed Up & Go (TUG), Step Stool, and Berg Balance Scale (BBS).

**Results:** 65% of the subjects could not discriminate between tuning fork vibration and pressure sensation on either foot at MTP-I or malleolus. They had higher VPTs at the left MTP-I and MTP-V than the other subjects ( $p \leq 0.031$ ). These two groups did not differ in age, BBS, OLST and sway during posturography tests, nor in speed walking, performing the TUG and Step Stool tests. Higher VPTs and TPSTs were associated with lower BBS scores ( $p = 0.012$ ), shorter ipsilateral OLST with EO and heavier weight of the subjects ( $p \leq 0.033$ ), but not with more sway during posturography tests nor with age ( $p = \text{NS}$ ).

**Discussion:** Testing vibration perception in relatively healthy elderly with a tuning fork might be superfluous. More meticulous testing is probably required.

## OP19-3

Gait, Posture, and Spatial Orientation I

**CONTROL OF SELF-MOTION AND SICKNESS****Jelte BOS**<sup>1,2</sup><sup>1</sup>*Department of Perceptual And Cognitive Systems, Tno, Netherlands*<sup>2</sup>*Department of Behavioural And Movement Sciences, Vrije Universiteit Amsterdam, Netherlands*

Motion sickness can be considered a means to optimise the control of self-motion. In that sense it can be assumed that, e.g., postural instability (PI) as a measure of self-motion and motion sickness (MS) are related. So far, however, both positive and negative correlations between PI and MS have been observed, and an explanation is still lacking. A theoretical control-mechanism explicitly relating and explaining body motion as the main control variable, and sickness as an error signal, includes an internal model or “neural store” making a prediction of self-motion, the internal model itself being updated continuously based on the error between the predicted and actually sensed self-motion. This assumption implies that the state of the internal model can be optimal for one condition with, e.g., congruent visual and vestibular cues, but not in others with, e.g., incongruent visual and vestibular cues, or in case of patients suffering from vertigo with a central cause. As a consequence, the internal model may adapt to deal with the incongruent cues such that the mentioned error and hence the resulting sickness is minimized. The resulting habituation has indeed been observed. With this habituation in terms of sickness, however, an increased PI is predicted in addition, which has been observed too. The framework therefore is capable of explaining not only a positive, but also a negative correlation between PI and MS, which explanation has been lacking so far.

## OP19-4

Gait, Posture, and Spatial Orientation I

**3D ASSESSING THE STABILITY OF HUMAN LOCOMOTION: A STUDY IN YOUNG, MIDDLE-AGED AND ELDERLY SUBJECTS**QiuHong HUANG<sup>1</sup>, Peng LIU<sup>1</sup>, Yiqing ZHENG<sup>1</sup>, Yongkang OU<sup>1</sup>, Ling CHEN<sup>1</sup><sup>1</sup>*Department of Otolaryngology, Sun Yat-sen Memorial Hospital, Sun Yat-sen University, China*

**Objective:** To investigate the patterns of gait and locomotion in three dimension space in 30 people aged 20–70 years.

**Method:** A 3D OptiTrack motion system was applied in young, middle-aged and elderly to capture the gait and the rhythmic oscillations of the trunk, head, hip and knee when subjects walked on the treadmill under different condition. Several markers were placed on the subject. For each locomotor trial, the preferred walking speed, stride width, stride time, the absolute angular dispersions and stander deviation of four segments around the roll, pitch and yaw axes, and gait instability ( $\lambda$ ) were calculated to assess the equilibrium strategies of head, trunk, pelvis and knee.

**Result:** With increasing age there were decreases in preferring walking speed ( $F = 3.23, p < 0.05$ ) and increases in stride width ( $F = 3.87, p < 0.05$ ). The absolute angle of the segment of trunk in roll axis significantly increased, while the sway oscillation of head in roll axis and trunk in pitch decreased. Standard deviation of movement of knee joint increased. Using mediolateral- $\lambda$  to predict the gait stability, the results showed that significant increased in  $\lambda$  value by our small circle, which was positively correlated with age ( $r = 0.523; p < 0.001$ ), and  $\lambda$  value increased under visual and proprioception interruption in all age groups, however, the change of ML- $\lambda$  value was smaller in elderly than in young.

**Conclusion:** Gait instability begins to increase as early as age 40–50. This finding supports that local dynamic stability is likely to be an indicator of falling risk.

## OP19-5

Gait, Posture, and Spatial Orientation I

**THE INFLUENCE OF LONG-TERM 4G HYPERGRAVITY IN VESTIBULAR SYSTEM**Mi Joo KIM<sup>1</sup>, Yu Jin MIN<sup>1</sup>, Nam Beom KIM<sup>2</sup>, Gyu Cheol HAN<sup>3</sup><sup>1</sup>*Department of Otorhinolaryngology, Catholic Kwandong University International St. Mary's Hospital, Korea*<sup>2</sup>*Department of Neuroscience Research Institute, Gachon University, Graduate School of Medicine, Korea*<sup>3</sup>*Department of Otolaryngology-head And Neck Surgery, Gachon University of Medicine And Science, Graduate School of Medicine, Korea*

**Introduction:** The fact that benign paroxysmal positional vertigo is caused by otolithic organ and it is an undeniable fact. Otolithic organ is developed during embryonic stage and has lifetime maintenance. However, there have been insufficient further studies on how the stable otoconia is liberated and causing BPPV. Therefore, using hypergravity to arouse the modification of otoconia on small experiment animals has been considered. However, due to the technical confinements the maximum achievable hypergravity was 2.5 G. Thus, we set priority on researching the hypergravity (> 2.5 G) influence on semicircular canal.

**Method:** We observed the ICR mouse ( $n = 10$ , aged 8–10 weeks, weighing 18–25 g, Narabio tec.) on 4G condition for 2 weeks by remote observation method. The evaluation of vestibular function was measured by OVAV on 0.04, 0.08, 0.16, 0.32 Hz cycle on 100% peak velocity. Furthermore, we tilt the axis for 30° and rotated over 10 cycles to cause step velocity stimulation. From the achieved nystagmus data we made 3D analysis.

**Result:** The stimulated mice (under 4G for 2 weeks) have gained horizontal nystagmus data was  $0.211 \pm 0.125$ ,  $0.572 \pm 0.097$ ,  $0.649 \pm 0.083$ ,  $0.718 \pm 0.087$  under 0.04–0.08–0.16–0.32 Hz conditions respectively. Those of vertical nystagmus was  $0.958 \pm 0.455$ ,  $0.849 \pm 0.403$ ,  $0.800 \pm 0.257$ ,  $0.831 \pm 0.198$ . The per-rotatory Tc of OVAV data was  $5.7 \pm 2.238$  s which is reduced compare with the achievable data from healthy normal mice ( $p < 0.001$ ).

**Conclusion:** By observing above data we can induce the result that the 4G hypergravity stimulation cause the modification not only on the otolithic organ but also on the function of semicircular canals.

## OP20-1

Cochlear Implantation and Vestibular Function

**VESTIBULAR TESTS AND COCHLEAR IMPLANT: A SYSTEMATIC REVIEW AND META-ANALYSIS**

**Martin HITIER<sup>1,2,3</sup>, Moumainn ABOUZAYD<sup>1</sup>, Paul F SMITH<sup>4</sup>, Lise-Marie ROUSSEL<sup>1</sup>, Sylvain MOREAU<sup>1</sup>**

<sup>1</sup>Department of Otolaryngology Head And Neck Surgery, Caen University Hospital, France

<sup>2</sup>Department of Comete U1075, Inserm U1075, France

<sup>3</sup>Department of Anatomy, Unicaen, France

<sup>4</sup>Department of Pharmacology And Toxicology, University of Otago, New Zealand

**Objectives:** Vestibular function after cochlear implantation is difficult to understand, as subjective vestibular symptoms seem uncorrelated with the results of objective tests. Consequently, clinicians may struggle to decide what assessments to perform for a symptomatic patient. We used a systematic review and meta-analysis approach to enlighten this point.

**Design:** After a study inclusion process, results were classified into 4 different groups for each test in each study: 1) ‘true positive’ if the test showed impairment from pre-operative to post-operative in symptomatic patients; 2) ‘false positive’ if the test showed impairment from pre-operative to post-operative in asymptomatic patients; 3) ‘true negative’ if the test showed no impairment in asymptomatic patients; and 4) ‘false negative’ if the test showed no impairment in symptomatic patients. From these groups, sensitivities and specificities of each test were calculated in a meta-analysis.

**Results:** After reviewing more than 3000 references, 16 studies were included, representing 957 patients. The meta-analysis revealed a sensitivity of 0.21 for the Caloric Tests, of 0.32 for c-VEMP, and of 0.5 for the Head Impulse Tests. The analysis of prevalence revealed that c-VEMPs were the most often impaired, and the HIT the most often conserved.

**Conclusion:** Our review and meta-analysis revealed that no vestibular test is sensitive enough to be recommended as a single test. Ideally, all the 5 vestibular sensors should be tested. In clinical practice, we suggest a case-to-case strategy according to patient’s symptoms and their suspected origin

## OP20-2

Cochlear Implantation and Vestibular Function

**PRE- AND POSTOP VESTIBULAR EVALUATION IN CI PATIENTS: OVERKILL OF TESTS OR DO WE IT NEED ALL?**

**Andy J BEYNON<sup>1,2</sup>**

<sup>1</sup>Department of Otorhinolaryngology, Radboud University Medical Center, Netherlands

<sup>2</sup>Department of Neuroscience, Donders Institute Brain, Cognition, Behaviour, Netherlands

**Background:** Cochlear implant (CI) candidates receive pre- (and post)operatively many tests, questionnaires (e.g. quality of life, psychological). The need for vestibular tests has been shown previously (27th Barany Society, 2012). In this study, pre-postop caloric data are compared, and the need of the DHI and its overlap with calorics are investigated to optimize testprotocols for CI.

**Methods:** Retrospectively, data of > 400 CI subjects implanted between 2011–2015 were obtained and analyzed, i.e. subjective (DHI) and objective (caloric irrigation, rotary chair, vHIT, latter two not discussed here). In total, 130 patients were implanted with residual vestibular function; of 79 patients complete bi-thermal caloric and complete DHI data was available for analysis. Caloric responses were defined in 5 classifications related to a degree of deterioration. The same was done for DHI scores (4 classes, 4 domains, i.e. total, functional, physical, emotional). Finally, relation between both subjective and objective measures are analyzed pre-post CI intervention.

**Results:** Pre-post comparison tests show a mean deterioration of caloric responses in 23% of subjects; 12% experience more dizziness postop. Although subjective DHI data (mainly functional domain) and bi-thermal calorics seem to correlate, a substantial part (18%) did not, indicating the limited sensitivity of the caloric irrigational test.

**Conclusion:** Since the ‘CI candidate’ has been changed from deaf patients to patients with substantial residual hearing and intact vestibular function, both DHI and caloric are complementary and still needed, but even more additional tests (e.g. vHIT, VEMP) needed, since postop complaints are obviously and expectedly not covered by just calorics.

OP20-3

Cochlear Implantation and Vestibular Function

**BEHAVIOURAL PERCEPTION OF VERTICAL IMPROVES WITH COCHLEAR IMPLANT STIMULATION IN A LARGE PAEDIATRIC COHORT**

**Sharon L CUSHING**<sup>1,2,3</sup>, Joshua GNANASEGARAM<sup>3</sup>, William J PARKES<sup>1,2,3</sup>, Carmen L MCKNIGHT<sup>3</sup>, Karen A GORDON<sup>2,3</sup>, Blake C PAPSIN<sup>1,2,3</sup>

<sup>1</sup>Department of Otolaryngology, Hospital For Sick Children, Canada

<sup>2</sup>Department of Otolaryngology, Head And Neck Surgery, University of Toronto, Canada

<sup>3</sup>Department of Archie's Cochlear Implant Laboratory, Hospital For Sick Children, Canada

**Background:** Vestibular dysfunction, common in children with sensorineural hearing loss (SNHL), translates to poor balance, which can improve with cochlear implant (CI) use. Effects on additional measures of vestibular function, including the perception of vertical, are unknown.

**Objective:** To determine whether the perception of vertical is disrupted in children with SNHL and if so, whether it improves with CI stimulation.

**Methods:** Fifty-two unilaterally ( $n = 9$ ) or bilaterally (sequential,  $n = 37$ ; simultaneous,  $n = 6$ ) implanted participants ( $15.2 \pm 4.0$  yrs) were recruited. The subjective visual vertical (SVV) was measured using the Visual VerticalTM (Clear Health Media, Wonga Park, Australia) application on an iPod fastened to the bottom of a bucket. Testing was done in dark, and the bucket filled the field of view, eliminating external visual cues. SVV measurements were collected first without CI stimulation and while stimulating at 5.1Hz from an apical or basal electrode.

**Results:** In the absence of stimulation, 54% (28/52) of participants had a normal SVV score (i.e., deviation  $< 2^\circ$  to the left or right of zero). With CI use, the SVV shifted toward centre; the degree and direction of shift were significantly correlated with the degree and direction of initial tilt from centre for both right and left stimulation (Right:  $R^2 = 0.329$ ,  $p < 0.001$ ; Left:  $R^2 = 0.335$ ,  $p < 0.001$ ). The proportion of participants with normal scores improved significantly to 75% (39/52) with CI use (Fisher's exact test,  $p = 0.0398$ ).

**Conclusion:** Electrical stimulation improves the abnormal perception of vertical in children with SNHL, an effect possibly mediated through current spread to the utricular afferents from the CI.

OP20-4

Cochlear Implantation and Vestibular Function

**RESTORATION OF VESTIBULAR RESPONSIVENESS USING COCHLEAR IMPLANT STIMULATION IN A LARGE PEDIATRIC COHORT**

**Sharon L CUSHING**<sup>1,2,3</sup>, William J PARKES<sup>1,2,3</sup>, Joshua GNANASEGARAM<sup>3</sup>, Carmen L MCKNIGHT<sup>3</sup>, Karen A GORDON<sup>2,3</sup>, Blake C PAPSIN<sup>1,2,3</sup>

<sup>1</sup>Department of Otolaryngology, Hospital For Sick Children, Canada

<sup>2</sup>Department of Otolaryngology, Head And Neck Surgery, University of Toronto, Canada

<sup>3</sup>Department of Archie's Cochlear Implant Laboratory, Hospital For Sick Children, Canada

**Background:** Children with profound sensorineural hearing loss treated with cochlear implants frequently have concomitant vestibular deficits. While the most common reason for these deficits is a shared etiology with the associated deafness (i.e. Usher Syndrome), cochlear implantation itself also poses a risk to the vestibular end-organs, in particular the otoliths.

**Objective:** To determine if vestibular potentials can be electrically restored using cochlear implant (CI) stimulation in children with otolithic dysfunction.

**Methods:** Vestibular responsiveness to electrical stimulation from CIs was assessed using vestibular evoked myogenic potential (VEMP) testing in 53 children and young adults with CIs.

**Results:** Of the 53 participants tested, 22 (42%) showed no myogenic vestibular potentials in response to acoustic stimulation. Ninety-six ears were stimulated acoustically: cVEMPs were absent in 51(53%) and oVEMPs were absent in 71(74%).

In the ears with absent VEMP responses to acoustic stimuli, electrically-evoked cVEMPs and oVEMPs were present in 14 (27%) and 18 (25%) ears, respectively. These electrically-evoked VEMPs were fast in onset: cVEMP P1-11.6  $\pm$  1.1 ms; oVEMP N1-7.1  $\pm$  1.9 ms (mean  $\pm$  SD).

**Conclusions:** VEMP responses can be elicited by electrical stimulation in a proportion of children with CIs whose otoliths do not respond to acoustic stimulation. This demonstrates current spread from the intracochlear electrode array to the vestibular system. The ability to electrically-evoke VEMPs in acoustically nonresponsive ears combined with the short latencies of these responses suggest that electrical current from a CI can bypass the dysfunctional otoliths and directly stimulate vestibular neural elements.

## OP20-5

Cochlear Implantation and Vestibular Function

**BALANCE AND HEARING AFTER LABYRINTHECTOMY AND COCHLEAR IMPLANTATION IN MENIERE'S DISEASE – LONG-TERM RESULTS**

**Martin WESTHOFEN**

*Department of ORL, University Hospital Aachen, RWTH Aachen University, Germany*

**Purpose:** In Meniere's disease ablative surgery can be indicated. Speech understanding with new cochlear implant devices allows inner ear destruction even in moderate hearing loss.

**Method:** 15 patients with Meniere's disease (AAO-HNS guideline) were treated by cochleosacculotomy and CI. Findings are compared pre- and postoperatively.  $N = 7$  had no adequate speech intelligibility preoperatively. 1 patient was treated with cochlear implant electrode in-situ. In  $n= 14$  cases cochleosacculotomy and CI were performed simultaneously.

**Results:** No complications were recorded postoperatively. Observation interval is 6–35 months. All patients are free of symptoms postoperatively. The mean DHI score is 6. Caloric responses, vHIT, cVEMP and oVEMP are negative ipsilaterally in 13 of 15 patients, postoperative SVV is permanently asymmetrical in all patients. Bimodal application of hearing aid and CI is used by 12 patients. 6 months results of speech understanding in quiet and noise are in the upper quartile of adult CI patients with other indications. Patient's speech recognition of monosyllables in quiet is > 50%, speech recognition in noise is improved 5.2 dB (SN ratio). Binaural orientation is reported by all of the 5 patients. During the observation period up to 3 years postoperatively patients are free of symptoms and speech recognition of the CI-ear is stable > 75% in quiet.

**Conclusion:** Even in long-term course up to 3 years symptom free situation is observed in cases of intractable Meniere's disease with moderate to profound hearing loss after cochleosacculotomy and cochlear implantation. All patients have compensated the labyrinth ablation.

## OP20-6

Cochlear Implantation and Vestibular Function

**COCHLEAR IMPLANT IN MÉNIÈRE'S DISEASE. DOES IT AFFECT AUDITORY AND VESTIBULAR FUNCTION?**

**Raquel MANRIQUE<sup>1</sup>, Diego CALAVIA<sup>1</sup>, Manuel MANRIQUE<sup>1</sup>, Nicolas PEREZ<sup>1</sup>**

<sup>1</sup>*Department of Otorhinolaryngology, University of Navarra Clinic, Spain*

**Introduction:** MD is an inner ear disease characterized by cochlear and vestibular symptoms. Given the disease process, hearing loss progresses to a severe-profound degree in up to 6% of the patients. In such cases cochlear implantation is indicated.

The aim of the study is to measure auditory and vestibular outcomes in MD patients who have undergone CI.

**Material and methods:** A prospective study including 21 patients diagnosed of definite Ménière Disease (case group) and 29 patients diagnosed of otosclerosis (control group) and treated with cochlear implant is performed. Auditory and vestibular function is based on pure tone audiometry and speech understanding, video head impulse test and vibratory ocular, cervical vestibular evoked myogenic potentials and Dizziness Handicap Inventory test. A comparison with t Student test before and after CI is performed. Statistical analysis with the IBM SPSS Statistics was used.

**Results:** A benefit after CI in both case (80% disyllabic) and control group (72%) are seen with no statistical differences ( $p = 0.072$ ).

Neither semicircular canal function nor otolith function vary after implantation. However, regarding the oVEMPS, promontorial approach is more traumatic than RW (asymmetry is 31.82 for RW and 75.87% for promontory group ( $p = 0.016$ )).

And last, DHI mean score is 34.5 (SD 16.97). A comparison with moderate incapacity shows no statistical significant differences ( $p = 0.921$ ).

**Conclusions:** Ménière disease patients with severe to profound sensorineural hearing loss are excellent candidates for cochlear implantation.

Surgical maneuvers entail trauma at the level of the utricle if a promontorial approach to the cochlea is performed.

#### OP21-1

Benign Paroxysmal Position Vertigo II

#### BONE MINERAL DENSITY AND 25-HYDROXYVITAMIN D IN PATIENTS WITH IDIOPATHIC BENIGN PAROXYSMAL POSITIONAL VERTIGO

Chan Joo YANG<sup>1</sup>, Yehree KIM<sup>1</sup>, Hwan Seo LEE<sup>1</sup>, **Hong Ju PARK<sup>1</sup>**

<sup>1</sup>Department of Otolaryngology, Asan Medical Center, University of Ulsan College of Medicine, Korea

The aim of this study was to evaluate the relationship between bone mineral density (BMD) and 25-hydroxyvitamin D with the occurrence and recurrence of idiopathic BPPV. The records of patients with idiopathic BPPV who underwent bone mineral densitometry between June 2013 and June 2015 were reviewed retrospectively. We compared the BMD and serum 25-hydroxyvitamin D between the patients and age- and sex-matched controls, and also compared the BMD between recurrent and non-recurrent BPPV groups. One hundred and thirty BPPV patients ( $55 \pm 12$  years old, 30 men and 100 women) and 130 age- and sex-matched controls were analyzed. BPPV patients showed a significantly higher prevalence (17%) of osteoporosis compared to the controls (4%,  $p = 0.001$ ). Among the female subjects, the BPPV group showed a significantly decreased BMD in all measured areas (lumbar spine and femur) compared to the controls ( $p < 0.05$ ). The men in the control group had significantly higher 25-hydroxyvitamin D levels than the men with BPPV ( $p < 0.05$ ). Sixty-three patients (48%, 50% in women and 43% in men) reported recurrent attacks of BPPV. The women with recurrent BPPV were significantly older and showed a significantly lower BMD than non-recurrent women ( $p < 0.001$ ). However, multiple regression analysis revealed that age alone was significantly associated with the recurrence of BPPV. BMD in women and serum 25-hydroxyvitamin D levels in men are associated with the occurrence of idiopathic BPPV. Only age is an independent predictor of recurrence, though a low BMD and age correlate with the recurrence of BPPV.

#### OP21-2

Benign Paroxysmal Position Vertigo II

#### THE IMPORTANCE OF DUPLICATE TEST OF ROLLING TEST FOR LOCALIZATION DIAGNOSIS IN HORIZONTAL SEMICIRCULAR CANALITHIASIS

Taisheng CHEN<sup>1,2</sup>, Yuan ZHAO<sup>1,2</sup>, Honghua LU<sup>1,2</sup>, **Wei WANG<sup>1,2</sup>**, Kaixu XU<sup>1,2</sup>, Chao WEN<sup>1,2</sup>, Qiang LIU<sup>1,2</sup>, Peng LIN<sup>1,2</sup>

<sup>1</sup>Department of Otorhinolaryngology Institute of Tianjin, Tianjin First Central Hospital, China

<sup>2</sup>Department of Department of Otorhinolaryngology Head And Neck Surgery, Tianjin First Central Hospital, China

**Objective:** To investigate the influence of roll test repetitions in Horizontal Semicircular Canalithiasis (HSC-Can) Localization diagnosis, in order to modify the roll test methods. Methods Patients with complaint of positional vertigo accepted two consecutive cycles roll test, the evoked nystagmus characteristics of each cycle recorded by video-nystagmography (VNG). Parameters including direction, intensity, duration and other characteristics were analyzed in 51 HSC-Can. Results The direction of induced Horizontal nystagmus was in the same with turning side in HSC-Can roll test. 24 cases (47.1%) of 51 HSC-Can showed the same strength side nystagmus both in roll test cycle 1 and cycle 2; To the induced nystagmus in the opposite strength side of the two loops, nystagmus intensity evoked in cycle 1 was weaker than cycle 2. 25 cases (49.0%) were determined HSC-Can affected side based on cycle 2 results; the other two cases (3.9%) turned around loop 2 induced nystagmus intensity ratio of about 1: 1, in order to determine involved side by cycle 1 record. Among 51 HSC-Can patients, 44 patients accepted repositioning

maneuver. 41 cases of 44 patients (93.2%) showed complete resolution of symptoms after 1-2 times of maneuver, and all cases improved their symptom after treatment. Conclusion It is necessary for patients suspicious with HSC-Canto perform at least two cycles roll test. The second cycle was more helpful to determine the locating of the responsibility semicircular canals.

#### OP21-3

Benign Paroxysmal Position Vertigo II

#### MULTICENTER RCT: COMPARISON OF THE EFFECTIVENESS OF TWO DIFFERENT GUFONI MANEUVER FOR TX. IN APOGEOTROPIC HC-BPPV

Dae Bo SHIM<sup>1</sup>, Minbum KIM<sup>2</sup>, Min Beom KIM<sup>3</sup>, Chang-Hee KIM<sup>4</sup>, Myung-Whan SUH<sup>5</sup>, Jae-Hyun SEO<sup>6</sup>, No Hee LEE<sup>7</sup>, Jong-Dae LEE<sup>8</sup>, Ho Suk CHU<sup>9</sup>, Suk Min HONG<sup>10</sup>, Sung Kwang HONG<sup>11</sup>, **Sung Huhn KIM**<sup>12</sup>

<sup>1</sup>Department of Otorhinolaryngology, Myongji Hospital, Seonam University College of Medicine, Korea

<sup>2</sup>Department of Otorhinolaryngology, Catholic Kwandong University College of Medicine, Korea

<sup>3</sup>Department of Otorhinolaryngology, Sungkyunkwan University College of Medicine, Korea

<sup>4</sup>Department of Otorhinolaryngology, Konkuk University College of Medicine, Korea

<sup>5</sup>Department of Otorhinolaryngology, Seoul National University College of Medicine, Korea

<sup>6</sup>Department of Otolaryngology-hns, The Catholic University of Korea College of Medicine, Korea

<sup>7</sup>Department of Otology, Hana Ent Clinic, Korea

<sup>8</sup>Department of Otorhinolaryngology, Soonchunhyang University College of Medicine, Korea

<sup>9</sup>Department of Otology, Hana Ent Hospital, Korea

<sup>10</sup>Department of Otorhinolaryngology, Hallym University Sacred Heart Hospital, Korea

<sup>11</sup>Department of Otorhinolaryngology, Hallym University College of Medicine, Korea

<sup>12</sup>Department of Otorhinolaryngology, Yonsei University College of Medicine, Korea

Gufoni maneuver has been introduced for treatment of apogeotropic type of horizontal semicircular canal benign paroxysmal positional vertigo (HC-BPPV) involving a side-lying onto the affected side and then looking down- or upward. The aim of this study was to evaluate the immediate and short-term therapeutic efficacies of two different types of Gufoni maneuver in apogeotropic HC-BPPV in a prospective multicenter randomized double-blind controlled. In 12 dizziness clinics of Korea, 63 consecutive patients (mean age  $\pm$  SD = 51.1  $\pm$  15.1) with apogeotropic HC-BPPV were randomized to upward rotation type of Gufoni maneuver [Gufoni-up, ( $n = 32$ )] or downward rotation type of Gufoni maneuver [Gufoni-down, ( $n = 31$ )]. For Gufoni maneuver, patients underwent ipsilesional side-lying and upward or downward head-turn for migration of the debris toward the vestibule. Each maneuver was repeated twice if there was still positional vertigo or nystagmus on the initial visit day, and the presence of nystagmus and vertigo on positional testing were evaluated immediately, 1 day, and 1 week after treatment. After a maximum of 2 maneuvers on the initial visit day, no difference of therapeutic efficacy was observed between the Gufoni-up group (52.4%) and the Gufoni-down group (42.1%) ( $p = 0.516$ ). The therapeutic effects on the 1 day and 1 week after treatment did also not differ between Gufoni-up and Gufoni-down groups ( $p = 0.06$  and  $p = 0.489$ , respectively). Using a prospective randomized trial, we demonstrated that the efficacy of the two different types of Gufoni maneuver are not differ in treating apogeotropic HC-BPPV.

#### OP21-4

Benign Paroxysmal Position Vertigo II

#### CHARACTERISTICS OF VERTICAL NYSTAGMUS ELICITED BY ALCOHOL

Tatjana TOMANOVIC<sup>1,2</sup>, Johan BERGENIUS<sup>1,2</sup>, **Bela BUKI**<sup>3</sup>

<sup>1</sup>Department of Hearing and Balance Disorders, Karolinska Hospital, Solna, Sweden

<sup>2</sup>Department of Clinical Science, Intervention and Technology, Karolinska Institute, Stockholm, Sweden

<sup>3</sup>Department of ENT, Karl Landsteiner University, Krems an der Donau, Austria

In the last few years interest in the first phase of positional alcohol nystagmus (PAN I) has been revived by the fact that the condition of the light cupula and therefore positional direction changing nystagmus can be caused by pathologic processes and occur in clinical situations. The behaviour of the horizontal canal cupula and the evoked nystag-

mus types during the first and the second phases of PAN are well documented, however, publications concerning the vertical canal cupula and nystagmus types elicited with alcohol are scarce. In our experiment we measured the PAN I elicited by symmetrical positioning in head hanging prone, head hanging supine and sitting positions in order to activate/inhibit the vertical canals. We show that this is possible and the elicited nystagmus types correspond to the anticipated eye movements if the three dimensional positions of the anterior and posterior canal cupulae, the starting position and the final, provoking position are taken into account.

Our results may help to understand clinical cases in which isolated light cupula in the vertical canal may cause positional direction changing nystagmus.

#### OP21-5

Benign Paroxysmal Position Vertigo II

#### THE CLINICAL SIGNIFICANCE OF VERTICAL NYSTAGMUS IN BOW AND LEAN TEST

Oak-Sung CHOO<sup>1</sup>, Miyou KO<sup>1</sup>, Jung Hee CHOI<sup>1</sup>, Jeong Hun JANG<sup>1</sup>, Hun Yi PARK<sup>1</sup>, Yun-Hoon CHOUNG<sup>1</sup>

<sup>1</sup>*Department of Otolaryngology, Ajou University School of Medicine, Korea*

**Objective:** The Bow and Lean Test(BLT) was developed for proper diagnosis of lateral semicircular canal benign paroxysmal positional vertigo (LSC-BPPV) by Yun-Hoon Choung. It has been recognized as a diagnostic tool to overcome the limitations of head roll test (HRT), and to accurately determine the affected ear in LSC-BPPV. Occasionally, vertical nystagmus of down and/or up beating is observed in BLT. The present study analyzed cases presenting vertical nystagmus during BLT to comprehend the clinical significance of this specific type of nystagmus.

**Methods:** Two hundred and eight patients who showed vertical nystagmus during BLT in Ajou University Hospital between 2010 and 2015 were enrolled. All tests were performed using an electronystagmography and computerized video eye movement recorder to document the nystagmus. Clinical characteristics, diagnoses, and vestibular symptoms of the patients were reviewed.

**Results:** In a total of 208 patients, 163 patients were diagnosed as PSC-BPPV (78.4%), 35 as LSC-BPPV (16.2%), 2 as SSC-BPPV (1.0%), and 8 as mixed type BPPV (3.8%). BPPV patients with continuous vertical nystagmus even after remission by repositioning maneuvers showed higher residual symptoms compared to the patients without continuous vertical nystagmus. From the BPPV negative group (17 patients), 4 patients had a history of BPPV, 5 were under sedatives, and surprisingly radiologic evaluation to detect any signs of central origin vertigo all showed normal findings.

**Conclusion:** The vertical nystagmus during BLT may indicate central origins as well as the presence of PSC or SSC BPPV. Thus nystagmus of all directions should be thoroughly examined in BLT for proper diagnosis and successful treatment outcomes.

#### OP21-6

Benign Paroxysmal Position Vertigo II

#### MODEL EXPERIMENT OF BPPV WITH BIPHASIC NYSTAGMUS USING ISOLATED SEMICIRCULAR CANAL

Masanori YATOMI<sup>1</sup>, Mamoru SUZUKI<sup>2</sup>, Yasuo OGAWA<sup>1</sup>, Taro INAGAKI<sup>2</sup>, Koji OTSUKA<sup>2</sup>, Kiyoshi TSUKAHARA<sup>2</sup>

<sup>1</sup>*Department of Otolaryngology, Tokyo Medical University Hachiouji Medical Center, Japan*

<sup>2</sup>*Department of Otolaryngology, Tokyo Medical University, Japan*

**Objective:** To investigate the mechanism of spontaneous inversion of nystagmus direction without a positional change in experimental models of co-existence of cupulolithiasis and canalolithiasis.

**Methods:** The co-existence canalolithiasis and cupulolithiasis models were prepared using the bullfrog posterior semicircular canal (PSC). Ten bullfrogs were used in this study. The ampullary nerve discharge were recorded as the compound action potentials (CAP). First, the otoconial mass was placed on the cupula to develop cupulolithiasis subsequently another otoconial mass was introduced into the canal lumen to introduce canalolithiasis. Decremental time constant by cupulolithiasis and incremental time constant by canalolithiasis were determined.

**Results:** At first the CAP increased and continued long time when the cupulolithiasis generated. And subsequently the CAP was suppressed by making canalolithiasis. Finally, the CAP increased again after the moving of otoco-

nia in the canal lumen stopped. The decremental time constant by cuprolithiasis was significantly longer than the incremental time constant by canalolithiasis.

**Conclusions:** The coexistence of cuprolithiasis and canalolithiasis might to be a possible mechanism of the spontaneous inversion of positional nystagmus.

#### OP22-1

VEMP and Otolithic Function Tests II

#### IS THERE A DIFFERENCE IN VEMPS BETWEEN TRAUMATIC AND SPONTANEOUS VESTIBULAR DISEASE?

**Neil S LONGRIDGE<sup>1</sup>, Arthur I MALLINSON<sup>2</sup>**

<sup>1</sup>*Department of Otolaryngology, University of British Columbia, Canada*

<sup>2</sup>*Department of Neurotology, Vancouver General Hospital, Canada*

Dizziness after traumatic acceleration/deceleration injury is well known and the complaints voiced by these patients are similar to those of many non-trauma patients referred with vestibular sounding complaints. Many patients deny spinning but instead voice “non traditional” complaints of imbalance, unsteadiness, subtle boat like feelings and nausea because of otolithic damage.

Now that VEMP assessment is available, otolithic pathology can be documented and quantified. We routinely find CVEMP and OVEMP abnormalities in both traumatic and nontraumatic patients. This paper assesses the effect of trauma and spontaneous vestibular disease on VEMP results in the two groups of patients. It is traditionally thought that most spontaneous vestibular pathology is unilateral. It is assumed that trauma patients have suffered bilateral damage due to the mechanism of the injury. Pathology in these patients is important to define, as bilateral pathology is more of a challenge to compensate for. In addition, it is important to document the pathology in these patients as being vestibular, as the treatment for vestibular pathology is activity, while the treatment for “post concussion syndrome” is complete rest.

OVEMP and CVEMP results were compared in 25 whiplash trauma patients with an age and sex matched group of non-trauma patients with spontaneous vestibular disease. The data of the two groups have been analyzed. There is a statistically higher OVEMP abnormality rate in the trauma group when compared to the vestibular non-trauma patients.

#### OP22-2

VEMP and Otolithic Function Tests II

#### O-VEMPS AND C-VEMPS IN PATIENTS WITH "CLINICALLY CERTAIN" MENIERE'S DISEASE

**Sarah-Anne JOHNSON<sup>1</sup>, Gregory O'BEIRNE<sup>1</sup>, Emily LIN<sup>1</sup>, John GOURLEY<sup>2</sup>, Jeremy HORNIBROOK<sup>1,2</sup>**

<sup>1</sup>*Department of Communication Disorders, University of Canterbury, New Zealand*

<sup>2</sup>*Department of Otolaryngology-head And Neck Surgery, Christchurch Hospital, New Zealand*

Vestibular-evoked myogenic responses (VEMPs) are muscle responses arising from stimulation of the utricle and saccule, which can be measured respectively from the contralateral inferior oblique muscle and the ipsilateral sternomastoid muscle, and which are independent from hearing. Many investigators have sought VEMP abnormalities which might be a unique objective diagnostic indicator for Meniere's disease and vestibular migraine, with conflicting findings as to the significance of amplitude, latency and threshold measures.

oVEMP and cVEMP thresholds, latency and amplitude were measured in 22 control “normal ear” subjects and in both ears of 18 patients with “Clinically Certain” Meniere's disease who had tone-burst electrocochleographic proof of cochlear endolymphatic hydrops.

There was significant overlap of all measures between Meniere's ears and normal ears, so that no measure could be used as a reliable indication of Meniere's disease. In Meniere's ears hydrops is assumed to begin in the cochlea and then move to the vestibule. The jeopardy of any VEMP study without confirmation of cochlear hydrops is that the patient may not have Meniere's disease.

OP22-3

VEMP and Otolithic Function Tests II

### HOW SOUND AND VIBRATION TEST OTOLITH FUNCTION

**Ian S CURTHOYS**

*Department of Psychology, University of Sydney, Australia*

Colebatch and others transformed testing of the linear acceleration (otolithic) sensors by showing that sound and vibration elicit small vestibular-evoked myogenic potentials (VEMPs). Paradoxically VEMPs occur because linear acceleration is not the only stimulus to activate otolithic receptors – neural evidence now shows that sound and vibration are effective stimuli for otolithic receptors and primary otolithic afferents. Otolithic afferents with irregular resting discharge originate from the unique type I receptors at the striola of the utricular and the saccular macula and are not only activated by both sound and vibration but phase lock their spikes to individual cycles of the stimuli up to very high frequencies ( $\sim 3000$  Hz), probably because of the deflection of the short cilia of these receptors by fluid displacement. The result is that striolar type I vestibular receptors have phase-locking characteristics similar to cochlear inner hair cells. Given the very fast dynamics of otolith irregular neurons, the very short latency of VEMPs, and the short paths from the inner ear to the muscles concerned, it is clear that stimulus onset is crucial for generating VEMPs. Experimental data shows that the ideal stimulus for clinical otolith testing is one with a very short rise time. I have suggested that the differential function of the utricular and saccular macula can be gauged by measuring how sound or vibration affect oculomotor and cervical myogenic potentials respectively, since the utricular and saccular maculae have striolar receptors with similar properties but the afferent projections to eye muscles and neck muscles are different.

OP22-4

VEMP and Otolithic Function Tests II

### COMPARISON OF SUBJECTIVE VISUAL VERTICAL (SVV) USING TWO TECHNIQUES: A TEST-RETEST RELIABILITY STUDY

**Devin L MCCASLIN<sup>1</sup>, Michelle R PETRAK<sup>2</sup>, Patricia L MICHELSON<sup>1</sup>**

<sup>1</sup>*Department of Hearing And Speech Sciences, Vanderbilt University Medical Center, USA*

<sup>2</sup>*Department of Audiology, Northwest Audiology Speech And Hearing, USA*

**Purpose:** The subjective visual vertical (SVV) is a perceptual measure of one's upright horizon. Recent technology has enabled more efficient measures of a patient's SVV in clinical settings. The purpose of this study was to describe the variability and test-retest reliability of a commercially available SVV system (Chronos Vision – cSVV) compared to the bucket test.

**Methods:** Binocular measurements of the SVV were made using two different methods in 15 healthy subjects. The first method consisted of using a commercial system known as the Chronos Vision headset. Seven different head tilt conditions using both the bucket test and Chronos Vision system were conducted. Each participant was retested again using both methods. This study compared the within-session reliability of the Chronos system with the bucket. For evaluating test-retest reliability, two repetitive sessions were performed for calculating the intraclass correlation coefficient (ICC) for both tests.

**Results and conclusions:** The difference between the test-retest measurements was investigated by means of mixed-model repeated measures ANOVA. Analysis for the effect of System and Head Position indicated that there was an effect of Head Position. There was no statistically significant difference in SVV estimation within-subjects across system or run. Reliability was described as excellent, fair to good, or poor based on the ICC. Test-retest reliability of the Chronos system was excellent in the 45 degrees left position and fair to good in 45 degrees head right and 0 degrees position. Test-retest reliability of the bucket test was poor in all head positions.

## OP22-5

VEMP and Otolithic Function Tests II

**OPERATION PROTOCOL FOR ELICITING OCULAR VESTIBULAR-EVOKED MYOGENIC POTENTIALS****Kuei-You LIN<sup>1</sup>, Yi-Ho YOUNG<sup>2</sup>**<sup>1</sup>*Department of Otolaryngology, Shin Kong Wu Ho-su Memorial Hospital, Taiwan*<sup>2</sup>*Department of Otolaryngology, National Taiwan University Hospital, Taiwan*

**Objective:** While both Fz and Fpz are effective sites for generating ocular vestibular evoked myogenic potential (oVEMP), the variation in skull shapes and properties will lead to different acceleration profiles being transmitted to the vestibular apparatus. Thus, if tapping Fz (Fpz) site fails to produce oVEMP, the examiner should try Fpz (Fz) site. This study aims to establish an operation protocol for routine oVEMP test.

**Method:** One hundred patients with unilateral peripheral vestibular diseases were enrolled. All patients underwent oVEMP test via Fpz and Fz tapping in a randomized order. Then, 100 patients were assigned to four groups based on oVEMP results, namely Group A ( $n = 17$ , mean 39Y), Fpz(+)Fz(+); Group B ( $n = 30$ , mean 39Y), Fpz(+)Fz(-); Group C ( $n = 24$ , mean 57Y), Fpz(-)Fz(+); and Group D ( $n = 49$ , mean 51Y), Fpz(-)Fz(-).

**Results:** The ages of Groups A and B were significantly younger than those of Groups C and D ( $p < 0.05$ ), indicating that younger age yields more positive oVEMPs via Fpz tapping than Fz tapping. However, such age factor was not identified in oVEMPs via Fz taps. Further, males yielded more response rate of oVEMPs via Fpz tapping than Fz tapping ( $p < 0.001$ ); while vice versa in females ( $p < 0.05$ ).

**Conclusion:** In those  $< 45$  years, especially the males, Fpz tapping should be performed first for eliciting oVEMPs; while those  $> 45$  years, especially the females, Fz site is advised for tapping first. This operation protocol for routine oVEMP test may save time and energy, and help increase test efficiency.

## OP22-6

VEMP and Otolithic Function Tests II

**ASSESSMENT OF THE OTOLITH FUNCTION IN PATIENTS WITH MENIERE'S DISEASE USING ECCENTRIC ROTATION TEST****Tomoko OKUMURA<sup>1</sup>, Takao IMAI<sup>1</sup>, Yasumitsu TAKIMOTO<sup>2</sup>, Noriaki TAKEDA<sup>3</sup>, Tadashi KITAHARA<sup>4</sup>, Atsuhiro UNO<sup>5</sup>, Takehumi KAMAKURA<sup>1</sup>, Yasuhiro OSAKI<sup>6</sup>, Yoshiyuki WATANABE<sup>7</sup>, Hidenori INOHARA<sup>1</sup>**<sup>1</sup>*Department of Otorhinolaryngology – Head And Neck Surgery, Osaka University Graduate School of Medicine, Japan*<sup>2</sup>*Department of Otorhinolaryngology, Suita Municipal Hospital, Japan*<sup>3</sup>*Department of Otorhinolaryngology – Head And Neck Surgery, Tokushima University Graduate School of Medicine, Japan*<sup>4</sup>*Department of Otorhinolaryngology – Head And Neck Surgery, Nara Medical University School of Medicine, Japan*<sup>5</sup>*Department of Otorhinolaryngology, Osaka General Medical Center, Japan*<sup>6</sup>*Department of Otorhinolaryngology, Osaka Medical Center And Research Institute For Maternal And Child Health, Japan*<sup>7</sup>*Department of Diagnostic And Interventional Radiology, Osaka University Graduate School of Medicine, Japan*

To assess the otolith function in patients with Meniere's disease (MD) using vestibulo-ocular reflex during eccentric rotation (ER). We evaluated 21 patients diagnosed unilateral definitive MD based on AAO- HNS criteria. When a patient is rotated while displaced from the axis of rotation (ER), the vestibulo-ocular reflex (VOR) caused by the utricle (linear VOR; IVOR) is induced. All patients sat on a chair at three different positions: on the axis (center rotation, CR), at 90 cm behind the axis (nose-in ER, NI-ER) and at 90 cm in front of the axis (nose-out ER, NO-ER) and were rotated sinusoidally. When the VOR gain during NI-ER was higher and/or that during NO-ER was lower than during CR, the response to ER was abnormal. Ocular VEMP (oVEMP), cervical VEMP (cVEMP) and gadolinium contrast-enhanced magnetic resonance image (Gd-enhanced MRI) were also performed.

Vestibular hydrops were seen in 14 patients using Gd-enhanced MRI. Only four patients showed abnormal ER response. In three of these four cases, the response to oVEMP was also abnormal. However, 16 of 17 patients whose ER response was normal showed a normal oVEMP response.

Patients with MD who had oVEMP utricle hypo-function showed IVOR failure induced by utricle during ER. This study showed that ER can be useful as a otolith functional test in patients with vertigo and/or dizziness such as MD.

OP23-1

Vestibular Compensation and Rehabilitation I

### **PRELIMINARY RESULTS OF DIFFERENT VESTIBULAR REHABILITATION PROGRAMMES IN UNILATERAL VESTIBULAR WEAKNESS**

**Fazıl Necdet ARDIÇ<sup>1</sup>, Hakan ALKAN<sup>2</sup>, Funda TÜMKAYA<sup>1</sup>, Füsun ARDIÇ<sup>2</sup>**

<sup>1</sup>*Department of Otolaryngology, Pamukkale University, Turkey*

<sup>2</sup>*Department of Physical Medicine And Rehabilitation, Pamukkale University, Turkey*

**Objectives:** The aim of this study was to compare the efficacy of a home based vestibular rehabilitation programme, posturographic biofeedback training and whole body vibration therapy on balance and fall risk in patients with unilateral vestibular weakness.

**Materials and methods:** A total of 30 patients who were diagnosed as unilateral vestibular weakness in this randomized controlled study. They were randomized into one of three groups each consisting of 10 patients; home-based vestibular rehabilitation, posturographic biofeedback training and whole body vibration training group. Vestibular rehabilitation exercises were prescribed as once daily with 10 repetitions at home for one month. Biofeedback training and whole body vibration training were performed five days a week during a month for 20 minutes for a total of 20 sessions. At the beginning and at the end of the study, fall risk yielded by posturography, Berg balance test (BBT), Timed Up-and-Go (TUG) test, vertigo visual analogue scale (VAS), Dizziness Handicap Inventory (DHI), were filled by a doctor who is blinded to the type of intervention.

**Results:** In the whole body vibration training group, there were statistically significant improvements in risk of falling, balance, TUG, vertigo VAS, DHI scores at the end of the study when compared to baseline ( $p < 0.05$ ). However there were no statistically significant difference between groups at the end of the treatment.

**Conclusion:** Whole body vibration training, is effective in reducing risk of falling, improving balance, functional mobility, vertigo severity, the handicap arising from vertigo.

OP23-2

Vestibular Compensation and Rehabilitation I

### **SENSORY REWEIGHTING REVISITED**

**Fredrik Tjernström<sup>1</sup>, Per-Anders FRANSSON<sup>1</sup>, Mikael KARLBERG<sup>1</sup>, Måns MAGNUSSON<sup>1</sup>**

<sup>1</sup>*Department of Otorhinolaryngology, Head And Neck Surgery, Clinical Sciences, Lund University, Sweden*

**Background:** Sensory reweighting is central in compensation after vestibular loss. Conceptually the visual system is upgraded and the postural control system becomes visually dependent.

**Aim:** To analyze whether different modes of deafferentation induces different sensory reweighting.

**Material and method:** 76 patients with vestibular schwannoma were examined with posturography (Romberg ratio (eyes closed vs. eyes open)) and Rod&Frame test before surgery and 6 months afterwards) and divided into 3 groups according to vestibular function prior to surgery; 1) No measurable vestibular function ( $n = 27$ ) 2) Remaining vestibular function ( $n = 12$ ) 3) Patients with function but treated with gentamicin prior to surgery (PREHAB) ( $n = 18$ ).

**Results:** With ipsilesional frame tilt there were no differences before surgery between the groups, and 6 months after surgery between group 1 and 2 ( $p < 0.05$ ) and group and 3 ( $p < 0.05$ ) where the frame effect increased in groups 1 and 3 and decreased in group 2. The same was found with contralateral frame tilt; after surgery between group 1 and 2 ( $p < 0.01$ ) and group and 3 ( $p < 0.05$ ). The Romberg ratio during vibratory stimulation decreased in all 3 groups but most in group 2 (not significant).

**Discussion:** Visual reweighting after vestibular deafferentation seems to depend on how the deafferentation occurs. If abrupt deafferentation the postural control system seems to rely less on visual cues. This could be attributed to induced nystagmus and ocular tilt reaction, in contrast to a slower deafferentation induced by gentamicin, that also allowed patients to continue vestibular rehabilitation exercises as the vestibular function declined.

## OP23-3

Vestibular Compensation and Rehabilitation I

**EVALUATION OF EMOTIONAL DISTRESS IN PATIENTS WITH DIZZINESS USING HOSPITAL ANXIETY AND DEPRESSION SCALE****Eun Jin SON<sup>1</sup>, Kyung Jin ROH<sup>1</sup>, Sanghyun KWAK<sup>1</sup>, Min Ki KIM<sup>1</sup>, Seong Ah HONG<sup>1</sup>, Seon Geum KIM<sup>1</sup>**<sup>1</sup>*Department of Otorhinolaryngology, Gangnam Severance Hospital, Yonsei University College of Medicine, Korea*

Psychological comorbidities are more common in patients with dizziness. Common disorders such as anxiety and depression often complicate the patients' ability to cope with dizziness. The Hospital Anxiety and Depression Scale (HADS) is a widely used self-report instrument used to screen for anxiety and depression in medical outpatient settings. The purpose of this study was to investigate the emotional distress using HADS and compare the results with subjective severity of dizziness using the Dizziness Handicap Inventory (DHI) in patients presenting with dizziness. A retrospective review of patients presenting with dizziness was performed. The HADS and DHI were administered to 275 patients. We investigated the correlation between subjective dizziness handicap and emotional distress using total and subscale scores. The results revealed moderate correlation between the DHI-total scores and HADS-total scores ( $r = 0.49$ ). By comparing the subscales of DHI with HADS scores, DHI-E showed higher correlation with HADS (total, Anxiety- and Depression-subscales) than did DHI-F or DHI-P.

In summary, our findings suggest that the HADS could be used in conjunction with DHI as a tool to inquire into emotional distress caused by anxiety and depression, which are common psychological conditions in patients with dizziness.

## OP23-4

Vestibular Compensation and Rehabilitation I

**CAN AGE RELATED DISEQUILIBRIUM BE CURED?****Yasuyuki NOMURA<sup>1</sup>, Teruo TOI<sup>1</sup>, Akihiro KISHINO<sup>1</sup>, Yusuke KIMURA<sup>1</sup>, Masatoshi MIURA<sup>1</sup>, Shuntaro SHIGIHARA<sup>1</sup>, Takeshi OSHIMA<sup>1</sup>**<sup>1</sup>*Department of Otolaryngology – Head and Neck Surgery, Nihon University School of Medicine, Japan*

**Introduction and aims of the study:** Japan has entered into a period of an aging society. Presbytaxis is a state of dizziness and balance disorder which is caused pathophysiologically by aging. This age related disequilibrium is a progressive condition due to aging and worsens with time, just like cancer, without intervention or treatment. Presbytaxis in Japan seems to have increased as the population ages. In this study, we tried to see if presbytaxis could be improved or cured with intervention.

**Purpose:** The purpose of this study is to find out whether or not presbytaxis can be improved or cured.

**Methods:** After categorizing dizziness and disequilibrium patients from the outpatient clinic into those whose symptoms are caused by presbytaxis, we conducted simple physical therapies.

**Results:** Dizziness patients were categorized into four groups. A few cases of presbytaxis could be improved and patients were relieved from their balance disorders.

**Conclusions:** Presbytaxis is a pathophysiologically progressive condition just like cancer that worsens overtime without intervention. According to our results, some simple physical therapy seems to have relieved patients of some of their symptoms and improved their conditions.

## OP23-5

Vestibular Compensation and Rehabilitation I

**A NOVEL SUPPRESSION HEAD IMPULSE PARADIGM (SHIMP) IS USEFUL IN VESTIBULAR REHABILITATION AFTER VESTIBULAR NEURITIS****Leonardo MANZARI<sup>1</sup>, Ann M BURGESSION<sup>2</sup>, Ian S. CURTHOYS<sup>3</sup>**<sup>1</sup>*Department of Ent, Msa Ent Academy Center – Cassino, Italy*<sup>2</sup>*Department of Vestibular Research Laboratory, University of Sydney, Australia, Australia*<sup>3</sup>*Department of Vestibular Research Laboratory, University of Sydney, Australia, Australia*

A new vHIT protocol, called SHIMPs, requires the subject to maintain fixation on a head-fixed rather than an earth-fixed target during the head impulse. The head-fixed target is a spot of light from a cyclist's headlamp worn by the subject and projected on the wall. The results are complementary to the results of the standard head impulse protocol: with SHIMPs it is healthy individuals who make a corrective saccade because initially they do not suppress their VOR and so their gaze is driven off the head-fixed target during the head turn requiring a corrective saccade at the end. In contrast, in patients with vestibular loss, their inadequate VOR does not drive their eyes off the head-fixed target so they do not make corrective saccades.

Sixteen patients with acute unilateral vestibular loss (UVL) were measured with vHIT at the time of the attack and then after approximately 1 week and 1 month. During this time, patients were instructed to perform active SHIMPs head turns with a head-lamp and they completed Dizziness Handicap Inventory questionnaires at each test epoch. The reappearance of anti-compensatory saccades in the SHIMP paradigm during rehabilitation coincided with the recovery of the subjective well-being of the patient (shown by DHI scores) despite the gain of the VOR remaining low.

The return of corrective saccades using the SHIMP test paradigm is an objective indicator of recovery of function. The SHIMP paradigm is simple to perform, easier to explain to patients, and can be readily implemented in vestibular rehabilitation programs.

#### OP23-6

Vestibular Compensation and Rehabilitation I

#### **THE EFFECT OF VESTIBULAR STIMULATION ON MOTOR FUNCTION OF CHILDREN WITH CEREBRAL PALSY**

**Leonardo MANZARI<sup>1</sup>, Alessandra MEDICI<sup>2</sup>, Marco IOSA<sup>2</sup>, Alessia CHIARLOTTI<sup>2</sup>, Giulia FUSILLO<sup>2</sup>, Daniela MORELLI<sup>2</sup>, Marco TRAMONTANO<sup>2</sup>**

<sup>1</sup>Department of Ent, Msa Ent Academy Center Cassino, Italy

<sup>2</sup>Department of Neurorehabilitation, I.r.c.c.s. Fondazione Santa Lucia, Italy

Cerebral palsy (CP) has been defined as a non-progressive disease of movement and posture development caused by brain injury during the prenatal, perinatal and postnatal period. Physical therapy techniques use different forms of sensory stimulation to improve neuromotor development. The aim of this study was to assess the efficacy of tailored vestibular rehabilitation training in improving motor functions in children with CP.

**Methods:** 14 children with CP were randomly separated into two different groups in a cross-over trial. Over a period of 10 weeks, each group performed 10 sessions of 50 minutes of neurodevelopmental treatment (NDT) and 10 sessions of experimental training, consisting of 20 minutes of NDT and 30 minutes of vestibular rehabilitation (VR).

Children were evaluated in each phase of the study with the Gross Motor Function Measurement-88 scale, (GMFM), the Goal Attainment Scale (GAS) and the root mean square (RMS) of head accelerations.

**Results:** A significant improvement in the GAS-score ( $p = 0.003$ ) was noted after NDT+VR. The distributions of percentage changes of acceleration were below zero mainly after the experimental therapy, but not after the conventional therapy ( $p = 0.044$ ).

**Conclusions:** Our results show that this training could activate a system to facilitate static and dynamic balance control in children with CP. VR in addition to NDT proved to be an effective complementary therapy for facilitating motor functioning.

#### OP24-1

Vascular Vertigo

#### **PREDICTORS OF STROKES IN DIZZY PATIENTS PRESENTING TO EMERGENCY DEPARTMENT: THE ABCD2 PLUS BALANCE (AB2CD2)**

**Ji-Yun PARK<sup>1</sup>, Sun-Young KIM<sup>1</sup>, Hyung-Jun KIM<sup>2</sup>, Su-Ik KIM<sup>2</sup>, Ji-Hun KANG<sup>2</sup>, Ji-Soo KIM<sup>3</sup>**

<sup>1</sup>Department of Neurology, Ulsan University Hospital, Ulsan University College of Medicine, Korea

<sup>2</sup>Department of Emergency Medicine, Presbyterian Medical Center, Korea

<sup>3</sup>Department of Neurology, Seoul National University Bundang Hospital, Seoul National University College Medicine, Korea

**Objective:** Dizziness is a common symptom in the emergency department (ED). Although the causes of dizziness are mostly benign, identifying cerebrovascular etiologies is important. The ABCD2 score is a simple, validated, and widely applied clinical prediction tool for assessing the risk of stroke after a transient ischemic attack (TIA). In several retrospective studies, ABCD2 score has been the simple tool for assessing the cerebrovascular risks among the patients with dizziness. In this study, we determined the clinical utility of AB2CD2 (ABCD2 plus balance) score in identifying cerebrovascular causes among the patients with dizziness presenting to ED in comparison with ABCD2 score.

**Methods:** We prospectively recruited patients with dizziness presenting to ED from April to July 2013 for 4months. We analyzed the patterns of dizziness, associated symptoms, past medical history, ABCD2 score, AB2D2 score, findings of neuro-otologic examination(head thrust, directional change, skew deviation), and final diagnosis in 302 consecutive patients with dizziness presenting to the ED for 5 months.

**Results:** Cerebrovascular causes were indentified in 9.6% (29/302), and included cerebellar infarction in 15, cerebral infarction in 6, vertebrobasilar TIA in 5, cerebellar hemorrhage in 2, and giant aneurysm of the middle cerebral artery in one. Patients with dizziness from cerebrovascular causes had higher prevalence of hypertension, diabetes mellitus, imbalance, and abnormal neuro-otologic findings. The area under the ROC curve (area under the ROC; AUC) was 0.813 (95% CI, 0.747–0.887) for the ABCD2 score and 0.913 (95% CI, 0.858–0.969) for the AB2CD2 score.

**Conclusions:** AB2CD2 is a simple tool for distinguishing cerebrovascular from non-cerebrovascular causes of dizziness in patients presenting to the ED and is superior to ABCD2 scores.

#### OP24-2

Vascular Vertigo

#### ENDOVASCULAR TREATMENT OF VERTIGO CAUSED BY JUGULAR BULB ABNORMALITIES

**Martin HITIER**<sup>1,2,3</sup>, Marie-Aude THENINT<sup>4</sup>, Vincent PATRON<sup>1</sup>, Patrick COURTHEOUX<sup>4</sup>, Sylvain MOREAU<sup>1</sup>

<sup>1</sup>Department of Otolaryngology Head And Neck Surgery, Caen University Hospital, France

<sup>2</sup>Department of Comete U1075, Inserm U1075, France

<sup>3</sup>Department of Anatomy, Unicaen, France

<sup>4</sup>Department of Neuroradiology, Caen University Hospital, France

**Objective:** Jugular bulb abnormalities can induce tinnitus, hearing loss, or vertigo. Vertigo can be very disabling and may need surgical treatments with risk of hearing loss, major bleeding or facial palsy. Hence, we have developed a new treatment for vertigo caused by jugular bulb anomalies, using an endovascular technique.

**Patients:** Fourth patients presented with severe vertigos mostly induced by high venous pressure. One patient showed downbeat vertical nystagmus during the Valsalva maneuver; another exhibited VEMP at low threshold. The temporal-bone CT scan showed a high rising jugular bulb or a jugular bulb diverticulum with dehiscence and compression of the vestibular aqueduct in all cases.

**Intervention:** In each case, we plugged the upper part of the bulb with coils, and we used a stent to maintain the coils and preserving the venous permeability.

**Results:** After 1 to 5 years of follow-up, those patients experienced no more vertigo, allowing return to work. The 3-month-arteriographs showed good permeability of the sigmoid sinus and jugular bulb through the stent, with complete obstruction of the upper part of the bulb in all cases.

**Conclusion:** Disabling vertigo induced by jugular bulb abnormalities can be effectively treated by an endovascular technique. This technique is minimally invasive with a probable greater benefit / risk ratio compare to surgery.

#### OP24-3

Vascular Vertigo

#### TRUNCAL ATAXIA AS A CARDINAL SIGN IN ACUTE VESTIBULAR SYNDROME, A COMPARISON AGAINST HINTS PROTOCOL

**Sergio CARMONA**<sup>1</sup>, Carlos MARTINEZ<sup>2</sup>, Guillermo ZALAZAR<sup>2</sup>, Marcela MORO<sup>2</sup>, Romina

WEINSCHELBAUM<sup>1</sup>

<sup>1</sup>Department of Neurotology, Instituto De Neurociencias De Buenos Aires (ineba), Argentina

<sup>2</sup>Department of Neurology, Hospital Universitario Cullem, Argentina

The HINTS protocol set a new paradigm to differentiate peripheral disease from stroke in patients with acute vestibular syndrome (AVS). Truncal ataxia has not been systematically studied.

We studied a group of 114 patients who were admitted to a General Hospital due to acute AVS.

72 of them with Vestibular Neuritis, and in the rest Stroke, 32 of them in the PICA territory and 10 in AICA.

Truncal ataxia was measured using independent observers in grade 1, mild to moderate imbalance with walking independently; grade 2, severe imbalance with standing, but cannot walk without support; grade 3, falling at upright posture.

When we applied the HINTS protocol to our sample, we obtained the same results with a 100% sensitivity and 94.4% specificity.

Only those patients with Stroke presented grade 3 ataxia.

With grade 2 ataxia (38 patients), 11 had a central lesion and 28 a peripheral one, and this was not related to the patient's age.

Taking grade 3 ataxia, it presented a 92.9% sensitivity to separate stroke, with a 61.1% specificity; the sensitivity reaches 100% in AICA infarctions with the same specificity.

In turn, two signs (nystagmus of central origin and Grade 2-3 Ataxia) had a 100% sensitivity with a 61.1% specificity,

– We obtained the same results as those from previous studies using HINTS

– Ataxia has slightly less sensitivity to HINTS but is much easier to evaluate, plus the fact that nystagmus has the same sensitivity as HINTS with less specificity.

OP24-4

Vascular Vertigo

#### **ACUTE TRANSIENT VESTIBULAR SYNDROME: STROKE PREVALENCE AND EFFICACY OF BEDSIDE INFORMATION**

Jae-Hwan CHOI<sup>1</sup>, Kwang-Dong CHOI<sup>2</sup>, Ji Soo KIM<sup>3</sup>

<sup>1</sup>*Department of Neurology, Pusan National University Yangsan Hospital, Korea*

<sup>2</sup>*Department of Neurology, Pusan National University Hospital, Korea*

<sup>3</sup>*Department of Neurology, Seoul National University Bundang Hospital, Korea*

**Objective:** The aim of this work was to determine the stroke prevalence and efficacy of bedside information in acute transient vestibular syndrome (ATVS).

**Methods:** We prospectively recruited 86 patients who presented with ATVS. All patients received constructed examination including four-item HINTS “plus” (head impulse test, nystagmus pattern, test of skew, and hearing loss), and brain MRI. Patients without an obvious causes further received perfusion-weighted imaging (PWI). Multivariable logistic regression was used to determine clinical parameters to identify stroke in ATVS.

**Results:** In ATVS, overall stroke prevalence was 27%, and the efficacy of HINTS plus examination and clinical MRI was limited. HINTS plus could not be applied to the majority of patients due to the resolution of vestibular symptoms, and the sensitivity (57%) of MRI was very low. There was a significantly higher hazard risk of developing stroke in ATVS associated with craniocervical pain (OR = 8.4, 95% CI = 2.0 ~ 34.3) and focal neurologic symptoms/signs (OR = 12.2, 95% CI = 2.4 ~ 60.7). Ten (43%) of 23 patients with stroke showed unilateral cerebellar hypoperfusion on PWI, and eight of them had a focal stenosis or hypoplasia in the corresponding vertebral artery.

**Conclusions:** Our results show that ATVS has a diagnostic challenge simply based on bedside information and clinical MRI. PWI and associated craniocervical pain and neurological symptoms may increase the diagnostic yield for stroke in ATVS. Cerebellar hypoperfusion in ATVS provides an evidence that isolated vertigo actually occur in vertebrobasilar transient ischemic attack requiring broader diagnostic criteria.

## OP24-5

Vascular Vertigo

**HORIZONTAL HEAD IMPULSE IN LATERAL MEDULLARY STROKE PRESENTING AS ACUTE VESTIBULAR SYNDROME****Luke CHEN<sup>1</sup>, Michael J TODD<sup>1</sup>, Michael HALMAGYI<sup>1</sup>, Swee T AW<sup>1</sup>**<sup>1</sup>*Department of Neurology, Rpa Hospital, Australia*

**Background:** Clinical head impulse test may be abnormal in lateral medullary stroke (LMS) presenting as acute vestibular syndrome (AVS), but vestibulo-ocular reflex (VOR) gain and compensatory saccades characteristics, as compared to acute vestibular neuritis (VN), remains unknown.

**Method:** We studied 7 LMS and 20 vestibular neuritis (VN) less than 7 days from vertigo onset (mean 3.4 days), using binocular dual search coils to record eye rotation in response to passive horizontal head impulses.

**Results:** In LMS the VOR gain was mildly reduced bilaterally in 6 (ipsilesional [I] = 0.68, contralateral [C] = 0.69; asymmetry 9%), in contrast to VN (I = 0.22, C = 0.76; asymmetry = 54%). Saccade cumulative amplitude was smaller in LMS unilaterally (I = 2.7°, C = 1.7°) compared with VN (I = 8.5°, C = 1.3°), and amplitude asymmetry was less in LMS (48%) than VN (84%). In one patient gain (I = 0.27, C = 0.65; asymmetry 37%), saccade cumulative amplitude (I = 8.8°, C = 1.0°) and amplitude asymmetry (88%) were similar to VN.

**Conclusion:** In LMS gain and saccade characteristics differ from VN, but occasionally can mimic VN. Future prospective studies should determine the diagnostic utility of gain and saccade analysis in unselected AVS.

## OP24-6

Vascular Vertigo

**ICTAL NYSTAGMUS CHARACTERISTICS IN CENTRAL ACUTE VESTIBULAR SYNDROMES****Gulden AKDAL<sup>1</sup>, Tural TANRIVERDI<sup>1</sup>, Druvinka BANDARANAYAKE<sup>2</sup>, Hatice LIMONCU<sup>1</sup>, Andrew BRADSHAW<sup>2</sup>, Miriam WELGAMPOLA<sup>2</sup>**<sup>1</sup>*Department of Neurology, Dokuz Eylul University Hospital, Izmir, Turkey*<sup>2</sup>*Department of Neurology, Royal Prince Alfred Hospital, Australia*

**Background:** Ictal nystagmus characteristics complement head-impulse testing in the separation of vestibular neuritis from strokes.

**Aims:** To describe the ictal nystagmus characteristics of acute vestibular syndromes (AVS) of central origin.

**Methods:** Ten subjects who presented to a tertiary referral hospital with acute vestibular syndromes of vascular origin (two mesencephalic, one pontine, three medullary, three cerebellar and one thalamic stroke) underwent serial bedside video-nystagmography using stand-alone portable video glasses. Video data were acquired at a sampling frequency of 30Hz and analysed in 2D.

**Results:** All three subjects with medullary infarcts had contraversive horizontal-nystagmus recorded on five consecutive days after symptom onset (SPV range 3.1–29.1 deg/s). One subject with Wallenberg syndrome had a variable upbeat component (SPV 3.1–12.4 deg/s). One further subject with Wallenberg syndrome demonstrated additional gaze-evoked nystagmus and upbeat torsional-geotropic nystagmus on Hallpike testing.

Pontine infarction was associated with contraversive horizontal 7.3 deg/s and upbeat (9.2 deg/s) spontaneous nystagmus.

Mesencephalic infarcts were associated with very low-amplitude ipsiversive and contraversive horizontal-nystagmus (1–2 deg/s) with upbeat components.

Cerebellar infarcts were associated with both ipsiversive and contraversive horizontal-nystagmus.

The subject with a right thalamic infarct demonstrated right-beating horizontal-nystagmus (SPV 6.3 deg/s).

**Conclusions:** Our preliminary observations indicate that central AVS can present with diverse nystagmus patterns that evolve over time. Familiarity with these nystagmus patterns and their comparison with spontaneous-nystagmus observed in vestibular neuritis will be useful when assessing patients with delayed presentations.

## OP24-7

Vascular Vertigo

**LATERAL CANAL PERSISTENT DIRECTION CHANGING POSITIONAL NYSTAGMUS ACUTE VERTIGO DUE TO MICROVASCULAR CUPULOPATHY****Giacinto ASPRELLA LIBONATI***Department of Ent, Giovanni Paolo II Hospital, Policoro, Mt, Italy*

Acute vertigo is sometimes associated with Persistent Direction Changing Positional Nystagmus (PDCPN) beating on the horizontal axis and showing geotropism. Such a nystagmus is observed either rotating the head from side to side in the yaw plane while supine, or changing its bending angle in the pitch plane in upright position. It has been suggested that this phenomenon could be caused by a modified density ratio between the Lateral Semicircular Canal (LSC) cupula and the surrounding endolymph. It was hypothesized that the cupula is lighter than the endolymph (light cupula) in patients showing a geotropic PDCPN, beating towards the lowermost ear, and the cupula is heavier (heavy cupula) when apogeotropic nystagmus, beating towards the uppermost ear, is observed.

The pathophysiological mechanism modifying cupula's specific gravity isn't yet completely clarified.

Acute vertigo with PDCPN ascribable to a cupulopathy mechanism, has been described in course of vestibular migraine attack. It has been hypothesized that the mechanisms involved in migraine, e.g. a localized fluid diffusion from the labyrinth microcirculation due to migraine, could be held responsible for an acute perturbation in the labyrinthine function, which could generate a transitory cupula dynamics disorder such as a light/heavy cupula mechanism.

The Author reports his experience in observing acute vertigo in course of hypertensive crisis with clinical signs suggestive of a transitory cupulopathy with PDCPN ascribable to a light/heavy cupula mechanism.

The aim of this study is to describe the clinical characteristics of 25 patients with persistent PDCPN observed in course of hypertensive crisis.

## OP24-8

Vascular Vertigo

**THE AUDIO-VESTIBULAR CHARACTERISTICS OF VERTIGO WITH SUDDEN HEARING LOSS**

Jacob M POGSON<sup>1,2,3</sup>, Rachael L TAYLOR<sup>1,2</sup>, Allison S YOUNG<sup>1</sup>, Leigh A MCGARVIE<sup>1,2</sup>, Sean FLANAGAN<sup>3,4</sup>, G Michael HALMAGYI<sup>1,2</sup>, Miriam S WELGAMPOLA<sup>1,2</sup>

<sup>1</sup>Department of Neurology, Royal Prince Alfred Hospital, Sydney, Australia

<sup>2</sup>Department of Medicine, The University of Sydney, Sydney, Australia

<sup>3</sup>Department of Otolaryngology, Head And Neck And Skull Base Surgery, St Vincent's Hospital, Sydney, Australia

<sup>4</sup>Department of Medicine, Unsw, Sydney, Australia

Acute vertigo with sudden sensorineural hearing loss (SSNHL) is a rare clinical emergency. Here we report the clinical presentation, audiology and vestibular function tests of 26 subjects who presented with these symptoms.

The vestibular test battery consisted of a three-dimensional video head impulse test (vHIT) of semicircular canal function, and recording ocular and cervical vestibular evoked myogenic potentials (oVEMP, cVEMP) to test otolith dysfunction. Unlike vestibular neuritis, where the horizontal and anterior canal with utricular function is more frequently impaired, 83% of subjects with vertigo and SSNHL demonstrated impairment of the posterior canal gain ( $0.45 \pm 0.18$ ). Only 44% showed impairment of the horizontal canal gains ( $0.79 \pm 0.22$ ) and 38% of the anterior canal gains ( $0.75 \pm 0.24$ ), while 44% (asymmetry ratio[AR] =  $46.1 \pm 43$ ) of oVEMPs and 38% (AR =  $48.4 \pm 41.6$ ) of cVEMPs were significantly asymmetrical. Of the 24 patients who had complete vestibular testing 14 (56%) had abnormalities referable to both divisions of the vestibular nerve, 7 (28%) had abnormalities referable to the inferior vestibular nerve territory, and 4 (16%) had normal vestibular results. Twenty subjects were diagnosed with labyrinthitis, three with labyrinthine infarction, and one each with Ramsay Hunt Syndrome, labyrinthine haemorrhage and traction injury.

Eight subjects had additional paroxysmal positional vertigo and nystagmus indicative of secondary canalolithiasis; six affecting the posterior canal, one was affecting the horizontal canal, and one affecting both horizontal and posterior canals. All but one had prolonged paroxysms of positional nystagmus lasting 50-185 seconds.

Vestibular test results did not provide easy separation between ischaemic and non-ischaemic causes of vertigo with SSNHL.

#### OP25-1

Functional, Psychiatric, Autonomic Disorders, and Others II

#### MOTOR PERFORMANCE AND VESTIBULAR FUNCTION IN A CONGENITAL CYTOMEGALOVIRUS INFECTION OR A CONNEXIN 26 MUTATION

**Leen MAES**<sup>1,2</sup>, Alexandra DE KEGEL<sup>3,4,5</sup>, Hilde VAN WAELVELDE<sup>3</sup>, Els DE LEENHEER<sup>4,6</sup>, Helen VAN HOECKE<sup>4,6</sup>, Julie GODERIS<sup>4</sup>, Ingeborg DHOOGHE<sup>4,6</sup>

<sup>1</sup>Department of Speech, Language And Hearing Sciences, Ghent University, Faculty of Medicine And Health Sciences, Belgium

<sup>2</sup>Department of Biomedical Physics, Antwerp University, Faculty of Science, Belgium

<sup>3</sup>Department of Rehabilitation Sciences And Physiotherapy, Ghent University, Faculty of Medicine And Health Sciences, Belgium

<sup>4</sup>Department of Oto-rhino-laryngology, University Hospital Ghent, Belgium

<sup>5</sup>Department of Rehabilitation, Rehabilitation Center Sint-lievenspoort, Belgium

<sup>6</sup>Department of Otorhinolaryngology, Ghent University, Faculty of Medicine And Health Sciences, Belgium

**Introduction and objective:** Hearing-impaired children are at risk for vestibular damage and delayed motor development. Two major causes of congenital hearing loss are cytomegalovirus (CMV) infection and connexin (Cx) 26 mutations. Comparison of the motor performance and vestibular function between these specific groups is still underexplored. The objective of this study was to investigate the impact of congenital (c)CMV and Cx26 on the motor performance and vestibular function in 6 months old infants.

**Methods:** Forty children (mean age 6.7 months; range 4.8–8.9 months) participated in this cross-sectional design and were divided into five age-matched groups: normal hearing control, asymptomatic cCMV, normal hearing symptomatic cCMV, hearing impaired symptomatic cCMV, and hearing impaired Cx26. Children were examined with the Peabody Developmental Motor Scales-2 and collic vestibular evoked myogenic potential (cVEMP) test.

**Results:** Symptomatic hearing-impaired cCMV children demonstrated a significantly lower gross motor performance compared to the control group ( $p = 0.005$ ), the asymptomatic cCMV group ( $p = 0.034$ ) and the Cx26 group ( $p = 0.016$ ). In this symptomatic hearing-impaired cCMV group, 4 out of 8 children had absent cVEMP responses which was related to the weakest gross motor performance. The Cx26 children showed no significant delay in motor development compared to the control children and none of these children had absent cVEMP responses.

**Conclusions:** The weakest gross motor performance was found in symptomatic hearing-impaired cCMV-infected children with absent cVEMP responses. Abnormal saccular responses were a major factor for this motor delay. Systematic evaluation of cVEMP in cCMV-infected infants can add to early intervention strategies.

#### OP25-2

Functional, Psychiatric, Autonomic Disorders, and Others II

#### DIZZINESS AND DEPRESSION-SSRI AND VESTIBULAR FUNCTION

**Kensuke KIYOMIZU**<sup>1,2</sup>, Keiji MATSUDA<sup>2</sup>, Koji TORIHARA<sup>2</sup>, Hironori FUJII<sup>3</sup>, Hiroaki SHIMOGORI<sup>4</sup>, Ryuichiro TAKEDA<sup>5</sup>, Yasushi ISHIDA<sup>6</sup>, Kensei YOSHIDA<sup>1</sup>, Tetsuya TONO<sup>2</sup>

<sup>1</sup>Department of Psychiatry, Yoshida Hospital, Japan

<sup>2</sup>Department of Otorhinolaryngology, Head & Neck Surgery, Faculty of Medicine, University of Miyazaki, Japan

<sup>3</sup>Department of Otorhinolaryngology, University of Yamaguchi, Japan

<sup>4</sup>Department of Otorhinolaryngology, Yamaguchi Rosai Hospital, Japan

<sup>5</sup>Department of Healthcare And Security Center, University of Miyazaki, Japan

<sup>6</sup>Department of Clinical Neuroscience, Faculty of Medicine, University of Miyazaki, Japan

**Objective:** It is well known that selective serotonin reuptake inhibitor (SSRI) is effective for patients with dizziness and depression. However, there are only few papers about vestibular function for those patients. We therefore performed vestibular ocular reflex tests in rotation (VOR tests) and utilized Dizziness Handicap Inventory (DHI) questionnaire before and after SSRI therapy.

**Methods:** Out of 97 depressive patients in 820 patients with dizziness in our psychiatric hospital, the subjects were 9 patients (3 men, 6 women) (mean age, 57.7 years) experiencing dizziness and depression with the following conditions (SSRI group); 1) regular treatment including anti-vertiginous drugs, physical therapy, minor tranquilizer or sleep medications were not effective, 2) non-acute phase, 3) non-prescription of antidepressants, 4) signature of consent form approved by the ethics committee in University of Yamaguchi. VOR tests were performed using video-oculograph (Nystamo21 type 2, IRN-2, Morita Manufacturing corporation, Tokyo). Eye movements were monitored using an infrared eye camera installed in the goggles. Head movements were transduced to d.c. signals (range 0–5 V) by a small angular velocity sensor.

**Results:** After about 4 weeks of using additional SSRI treatment, DHI scores were improved significantly (57.4–31.8). In VOR tests, DP% scores (vestibular function) were improved significantly (26.6–9.46).

**Conclusions:** These results of the present clinical research suggested that SSRI might have some effects which improved the vestibular function in patients with dizziness and depression.

#### OP25-3

Functional, Psychiatric, Autonomic Disorders, and Others II

#### INTRANASAL SCOPOLAMINE AFFECTS THE SEMICIRCULAR CANALS CENTRALLY AND PERIPHERALLY.

Aurélie P WEERTS<sup>1,4,5</sup>, Lakshmi PUTCHA<sup>2</sup>, Stephen W HOAG<sup>3</sup>, Emma HALLGREN<sup>1,5</sup>, Angelique VAN OMBERGEN<sup>1,4,5</sup>, Paul H VAN DE HEYNING<sup>1,4,6</sup>, Floris L WUYTS<sup>1,5</sup>

<sup>1</sup>Department of Physics, Antwerp University Research Centre For Equilibrium And Aerospace, University of Antwerp, Belgium

<sup>2</sup>Department of Biomedical Operations And Research Branch, Nasa Johnson Space Center, USA

<sup>3</sup>Department of Pharmaceutical Sciences, School of Pharmacy, University of Maryland, USA

<sup>4</sup>Department of Faculty of Medicine And Health Sciences, University of Antwerp, Belgium

<sup>5</sup>Department of Physics, Faculty of Sciences, University of Antwerp, Belgium

<sup>6</sup>Department of Otorhinolaryngology, Antwerp University Hospital, Belgium

Space motion sickness (SMS), a condition caused by an intravestibular conflict, remains an important obstacle that astronauts encounter during the first days in space. Promethazine is currently the standard treatment of SMS, but scopolamine is used by some astronauts to prevent SMS. However, the oral and transdermal routes of administration of scopolamine are known to have substantial drawbacks. Intranasal administration of scopolamine ensures a fast absorption and rapid onset of therapeutic effect, which might prove to be suitable for use during spaceflights. The aim of this study was to evaluate the effects of intranasally administered scopolamine (0.4 mg) on the semicircular canals (SCCs) and the otoliths. This double-blind, placebo-controlled study was performed on 19 healthy male subjects. The function of the horizontal SCC and the vestibulo-ocular reflex, as well as the saccular function and utricular function, were evaluated. Scopolamine turned out to affect mainly the SCCs centrally and peripherally but also the utricles to a lesser extent. Centrally, the most probable site of action is the medial vestibular nucleus, where the highest density of muscarinic receptors has been demonstrated and afferent fibers from the SCCs and utricles synapse. Furthermore, our results suggest the presence of muscarinic receptors in the peripheral vestibular system on which scopolamine has a suppressive effect. Given the depressant actions on the SCCs, it is suggested that the pharmacodynamic effect of scopolamine may be attributed to the obliteration of intravestibular conflict that arises during (S)MS.

#### OP25-4

Functional, Psychiatric, Autonomic Disorders, and Others II

#### PSYCHOLOGICAL EVALUATION OF THE PATIENTS WITH VERTIGO DUE TO OTOLITH ORGAN

Toru SEO<sup>1</sup>, Takaaki KOBAYASHI<sup>1</sup>, Ko SHIRAISHI<sup>1</sup>, Mutsukazu KITANO<sup>1</sup>, Toshizou KOIZUMI<sup>1</sup>, Katsumi DOI<sup>1</sup>

<sup>1</sup>Department of Otolaryngology, Kinki University, Japan

**Introduction:** A new clinical entity as disequilibrium due to the otolith dysfunction has been established since era of vestibular evoked myogenic potential (VEMP). Some cases of them complained of severe psychological problems. We studied the psychological examinations for the patients with otolith vertigo,

**Subjects and a method:** Subjects were 19 patients who were diagnosed as otolith vertigo. The tentative diagnostic criteria is following; 1) the complaint was of non-rotatory disequilibrium. 2) Abnormal results were shown on cVEMP and/or oVEMP. 3) There were no abnormal results from routine examinations. 4) There were no cerebellar signs or intracranial lesions detected by brain MRI. Their psychological conditions were evaluated using Cornel Medical Index (CMI), State-Trait Anxiety Inventory (STAII) and a self-evaluation dejection standard (SDS). In addition, 13 patients with benign paroxysmal positional vertigo (BPPV) and 27 patients with Meniere's disease were also evaluated.

**Result:** Abnormal results on CMI were shown in 58%, 15% and 37% of the subject with otolith vertigo, BPPV and Meniere's disease respectively. The subjects with otolith vertigo resulted in higher state anxiety than trait anxiety in STAII. Depressive tendency on SDS was shown in 20%, 38% and 33% of subjects with otolith vertigo, BPPV and Meniere's disease respectively.

**Consideration:** The high anxiety in the subjects with otolith vertigo may originate from the recurrence of symptoms without trigger and diagnose as the unknown origin in another clinic. Their daily livings were not limited thus the tendency of depression was less in the subject with otolith vertigo.

#### OP25-5

Functional, Psychiatric, Autonomic Disorders, and Others II

#### NEUROPSYCHIATRIC DIFFERENCES BETWEEN DIZZINESS AND VERTIGO

**Byung In HAN<sup>1</sup>, Sung-Pa PARK<sup>2</sup>, Hyun Ah KIM<sup>3</sup>, Ho-Won LEE<sup>2</sup>, Pan-Woo KO<sup>2</sup>, Hyung LEE<sup>3</sup>**

<sup>1</sup>Department of Neurology, Do Neurology Clinic, Korea

<sup>2</sup>Department of Neurology, School of Medicine, Kyungpook National University, Korea

<sup>3</sup>Department of Neurology, Keimyung University Dongsan Hospital, Korea

**Background and purpose:** The objectives of this study were to identify the clinical characteristics in patients with dizziness, and patients with vertigo, with respect to the severity of symptoms of dizziness, fatigue, insomnia, anxiety, and depression.

**Methods:** Thirty patients (13 men and 17 women between the ages of 20 and 65; mean age 42.3) with a new episode of daily dizziness for less than 30 days were included and asked to complete the dizziness handicap inventory (DHI), fatigue severity scale (FSS), insomnia severity index (ISI), Beck anxiety index (BAI), and Beck depression index (BDI). Additionally, 19 patients (7 men and 12 women between the ages of 20 and 65; mean age 55.6) with vertigo who had BPPV (Benign paroxysmal positional vertigo) or unilateral vestibulopathy were included and were asked to complete the same measurements. The measured scores were compared between the dizziness group and the vertigo group.

**Results:** The means of age, symptom duration, DHI, FSS, ISI, BAI, and BDI of the dizziness patients were 42.3, 14.5 days, 29.4, 4.2, 10.1, 20.2, and 15.6 respectively. Those of vertigo patients were 55.6, 9.1 days, 19.8, 2.1, 7.1, 10.3, and 10.4 respectively. After correcting age and symptom duration, compared with vertigo patients, dizziness patients had higher scores in FSS ( $p = 0.001$ ) and BAI ( $p = 0.003$ ).

**Conclusion:** Dizziness patients had severer fatigue and anxiety than vertigo patients. Therefore, the dizziness patients would be benefited if their fatigue and insomnia are adequately treated.

**Key Words:** dizziness, vertigo, fatigue, insomnia, anxiety, depression

#### OP25-6

Functional, Psychiatric, Autonomic Disorders, and Others II

#### GULF WAR ILLNESS IN US VETERANS IS ASSOCIATED WITH OTOLITH HYPOFUNCTION AND DECREASED BRAIN BLOOD FLOW

**Jorge Manuel SERRADOR<sup>1,2,3</sup>**

<sup>1</sup>Department of Pharmacology, Physiology & Neuroscience, Rutgers, USA

<sup>2</sup>Department of War Related Injury & Illness, Dept of Veteran Affairs, USA

<sup>3</sup>Department of Cardiovascular Electronics, National University of Ireland Galway, Ireland

Gulf War Illness (GWI) is a chronic fatigue like syndrome that plagues almost 25% of the 700,000 veterans that returned from operation Desert Storm/Desert Shield in 1990–91 and presents with cognitive problems and brain fog. To examine a possible role for vestibular inputs in this syndrome, we recruited a group of 9 veterans with GWI who were participating in an autonomic study. We measured ocular torsion in these individuals during a  $\pm 20^\circ$  sinusoidal roll tilt at 0.05 Hz. We also measured beat-by-beat blood pressure using a finger cuff and cerebral blood flow velocity using transcranial Doppler during a sit to stand test. We found that ocular torsion was significantly correlated to the decrease in cerebral blood flow when standing ( $R = 0.47, P < 0.05$ ) with lower torsion being associated with greater decreases in cerebral flow. In contrast, there was no relationship between torsion and blood pressure or heart rate while standing. These data suggest that veterans with GWI and poor otolith function (indicated by low ocular torsion) demonstrate greater drops in brain blood flow when standing. Since maintenance of brain blood flow is essential to cognitive function, reduced brain blood flow upright might contribute to cognitive impairment. These data are consistent with the theory that otolith mediated inputs of gravity, help to dilate your cerebral vessels when upright and maintain cerebral blood flow when your head is above your heart. Without intact otolith function, this dilation may be impaired and these individuals may be suffering from cerebral hypoperfusion. Supported by grant W81XWH-14-1-0598 (Serrador).

## OP25-7

Functional, Psychiatric, Autonomic Disorders, and Others II

**STUDY OF MOTION SICKNESS IN PILOTAGE STUDENTS USING MOTION SICKNESS SUSCEPTIBILITY QUESTIONNAIRE PERSIAN-VERSION**

**Mehrnaz HOSSEINI<sup>1,2</sup>, Saeid FARAHANI<sup>2</sup>, Mansoureh ADEL GHAHRAMAN<sup>2</sup>, Shohre JALAIE<sup>3</sup>, Aboulfazl KHADEMI<sup>4</sup>**

<sup>1</sup>*Department of Audiology, Iran University of Medical Sciences, School of Rehabilitation, Iran*

<sup>2</sup>*Department of Audiology, Tehran University of Medical Sciences, School of Rehabilitation, Iran*

<sup>3</sup>*Department of Biostatistics, Tehran University of Medical Sciences, School of Rehabilitation, Iran*

<sup>4</sup>*Department of Aerospace Medicine, Aja University, School of Aerospace Medicine, Iran*

**Introduction:** Motion sickness is a known problem while facing with various types of evoking motions. Motion sickness susceptibility questionnaire short-form is the most applicable questionnaire to predict motion sickness. The aim of this study was to standardize the Persian version of this questionnaire; and then comparing motion sickness susceptibility between military pilotage students and students of Tehran university.

**Methods and materials:** The English version of questionnaire was translated to Persian using the international quality of life questionnaire (IQOLA) protocol; and then was culturally adapted. after face validity confirmation, the Persian version was conducted in 223 Tehran university and 80 pilotage school students. the reliability was checked after two weeks with 113 participants.

**Results:** The Persian version of questionnaire showed good face, concurrent and discriminant validity, and high internal consistency with Cronbach alpha of 0.91. Interclass correlation coefficient (ICC) was high for total score, and childhood and adulthood subscales ( $p < 0.00$ ). There was higher susceptibility for childhood subscale than adulthood ( $t = 8.702, p < 0.00$ ). Lower susceptibility was indicated for pilotage students ( $t = 7.418, p < 0.000$ ).

**Conclusion:** According to strong psychometric properties, the Persian version of questionnaire has good validity and reliability to predict different susceptibilities to motion sickness. Reduced susceptibility in adulthood than childhood suggests habituation effects due to repeated exposure to evoking motions. Lower susceptibility in military pilotage students probably reflects onset of vestibular adaptation process induced by continuous exposure to parabolic maneuver, or effect of being medical and physical selected individuals entering the military pilotage course.

**Keywords:** motion sickness, vestibular system, Persian

## OP25-8

Functional, Psychiatric, Autonomic Disorders, and Others II

**DYSFUNCTIONAL VESTIBULAR SYSTEM CAUSES A BLOOD PRESSURE DROP IN ASTRONAUTS RETURNING FROM SPACE**

Emma HALLGREN<sup>1</sup>, Pierre-Francois MIGEOTTE<sup>2</sup>, Liudmila KORNILOVA<sup>3</sup>, Quinten DELIÈRE<sup>2</sup>, Erik FRANSEN<sup>4</sup>, Dmitrii GLUKHikh<sup>1,3</sup>, Steven T MOORE<sup>5</sup>, Gilles CLÉMENT<sup>6</sup>, André DIEDRICH<sup>7</sup>, Hamish MACDOUGALL<sup>8</sup>, **Floris L WUYTS<sup>1</sup>**

<sup>1</sup>Department of Physics, Antwerp University Research Centre For Equilibrium And Aerospace, University of Antwerp, Belgium

<sup>2</sup>Department of Department of Cardiology, Laboratory of Physics And Physiology, Université Libre De Bruxelles & Erasmus Hospital, Belgium

<sup>3</sup>Department of Laboratory of Vestibular Physiology, Institute of Biomedical Problems of the Russian Academy of Sciences, Russia

<sup>4</sup>Department of Statua Center For Statistics, University of Antwerp, Belgium

<sup>5</sup>Department of Human Aerospace Laboratory, Icahn School of Medicine At Mount Sinai, USA

<sup>6</sup>Department of Lyon Neuroscience Research Center, Impact Team, University of Lyon, France

<sup>7</sup>Department of Autonomic Dysfunction Center, Vanderbilt University School of Medicine, USA

<sup>8</sup>Department of Sydney Human Factors Research, School of Psychology, University of Sydney, Australia

It is a challenge for the human body to maintain stable blood pressure while standing. The body's failure to do so can lead to dizziness or even fainting. For decades it has been postulated that the vestibular organ can prevent a drop in pressure during a position change – supposedly mediated by reflexes to the cardiovascular system. We show – for the first time – a significant correlation between decreased functionality of the vestibular otolith system and a decrease in the mean arterial pressure when a person stands up. Until now, no experiments on Earth could selectively suppress both otolith systems; astronauts returning from space are a unique group of subjects in this regard. Their otolith systems are being temporarily disturbed and at the same time they often suffer from blood pressure instability. In our study, we observed the functioning of both the otolith and the cardiovascular system of the astronauts before and after spaceflight. Our finding indicates that an intact otolith system plays an important role in preventing blood pressure instability during orthostatic challenges. Our finding not only has important implications for human space exploration; they may also improve the treatment of unstable blood pressure here on Earth.

## OP25-9

Functional, Psychiatric, Autonomic Disorders, and Others II

**THE IMPACT OF CHRONIC PERIPHERAL VESTIBULOPATHY ON BONE MINERAL DENSITY**

**Avi SHUPAK<sup>1,2,5</sup>**, Nabil FARANESH<sup>1,3</sup>, Suzane FARANESH ABOUD<sup>4</sup>, Suleiman ZAAROURA<sup>3</sup>, Nathan PELED<sup>4,5</sup>

<sup>1</sup>Department of Otoneurology, Lin Medical Center, Haifa, Israel

<sup>2</sup>Department of Otolaryngology Head And Neck Surgery, Carmel Medical Center, Haifa, Israel

<sup>3</sup>Department of Otolaryngology, Head And Neck Surgery, French Hospital, Nazareth, Israel

<sup>4</sup>Department of Radiology, Carmel Medical Center, Haifa, Israel

<sup>5</sup>Department of Bruce Rappaport Faculty of Medicine, Technion-israel Institute of Technology, Haifa, Israel

Control of bone remodeling by the sympathetic nervous system was demonstrated in mice and rats, while in humans an association was found between the use of β-blockers, reduced fracture risk and higher bone mineral density. Also, vestibular dysfunction affects autonomic respiratory control resulting in hypoventilation and hypercapnia while chronic hypercapnia is associated with reduced bone density. Recent studies in rodents suggest that vestibular dysfunction might alter bone remodeling by affecting the outflow of sympathetic nervous signals to the skeleton. These observations raise the question whether chronic vestibular dysfunction in humans is associated with reduced bone density. The data base of a tertiary otoneurology unit was retrospectively screened for patients who had CT of the lumbar spine for reasons not related to their vestibular evaluation. This cohort was divided to two groups: 49 patients with proved chronic peripheral vestibular dysfunction – the study group; 50 patients having normal

vestibular function – the control group. Bone mineral density (BMD) of the lumbar spine was calculated by a BMD application software. The average BMD scores for the study and control groups were  $90.46 \pm 23.88$  and  $89.85 \pm 28.25$  respectively ( $p = 0.9$ ). The average T scores that compare the patient's BMD to the mean BMD of a young healthy individual reached  $-2.95 \pm 0.72$  and  $-2.92 \pm 0.88$  respectively ( $p = 0.88$ ). The average Z scores comparing the patient's BMD to the mean BMD of patients their own age, gender, and race were  $-0.64 \pm 0.7$  and  $-0.68 \pm 0.89$  respectively ( $p = 0.82$ ). The results do not show significant association between chronic peripheral vestibular derangement and reduced BMD.

OP26-1

Head Impulse Test II

#### **ROLE OF VIDEO HEAD-IMPULSE TEST IN LATERALIZATION OF VESTIBULOPATHY: COMPARATIVE STUDY WITH CALORIC TEST**

Pona PARK<sup>1</sup>, Joo Hyun PARK<sup>2</sup>, Ji Soo KIM<sup>3</sup>, Ja-Won KOO<sup>4</sup>, Jae Joon HAN<sup>4</sup>

<sup>1</sup>Department of Otorhinolaryngology, Seoul National University Hospital, Korea

<sup>2</sup>Department of Otorhinolaryngology, Dongguk University Ilsan Hospital, Korea

<sup>3</sup>Department of Neurology, Seoul National University Bundang Hospital, Korea

<sup>4</sup>Department of Otorhinolaryngology, Seoul National University Bundang Hospital, Korea

Among diagnostic tests evaluating dizzy patients, caloric test and the head-impulse test (HIT) are important tools in evaluation of unilateral vestibular hypofunction. Since new video head-impulse test (vHIT) is introduced, various studies tried to evaluate the diagnostic value of this system. To evaluate the lateralization value of vHIT in unilateral vestibulopathy, we compared its variables with those of a caloric test.

In total, 19 healthy volunteers and 92 dizzy patients who underwent both a caloric test and a vHIT were enrolled. Patients were divided into two groups depending on their fluctuating pattern of vertigo. The vestibulo-ocular reflex (VOR) gain and gain asymmetry (GA) of a vHIT, and unilateral weakness (UW) and the sum of the slow-phase velocities (SPVs) of warm and cold irrigation of the same side were compared. A cutoff value of VOR gain of a vHIT was also calculated using a receiver-operating characteristic curve.

A VOR gain in an affected ear and GA of a vHIT showed a statistically significant correlation with UW in a caloric response. There was a significant correlation between vHIT parameters and a caloric test in the group with fluctuating vertigo. Moreover, the cutoff value of a vHIT was determined to be 0.875, derived under the assumption that UW of a caloric test equal to or less than 25% is normal.

A VOR gain or GA of a vHIT may be a useful parameter in evaluating unilateral vestibulopathy. The vHIT can act as a complementary tool for lateralization of unilateral vestibular hypofunction.

OP26-2

Head Impulse Test II

#### **VIDEO HEAD IMPULSE TEST IN PERIPHERAL VESTIBULAR DISEASES**

Ying LIN

Department of Otolaryngology Head Neck Surgery, Xijing Hospital, China

**Objectives:** The function of the semicircular canal receptors and the pathway of the vestibulo-ocular reflex (VOR) can be diagnosed with the clinical head impulse test. The aim of the study was to investigate the horizontal VOR by means of video head impulse test in peripheral vestibular disorders.

**Methods:** Using the vHIT, we examined horizontal semicircular canal VOR in a group of 55 patients and a control group of 20 healthy subjects. The group of patients included vestibular neuritis (VN) ( $n = 10$ ), vestibular schwannoma (VS) ( $n = 6$ ), Meniere's disease (MD) ( $n = 12$ ), bilateral vestibulopathy (BV) ( $n = 15$ ) and idiopathic sudden hearing loss with vertigo (ISHL) ( $n = 13$ ).

**Results:** Instantaneous gain of 40 ms, 60 ms and 80 ms of horizontal VOR is  $0.88 \pm 0.17$ ,  $0.94 \pm 0.13$  and  $0.96 \pm 0.13$ . Regression Gain at 60 ms is  $0.99 \pm 0.11$ , and asymmetry is  $5.6 \pm 3.5$ . Normal range of 60 ms instantaneous gain is  $>0.73$ , Normal range of regression gain is  $>0.80$ . Abnormal vHIT was found in VS (100%), VN (90.9%), BV (86.7%), MD (40%) and ISHL (38.5%). Three conditions of refixation saccades occurred in cases with abnormal

VOR: isolated covert saccades (12.5%), isolated overt saccades (45%) and the combination of overt and covert saccades (42.5%).

**Conclusions:** The vHIT detects abnormal VOR changes in the combination of gain assessment and refixation saccades. Since isolated covert saccades in VOR changes can only be seen with vHIT, peripheral vestibular disorders are likely to be diagnosed incorrectly with the HIT to a certain amount.

#### OP26-3

Head Impulse Test II

#### ASSESSMENT OF REPRODUCIBILITY OF VHIT MEASURES OF CANAL FUNCTION

**Jorge Manuel SERRADOR**<sup>1,2,3</sup>, Tien LE CAO<sup>2</sup>, **Michael SCHUBERT**<sup>4</sup>

<sup>1</sup>*Department of Pharmacology, Physiology & Neuroscience, Rutgers, USA*

<sup>2</sup>*Department of War Related Injury & Illness, Dept of Veteran Affairs, USA*

<sup>3</sup>*Department of Cardiovascular Electronics, National University of Ireland Galway, USA*

<sup>4</sup>*Department of Otolaryngology Head And Neck Surgery, Johns Hopkins School of Medicine, USA*

The recent introduction of the vHIT to assess canal function as part of vestibular screenings provides a novel and important method to assess all 6 canals. However, reproducibility has not been thoroughly assessed. 26 individuals participated in two vHIT trials on the same day. Peak head velocities were similar within canals, though the head velocities were larger during horizontal ( $\sim 160$  d/s) versus vertical canals ( $\sim 130$  d/s) rotation. We found that the vestibulo-ocular reflex (VOR) was very consistent across all canals with no significant differences in mean gains between trial 1 and 2 in the Left Lateral ( $0.905 \pm 0.09$  vs  $0.901 \pm 0.09$ ), Right Lateral ( $0.978 \pm 0.08$  vs  $0.986 \pm 0.09$ ), Left Anterior ( $0.870 \pm 0.16$  vs  $0.839 \pm 0.15$ ), Right Anterior ( $0.799 \pm 0.19$  vs  $0.783 \pm 0.17$ ), Left Posterior ( $0.803 \pm 0.15$  vs  $0.810 \pm 0.15$ ) or Right Posterior ( $0.837 \pm 0.14$  vs  $0.866 \pm 0.14$ ). Examination of Cronbach's alpha as a measure of reproducibility found quite good reproducibility (Left Lateral: 0.89; Right Lateral: 0.81; Left Anterior: 0.83; Right Anterior: 0.92; Left Posterior: 0.91; Right Posterior: 0.87). Examining the Interclass correlation we also find strong correlations between trial 1 and 2 for each of the canals (Left Lateral: 0.89; Right Lateral: 0.81; Left Anterior: 0.82; Right Anterior: 0.92; Left Posterior: 0.91; Right Posterior: 0.86). Our data suggest vHIT determined VOR gains are very consistent across trials within the same day. Future work is necessary to determine if values are consistent across days. In these data, the same examiner collected the data. Variability may increase if different technicians collect data across test sessions. Supported by DoD grants W81XWH-14-2-0012 (Serrador) and W81XWH-14-1-0598 (Serrador).

#### OP26-4

Head Impulse Test II

#### VHIT – ITS PLACE IN THE ORDER OF USE

**Neil T SHEPARD**<sup>1</sup>, James MCPHERSON<sup>1</sup>

<sup>1</sup>*Department of Otolaryngology, Mayo Clinic Rochester, USA*

We currently have 4 tools to determine peripheral pathology in vestibular testing – Caloric irrigations, Rotary Chair, Ocular/Cervical VEMPs and vHIT. We have previously shown that these tests are highly correlated, but not 100%, i.e. they do not all identify the same persons with peripheral involvement. The purpose of this study is to determine if there is an optimal order of presentation of the 4 tests for maximum efficiency. Out of a group of 400 consecutive patients, all examined by a single provider, 47 had a diagnoses of peripheral involvement that could be based on history and hearing evaluation without the use of vestibular testing (Meniere's, vestibular neuronitis and labyrinthitis). Another 35 had the diagnosis of definite vestibular migraine that was without peripheral involvement, again without the use of the vestibular tests. All patients had each of the 4 evaluations and sensitivity/specificity performance figures were developed for each. Then sensitivity/specificity performance was developed for a 5th & 6th test, the use of the 4 in a parallel loose criteria and the use of the 4 in a sequential (rotating the 1st test) loose criteria format – combined protocols. Logistic regression was then used to determine the contribution of each of the individual tests to the performance of the combined protocols. This information is used to estimate an optimal order of use contingent on which of the 4 are available. Results will be discussed at the presentation as they are currently in process.

## OP26-5

Head Impulse Test II

**A NEW SUPPRESSION HEAD IMPULSE PARADIGM ELICITS ANTI-COMPENSATORY SACCADES AS AN INDICATOR OF VESTIBULAR FUNCTION**Hamish G. MACDOUGALL<sup>1</sup>, Leigh A. MCGARVIE<sup>2</sup>, G. Michael HALMAGYI<sup>2</sup>, Stephen J. ROGERS<sup>1</sup>, Leonardo MANZARI<sup>3</sup>, Ann M. BURGESS<sup>1</sup>, Ian S. CURTHOYS<sup>1</sup>, **Konrad P. WEBER**<sup>4,5</sup><sup>1</sup>*Department of Psychology, University of Sydney, Australia*<sup>2</sup>*Department of Neurology, Royal Prince Alfred Hospital, Sydney, Australia*<sup>3</sup>*Department of Msa Ent Academy Center, Cassino, Italy*<sup>4</sup>*Department of Neurology, University Hospital Zurich, University of Zurich, Switzerland*<sup>5</sup>*Department of Ophthalmology, University Hospital Zurich, University of Zurich, Switzerland*

During the conventional head impulse test paradigm (HIMP), compensatory saccades are a sign of vestibular loss. Here we present a complementary suppression head impulse paradigm (SHIMP) designed to elicit anti-compensatory saccades as an indicator of vestibular function. For novel SHIMP, the subject is asked to follow a head-fixed target, which is rotating with the head, rather than to fixate an earth-fixed target as in HIMP. Five patients with unilateral vestibular loss (UVL), five patients with bilateral vestibular loss (BVL) and six normal subjects were measured with the video head impulse test (vHIT) to compare the two paradigms. Measures of the vestibulo-ocular reflex (VOR) showed close correlation with slightly but significantly lower gains during SHIMP compared to HIMP. As predicted SHIMP showed a reversed saccadic pattern compared to HIMP: While HIMP elicited compensatory saccades opposite to the direction of head rotation mainly in patients, SHIMP elicited anti-compensatory saccades in the direction of head rotation in normals, but only few in BVL patients. To their affected side some UVL patients elicited covert saccades during head rotation with HIMP, but mainly overt saccades after head rotation with SHIMP. Cumulative HIMP and SHIMP saccade amplitude both differentiated patients from normals with high sensitivity and specificity. In conclusion SHIMP elicits a saccadic pattern complementary to conventional HIMP: While compensatory saccades during HIMP indicate vestibular loss, anti-compensatory saccades during SHIMP indicate vestibular function. The new paradigm is simple to perform, easy to explain to patients, and can be readily implemented with vHIT.

## OP26-6

Head Impulse Test II

**EFFECT OF AGING AND DIRECTION OF IMPULSE ON GAIN OF VESTIBULE-OCULAR REFLEX IN VIDEO HEAD IMPULSE TEST****Tae Hwan KIM<sup>1</sup>, Sun O CHANG<sup>1</sup>, Min-Beom KIM<sup>1</sup>**<sup>1</sup>*Department of Otolaryngology Head And Neck Surgery, Kangbuk Samsung Hospital, Sungkyunkwan University, Korea*

**Background and objectives:** The aim of this study was to evaluate the difference of vHIT parameters according to the ages and the direction of the impulse.

**Materials and methods:** 1002 subjects were performed vHIT and 840 subjects were enrolled in this study. We excluded the subjects with current dizziness, abnormalities of caloric or vestibular evoked myogenic potentials, neurologic disorder and evident slippage of goggles. All participants were conducted vHIT (ICS impulse, Otometrics) with horizontal canal, and 462 participants were also performed vHIT with vertical canal. (PSCC, ASCC) The mean VOR gain of each canal with aging and difference of gain according to the direction (rightward or leftward) were analyzed.

**Results:** Mean VOR gain was maintained in horizontal canal below 70 years old ( $1.03 \pm 0.08$ ) and in vertical canal below 79 years old. (PSCC:  $0.94 \pm 0.12$ , ASCC:  $0.97 \pm 0.14$ ) But the decrease of VOR gain was identified over 70 years old in horizontal canal ( $0.97, p < 0.001$ ) and over 80 years old in vertical canal (PSCC:  $0.82 \pm 0.16$ , ASCC:  $0.85 \pm 0.13, p < 0.001$ ). In addition, VOR gain of rightward horizontal impulse was higher than leftward impulse (Rt gain:  $1.05 \pm 0.09$ , Lt gain:  $1.00 \pm 0.11, p < 0.001$ ), but there was no difference during the vertical impulse test.

**Conclusion:** VOR gain seemed to decline as age increased over 70s on horizontal canal and over 80s on vertical canal in vHIT. Additionally, horizontal VOR gain of rightward impulse was higher than leftward impulse in recording of right eye only, but vertical canal did not show difference of gain according to the direction of impulse.

#### OP27-1

Gait, Posture, and Spatial Orientation II

#### EVALUATING CHANGES IN BALANCE AT HIGH ALTITUDES

**Oz ZUR**<sup>1,2</sup>, Yacov FOGELMAN<sup>3</sup>, Eli CARMELI<sup>4</sup>

<sup>1</sup>Department of Director, The Israeli Center For Dizziness And Balance Disorders, Israel

<sup>2</sup>Department of Physical Therapy, Ben Gurion University of the Negev, Israel

<sup>3</sup>Department of Rappaport Faculty of Medicine, The Technion Institute of Technology, Israel

<sup>4</sup>Department of Physical Therapy, University of Haifa, Israel

**Background:** Due to hypoxia and hypobaric conditions at high altitudes, oxygen saturation decreases. Ataxia might occur and the ability to maintain balance is challenged.

**Objectives:** To determine whether a new balance assessment test, the Zur Balance Scale (ZBS) is reliable for detecting changes in balance at high altitudes.

**Methods:** Seven healthy men, 30–64 years of age, volunteered to participate. During a 14-day journey to Mt. Everest Base Camp, Nepal, balance was evaluated with the ZBS and the Single Leg Balance Test. Physiological tests included PO2 saturation (%), systolic and diastolic blood pressure (BP) (mmHg) and heart rate (pulse/min). Data were collected at altitudes of 0 m, 2,610 m, 3,300 m, 4,400 m, and 4,950 m above sea level.

**Results:** The ZBS scores decreased significantly ( $P < 0.001$ ) as altitude increased. For the Single Leg Balance Test, only balance with eyes closed decreased as altitude increased ( $P < 0.037$ ). Heart rate increased with increasing altitude, while systolic, diastolic BP and PO2 saturation decreased ( $P < 0.02$ ).

**Conclusions:** Poor balance control can contribute to risk of falls that might result in injury or death, especially from high places. Balance control is decreased at increasing altitudes. The ZBS is portable and easy to administer. It is a suitable test for measuring balance function at both normal and at high altitudes.

#### OP27-2

Gait, Posture, and Spatial Orientation II

#### IDENTIFICATION OF VESTIBULAR ILLUSIONS IN FLIGHT

**Jelte BOS**<sup>1</sup>, Mark HOUTBEN<sup>1</sup>, Eric GROEN<sup>1</sup>

<sup>1</sup>Department of Perceptual And Cognitive Systems, Tno, Netherlands

Investigators of airplane accidents can have difficulty to determine if a pilot suffered from spatial disorientation (SD). Although today's aviation is very safe, accidents and major incidents occur occasionally, and vestibular illusions have been suspected as an important contributing factor. To assist accident investigators in identifying possible events of illusory aircraft motion and attitude, based on, e.g., the flight path preceding a crash as recovered from the flight data recorder, we made a software tool that 1) takes an aircraft motion history, 2) predicts the pilot's perception of motion and attitude based on an existing vestibular neuro-physiological perception model, 3) identifies specific SD events based on a newly developed taxonomy, and 4) displays the results for interpretation, possibly together with the control inputs given by the pilot. The vestibular illusions reckoned and covering the most important ones in flight are those caused by subthreshold motion, the somatogravic illusion, and the somatogyral per-, post- and counter-rotatory illusions. Application of the model has been proved to be valuable in identifying specific SD events as the likely cause of a number of mishaps in which SD was suspected. Apart from these post-hoc analyses, the same approach may apply to future improvement of simulator training on SD phenomena, and eventually to be used as a real-time warning system in the cockpit.

OP27-3

Gait, Posture, and Spatial Orientation II

**FUNCTIONAL REORGANIZATION IN AN ASTRONAUT'S BRAIN AFTER LONG-DURATION SPACEFLIGHT.**

**Angelique VAN OMBERGEN**<sup>1</sup>, Athena DEMERTZI<sup>2</sup>, Ben JEURISSEN<sup>3</sup>, Elena S TOMILOVSKAYA<sup>4</sup>, Ekaterina PECHENKOVA<sup>5</sup>, Carol DI PERRI<sup>2</sup>, Liudmila LITVINOVA<sup>5</sup>, Enrico AMICO<sup>2</sup>, Alena D RUMSKISKAYA<sup>5</sup>, Ilya RUKAVISHNIKOV<sup>6</sup>, Jan SIJBERS<sup>3</sup>, Valentin SINITSYN<sup>5</sup>, Inessa B KOZLOVSKAYA<sup>4</sup>, Paul H VAN DE HEYNING<sup>1,7</sup>, Paul M PARIZEL<sup>8</sup>, Stefan SUNAERT<sup>9</sup>, Steven LAUREYS<sup>2</sup>, Floris L WUYTS<sup>1</sup>

<sup>1</sup>Department of Physics, Antwerp University Research Centre For Equilibrium And Aerospace, University of Antwerp, Belgium

<sup>2</sup>Department of Coma Science Group, University of Liège, Belgium

<sup>3</sup>Department of Physics, Iminds/Visionlab, Belgium

<sup>4</sup>Department of Sensorimotor Physiology And Countermeasures, Institute of Biomedical Problems, Russian Academy of Sciences, Russia

<sup>5</sup>Department of Radiology, Federal Center of Treatment And Rehabilitation, Russia

<sup>6</sup>Department of Medical Support of Space Flights, Institute of Biomedical Problems, Russian Academy of Sciences, Russia

<sup>7</sup>Department of Otorhinolaryngology, Antwerp University Hospital, Belgium

<sup>8</sup>Department of Radiology, Antwerp University Hospital, Belgium

<sup>9</sup>Department of Imaging And Pathology, Translational Mri, University of Leuven, Belgium

**Introduction and aim:** To date, hampered physiological function after exposure to microgravity has been primarily attributed to deprived peripheral neuro-sensory systems. However, to our knowledge, no MRI-based neuroimaging study has yet been performed to assess neuronal function in space-travelers. The aim of this ongoing study is to probe the effect of microgravity on the human central nervous system.

**Materials and methods:** A male cosmonaut (44y), who had his first long-duration mission to the ISS, was scanned with a functional MRI protocol twice: preflight (30 days) and postflight (9 days upon return). During both assessments, the cosmonaut had a scanning session in a resting condition and a session while executing active mental imagery tasks. A group of matched healthy controls was included to account for data variance.

**Results:** There was reduced connectivity in the right insula ( $pFDR < 0.05$  cluster-level) and ventral posterior cingulate cortex ( $pFDR < 0.05$  cluster-level) postflight. Network-level functional connectivity changes showed a reduced connectivity in the precentral gyrus and the postcentral gyrus postflight.

**Conclusions:** These results highlight the underlying neural basis for the observed physiological deconditioning due to spaceflight and indicate alterations in vestibular and motor-related regions. These dysfunctions can account for reduced vestibular function and motor control abilities at re-entry. Understanding this is pivotal for the development of adequate countermeasures and may have clinical relevance, e.g., for vestibular and immobilized patients.

OP27-4

Gait, Posture, and Spatial Orientation II

**DYNAMICS OF HUMAN DECISION-MAKING: VESTIBULAR PERCEPTION AND NEURAL CORRELATES**

**Koeun LIM**<sup>1,2,3</sup>, **Daniel M. MERFIELD**<sup>1,2,3</sup>

<sup>1</sup>Department of Health Sciences And Technology, Massachusetts Institute of Technology, USA

<sup>2</sup>Department of Otolaryngology, Jenks Vestibular Physiology Lab, Massachusetts Eye And Ear Infirmary, USA

<sup>3</sup>Department of Otology And Laryngology, Harvard Medical School, USA

Recent vestibular psychophysical studies have consistently shown that humans discriminate short-duration motions better than long-duration motions. This behavior can be modeled with a high-pass filter (HPF) having a time constant (circa 0.5 s) that is much shorter than all other behaviorally relevant time constants found in vestibular pathways. Here, we hypothesize that a HPF with such a short time window is part of the decision-making process. In order to investigate the dynamics of perceptual decision-making, we quantitatively analyzed choice behaviors as a function

of observation duration while performing a subjective visual vertical (SVV) task. Specifically, choice accuracy and confidence were simultaneously recorded in 12 normal subjects while observation duration of a tilted display was varied between 105 ms and 1600 ms. Both choice accuracy and confidence showed dynamics consistent with inclusion of a HPF with average time constants of 134 ms and 226 ms, respectively. The primary indication of this result is that the perceptual choice and confidence share at least parts of the same process. Based on this empirical result, we developed a computational model of perceptual decision-making, which incorporates a HPF into a pre-existing decision-making model of an integrative mechanism. There is one main practical implication predicted by this model that will provide a better understanding of the perceptual decision-making process in the brain: the scalp potential associated with decision-making may be correlated with confidence judgment rather than with the magnitude of the stimulus.

## OP27-5

Gait, Posture, and Spatial Orientation II

**UNLOCKING VESTIBULAR COGNITION: PREDICTIONS ARE THE KEY**

**Fred W MAST<sup>1</sup>, Andrew W ELLIS<sup>1</sup>**

<sup>1</sup>*Department of Psychology, University of Bern, Switzerland*

Vestibular cognition has recently gained attention. Plenty of experimental demonstrations provide evidence that vestibular and cognitive processes are nested and intertwined, for example in numerical tasks, body representation, decision making and affective control. Several studies from our group in different experimental settings with both healthy participants and vestibular patients suggest that cognitive processes, such as imagined spatial transformations, and the processing of vestibular information share common mechanisms. To date, however, these mechanisms are scarcely understood in terms of the underlying computations. Many computational models of vestibular processing a) naturally incorporate cognitive influences (e.g. Bayesian priors, representing previous experience or beliefs) and b) often include generative models. Such models generate synthetic input data, which are used to predict future sensory input. This type of model has been used to explain the phenomenon of velocity storage. Crucially, we suggest that the generative mechanisms that are in the service of predictions can also operate offline, such that they are drawn upon when people simulate body movements during imagined self-motion and spatial perspective transformations. We discuss how vestibular mechanisms could be involved in offline operations, and how interactions between online sensorimotor processing and offline usage might occur. This allows us to better conceptualize the interaction between vestibular and cognitive processes, including vestibular disorders.

## OP27-6

Gait, Posture, and Spatial Orientation II

**EFFECT OF LONG-TERM EXPOSITION OF MICROGRAVITY ON THE OCULAR COUNTER-ROLLING AND PERCEPTION OF TILT IN 24 COSMONAUTS**

Emma HALLGREN<sup>1</sup>, Liudmila KORNILOVA<sup>2</sup>, Dmitrii GLUKHIKH<sup>1,2</sup>, Ivan NAUMOV<sup>2</sup>, Hamish MACDOUGALL<sup>3</sup>, Steven T MOORE<sup>4</sup>, Pierre-Francois MIGEOTTE<sup>5</sup>, Gilles CLÉMENT<sup>6</sup>, André DIEDRICH<sup>7</sup>, Floris L WUYTS<sup>1</sup>

<sup>1</sup>*Department of Physics, Antwerp University Research Centre For Equilibrium And Aerospace, University of Antwerp, Belgium*

<sup>2</sup>*Department of Laboratory of Vestibular Physiology, Institute of Biomedical Problems of the Russian Academy of Sciences, Russia*

<sup>3</sup>*Department of Sydney Human Factors Research, School of Psychology, University of Sydney, Australia*

<sup>4</sup>*Department of Human Aerospace Laboratory, Icahn School of Medicine At Mount Sinai, USA*

<sup>5</sup>*Department of Cardiology, Laboratory of Physics And Physiology, Université Libre De Bruxelles & Erasmus Hospital, Belgium*

<sup>6</sup>*Department of Lyon Neuroscience Research Center, Impact Team, Lyon University, France*

<sup>7</sup>*Department of Autonomic Dysfunction Center, Vanderbilt University School of Medicine, USA*

A considerable number of space travelers suffer from, among others, postural control problems upon return to Earth. The cause of these problems experienced on return, is partially to be found in the vestibular otolith system, the

gravity sensor of the body. During a long-term exposure of microgravity, the brain is forced to adapt to the new gravity condition.

The goal with this study was to evaluate the effect of microgravity on the otolith system, and to evaluate the ability to estimate tilt. We have tested 24 cosmonauts before and after a 6-month spaceflight. The otolith function was evaluated by measuring a centrifuge-induced ocular counter-rolling (OCR), and the tilt perception was investigated by means of verbal reports during the centrifugation.

We found a statistical significant correlation between the otolith condition and the ability to estimate tilt. The more defected the otolith system was, the higher the tendency was to underestimate the perceived tilt. It is crucial to better understand how microgravity is affecting the otolith system and to find an adequate countermeasure for a otolith deconditioning, before we move on with future long-term spaceflight, for example to Mars. Perception of tilt is fundamental during several of the operational tasks taking place in space. A better understanding of the otolith function can also be beneficial to vestibular patients here on Earth.

OP28-1

Vestibular Compensation and Rehabilitation II

### **SHORT-TERM EFFECTIVENESS OF VESTIBULAR REHABILITATION IN ELDERLY PATIENTS WITH INSTABILITY**

**Marcos ROSSI-IZQUIERDO<sup>1</sup>, Pilar GAYOSO-DIZ<sup>2</sup>, Sofía SANTOS-PEREZ<sup>3</sup>, María DEL RIO-VALEIRAS<sup>3</sup>, Ana FARALDO-GARCIA<sup>3</sup>, Isabel VAAMONDE-SANCHEZ-ANDRADE<sup>3</sup>, Antonio LIROLA-DELGADO<sup>3</sup>, Andrés SOTO-VARELA<sup>3</sup>**

<sup>1</sup>*Department of Otolaryngology, University Hospital Lucus Augusti, Spain*

<sup>2</sup>*Department of Clinical Epidemiology, Instituto De Investigación Sanitaria De Santiago (idis), Spain*

<sup>3</sup>*Department of Otolaryngology, Complexo Hospitalario Universitario De Santiago De Compostela, Spain*

**Introduction:** Vestibular rehabilitation has been shown to be effective in improving postural control and confidence in elderly patients with instability. But there is insufficient evidence to discriminate between their efficacies, so the aim of the present study is to compare the short-term effectiveness of three different methods of vestibular rehabilitation in improving balance.

**Material and methods:** 139 elderly patients with high risk of falls were included and randomized to one of the following study arms: computer dynamic posturography (CDP) training, optokinetic stimulus, exercises at home or control group.

Patients were assessed with objective (CDP and modified timed up and go test) and subjective outcomes measures (dizziness handicap inventory and short falls efficacy scale-international questionnaires).

**Results:** General Linear Model (GLM) analysis revealed that CDP training had a statistical significant effect in improvement average balance score and reducing the number of falls in the sensorial organization test compared to the control group. Also GLM analysis showed a statistically significant effect in the limits of stability only with the CDP training in comparison with control group.

**Discussion:** In our present study, supervised and customized exercises with CDP had shown to be more effective than the control group in the posturographic short-term assessment. An increased age did not affect potential for improvement after training, so elderly patients with high risk of falling should begin vestibular rehabilitation as soon as possible in order to avoid the potential harm of falls, mainly injuries and psychological consequences due to fear of falling again.

OP28-2

Vestibular Compensation and Rehabilitation II

### **DOES USE OF INTRATYMPANIC GENTAMICIN BEFORE VESTIBULAR SCHWANNOMA SURGERY IMPROVE COMPENSATION**

**Ondej AKRT<sup>1</sup>, Martin CHOVANEC<sup>2,3</sup>, Zdenk ADA<sup>2</sup>, Kryštof SLABÝ<sup>1</sup>, Jaroslav JEÁBEK<sup>4</sup>**

<sup>1</sup>*Department of Rehabilitation And Sports Medicine, 2nd. Faculty of Medicine, Charles University In Prague And Motol University Hospital, Czech Republic*

<sup>2</sup>*Department of Otorhinolaryngology, Head And Neck Surgery, 1st. Faculty of Medicine, Charles University In*

*Prague And Motol University Hospital, Czech Republic*

<sup>3</sup>*Department of Otorhinolaryngology, 3rd. Faculty of Medicine, Charles University In Pragueand University Hospital Kralovske Vinohrady, Czech Republic*

<sup>4</sup>*Department of Neurology, 2nd Faculty of Medicine, Charles University In Prague And Motol University Hospital, Czech Republic*

**Background:** Unilateral vestibular deafferentation (uVD), as performed in vestibular schwannoma surgery, results in a chronic vestibular deficit affecting quality of life. It was shown that training with vestibular exercises and presurgery gentamicin ablation of vestibular function speed up recovery process.

Purpose of the study is to investigate whether only presurgical use of intratympanic gentamicin may speed compensation process compare to patients without gentamicin undergoing removal of vestibular schwannoma.

**Method:** 32 patients undergoing retrosigmoid schwannoma surgery were divided into two groups. First group was treated with gentamicin with the aim to produce uVD before surgery (10 patients, mean age 47.8 years), second group was without gentamicin (22 patients, mean age 47.5 years). Patients in both groups were treated from 5th to 14th day after surgery by intensive vestibular rehabilitation and balance exercises using visual feedback. Data from both groups were compared before surgery, after 5 and 14 days after surgery. Outcome measures included static posturography under four different conditions (mCTSIB), evaluation of subjective visual vertical (SVV) and The Activities-specific Balance Confidence (ABC) Scale. ANOVA for repeated measurements was used for statistical analysis.

**Results:** There was no significant difference between groups. After 2 weeks of intensive vestibular rehabilitation and balance exercises using visual feedback we observed significant improvement in posturography parameters, ABC scores and SVV deviations.

**Conclusion:** Our results show that presurgical use of intratympanic gentamicin alone did not speed up compensation process after vestibular schwannoma surgery.

**Acknowledgements:** This work was supported by the Foundation “Movement without help” and Grant TA030111 175.

#### OP28-3

Vestibular Compensation and Rehabilitation II

#### EFFECT OF VESTIBULAR REHABILITATION ON THE RECOVERY OF VESTIBULAR NEURITIS

Xiaoyan YAN<sup>1</sup>, Kai WANG<sup>1</sup>, Junru TIAN<sup>1</sup>

<sup>1</sup>*Department of Neurology, Beijing 305 Hospital, China*

**Objective:** Vestibular neuritis (VN) with acute unilateral vestibular deficit causes sustained severe vertigo with oscillopsia, imbalance with a tendency to fall, nausea and vomiting. The symptoms gradually resolve over 3–5 weeks under static conditions. However, the peripheral vestibular function does not spontaneously recover in most patients especially during rapid, high frequency head movements. The remaining deficit in the form of a dynamic dysfunction affects a patient’s quality of life. This study investigates the effect of vestibular rehabilitation on VN recovery.

**Methods:** 58 patients with VN were recruited based on the following criteria: acute continuous vertigo over 24 hours to several days, peripheral vestibular deficit, no central bedside signs, and no abnormal MRI. The patients with infarct or other vestibular diseases are excluded. Thirty three patients in the control group took Prednisone (40 mg/day for 2 weeks). In addition to this treatment, 25 patients in vestibular rehabilitation (VR) group started VOR\* 1 at 4 times a day, each lasting 20 min, until the static symptoms resolved. The weeks for resolution of static symptoms and recovery of daily activities were compared in these groups.

**Results:** The age and onset duration were not statistically different between the groups ( $P < 0.05$ ). The static symptoms resolved in the VR group ( $3.24 \pm 1.51$  weeks) were significantly quicker than the control group ( $4.84 \pm 1.62$  weeks) ( $P < 0.001$ ). More daily activities were significantly restored in VR group than in control group ( $P < 0.05$ ).

**Conclusion:** VR can significantly improve the recovery of VN, especially important in restoring daily activities.

## OP28-4

Vestibular Compensation and Rehabilitation II

**THE MAL DE DEBARQUEMENT SYNDROME, TREATMENT IN160 CASES****Mingjia DAI<sup>1</sup>, Sergei YAKUSHIN<sup>1</sup>, Catherine CHO<sup>1</sup>, Eric SMOUHA<sup>2</sup>, Bernard COHEN<sup>1</sup>**<sup>1</sup>*Department of Neurology, Mount Sinai School of Medicine, New York, USA*<sup>2</sup>*Department of Otolaryngology, Mount Sinai School of Medicine, New York, USA*

The Mal de Debarquement Syndrome (MdDS) featured by rocking sensation is an intractable disease caused by maladaptation of the Vestibulo-Ocular Reflex (VOR). It is associated with a number of debilitating symptoms. Two years ago, 24 MdDS patients were treated with a high rate of success (70%) by readaptation of the VOR (Dai et al 2014). Here, we report results in an additional 160 cases: 133 females, 27 males (Ages  $47 \pm 13$ ), 130 Classic cases (caused by a passive motion), 30 Aberrant cases (unknown cause). Duration:  $36 \pm 48$  months (1 month–27 years). Measures: Fukuda, rocking frequency, posturography, spontaneous nystagmus. Primary Protocol: Rolling the head while viewing a full-field optokinetic (OKN) stimulus. Additional Protocol: 1. Simple horizontal/vertical OKN. 2. Horizontal OKN with head up/down motion. Sessions: 0.5–5 minutes, 3-10 times per day, 4-5 days. Outcome Measures: Subjective rating of improvement on a 10-pt scale and posturography. Significance: A 50% reduction of symptoms on the last day of intervention. Results: The overall success 75% (scores:  $6.3 \pm 1.9$  before, and  $2.6 \pm 2.1$  after), with 81% in Classic cases and 43% in Aberrant cases. For duration  $\geq 3$  years, 66% (N = 54) and for  $< 3$  years, 79% (N = 106). Thus, the results are similar to those in our 2014 study. Patients treated earlier appeared to have better outcomes than those with delayed treatment but there was also significant benefit in the latter group. Conclusion: MdDS can be treated by the VOR readaptation. Further results will be reported when the long term follow-up and postural analyses are completed.

## OP28-5

Vestibular Compensation and Rehabilitation II

**A SIMPLIFIED VESTIBULAR REHABILITAION PROGRAM FOR PRIMARY CARE CLINICS****Byung In HAN<sup>1</sup>, Hyun Ah KIM<sup>2</sup>, Pan-Woo KO<sup>3</sup>, Ho-Won LEE<sup>3</sup>, Sung-Pa PARK<sup>3</sup>, Hyung LEE<sup>2</sup>**<sup>1</sup>*Department of Neurology, Do Neurology Clinic, Korea*<sup>2</sup>*Department of Neurology, Keimyung University Dongsan Hospital, Korea*<sup>3</sup>*Department of Neurology, School of Medicine, Kyungpook National University, Korea*

**Background:** Conventional vestibular rehabilitation programs require substantial human resources and equipment. To provide primary care clinics with a simpler alternative, we have established a program that only requires one instructor and a display instrument.

**Methods:** Varieties of exercises including gaze stabilization, postural stabilization, habituation, warm ups, stretching, and strengthening were invented and recorded in footage. Twenty-four patients with dizziness were recruited (10 men and 14 women between the ages of 45 and 84; mean age 70.3). They visited our clinics once weekly for 4 weeks. On each visit, 3 or 4 pieces of exercise footage were displayed consecutively to the patients through the monitor, making the total exercise time about 30 min. The patients followed the movements in the footage while the instructor controlled the monitor and supervised the patients. They were each given printed papers or computer files of the footage to practice the exercises at home. Outcomes were assessed with the Dizziness Handicap inventory (DHI), Berg Balance Index (BBI), and Visual Analog Scale (VAS) at the beginning and 4 weeks later.

**Results:** This program was easily and safely delivered and showed significant differences between the initial and final parameters in DHI ( $p = 0.008$ ), BBS ( $p = 0.000$ ), and VAS ( $p = 0.001$ ).

**Conclusion:** The key factor was to make varieties of exercise footage of each exercise, and to combine those to satisfy the patients' needs. This program will enable primary care clinics to establish their own program easily.

## OP28-6

Vestibular Compensation and Rehabilitation II

**CENTRAL VESTIBULAR NEURON RESPONSES TO SINUSOIDAL YAW AFTER COMPENSATION FROM UNILATERAL CANAL PLUGGING****Shawn D. NEWLANDS**<sup>1</sup>, Min WEI<sup>1</sup>, Hongge LUAN<sup>1</sup><sup>1</sup>*Department of Otolaryngology, University of Rochester Medical Center, USA*

After unilateral injury to the vestibular system, behavioral measures of vestibular performance recover to variable degrees (vestibular compensation). Central neuronal responses after unilateral labyrinthectomy (UL), which eliminates both afferent resting activity and sensitivity to movement, have been well studied. Unilateral semicircular canal plugging (UCP), which is form of vestibular lesion used experimentally and clinically that attenuates angular velocity detection but leaves afferent resting activity intact, has not been as extensively studied. The current study was performed to understand behavior of yaw sensitive neurons in the vestibular nuclei in the compensated state of three rhesus macaques that underwent UCP. The responses of central vestibular neurons to yaw rotation at a series of frequencies (0.1 to 2 Hz) and peak velocities (15 to 210 deg/sec) were compared between neurons recorded before UCP and those recorded at least 6 weeks after UCP. The sensitivity of central neurons after UCP was reduced relative to normal controls for bilateral type I neurons, as was seen with UL under the same protocols in an earlier study. Type II neurons after UCP have chronically reduced sensitivities. UCP reduced the number of ipsilesion type I neurons, but this reduction was less than seen following UL. There were no differences between the baseline (bias) firing rates or detection thresholds between control and compensated UCP neurons. The difference in central responses after UCP compared to UL is primarily in the distribution of type I and type II neurons in the vestibular nuclei, not the magnitude of responses of individual neurons.

## OP29-1

Imaging of the Inner Ear and Vestibular System

**DIFFERENCES IN ENHANCEMENT AND ADVERSE REACTION AFTER IT INJECTION OF 2 DIFFERENT GADOLINIUM AGENTS: 9.4-T MRI STUDY**Mina PARK<sup>1,2</sup>, Ho Sun LEE<sup>3</sup>, Hyeonjin KIM<sup>4,5</sup>, Seung Ha OH<sup>3,6</sup>, Jun Ho LEE<sup>3,6</sup>, **Myung-Whan SUH**<sup>3,6</sup><sup>1</sup>*Department of Otorhinolaryngology-head And Neck Surgery And Healthcare System Gangnam Center, Healthcare Research Institute, Seoul National University Hospital, Korea*<sup>2</sup>*Department of Translational Biomedical Research, Seoul National University College of Medicine, Korea*<sup>3</sup>*Department of Otorhinolaryngology-head And Neck Surgery, Seoul National University College of Medicine, Seoul National University Hospital, Korea*<sup>4</sup>*Department of Radiology, Seoul National University Hospital, Korea*<sup>5</sup>*Department of Biomedical Sciences, Seoul National University, Korea*<sup>6</sup>*Department of Sensory Organ Research Institute, Seoul National University Medical Research Center, Korea*

To compare the inner ear enhancement after intratympanic injection of two widely used gadolinium (Gd) agents by 9.4 MRI and to investigate the effects of Gd on the inner ear.

12 ears of six rats received intratympanic administration of 1/5 diluted Gd agents: Gd-DTPA for the left ear and Gd-DTPA-BMA for the right ear. MRI was performed every 30 min from 1 to 4 h after administration. 8, 6, and 7 ears treated with Gd-DTPA, Gd-DPTA-BMA, and nothing as controls, respectively, were processed for histological evaluation after MRI. After hematoxylin & eosin staining, adverse inflammatory reactions were evaluated for turbid aggregation and lymphocytes.

The perilymphatic enhancement of Gd-DTPA was superior to that of Gd-DTPA-BMA regardless of cochlear turn, compartment, and time point. Inflammatory reactions were found in 4/8 (50.0%) and 4/6 (66.6%) ears administered Gd-DTPA and Gd-DTPA-BMA, respectively. Regardless of the contrast agent used, inflammatory reactions were most definite in the scala tympani of the basal turn, i.e., near the round window. Slightly greater inflammatory reactions were observed in ears injected with Gd-DTPA-BMA compared to Gd-DTPA although the difference was not statistically significant. No inflammatory reaction was observed in any of the seven controls. The auditory brainstem response threshold was 11.8 dB SPL before IT Gd injection and it did not change for up to 5 days (15.4 dB SPL) post-injection.

Gd-DTPA was superior to Gd-DTPA-BMA for visualization of the inner ear. Administration of diluted Gd agents intratympanically may induce considerable inflammatory reactions in the inner ear.

#### OP29-2

Imaging of the Inner Ear and Vestibular System

#### CAPACITY OF OPTICAL COHERENCE TOMOGRAPHY FOR OBSERVATION OF MOUSE OTOLITH ORGANS

**Takayuki NAKAGAWA<sup>1</sup>, Yosuke TONA<sup>1</sup>, Tatsunori SAKAMOTO<sup>1</sup>, Akiko TAURA<sup>1</sup>, Shinichiro KITAJIRI<sup>1</sup>, Juichi ITO<sup>1</sup>, Koichi OMORI<sup>1</sup>**

<sup>1</sup>*Department of Otolaryngology, Head And Neck Surgery, Kyoto University, Japan*

**Aim:** To validate the capacity of optical coherence tomography (OCT) for detection of pathological changes in otoconia of mouse otolith organs.

**Methods:** ICR and Slc26a4 knock-out mice at the age of postnatal day 1 and 105 were used. Temporal bones were dissected and fixed with 4% paraformaldehyde. Images of cross section of otolith organs were obtained by OCT. After decalcification, OCT observation was done. Afterwards, paraffin sections were made in the same direction as OCT observation. Visualization of otoconia in OCT images were compared with that in HE stained paraffin sections.

**Results:** In neonatal and adult ICR mice, before decalcification, otoconia was visualized as signals with high intensity in OCT images, while decalcification apparently attenuated otoconia signals in OCT similarly to images of HE staining. In Slc26a4 knock-out mice, giant otoconia was sometimes found in the otolith organs in OCT images.

**Conclusion:** These findings indicate the utility of OCT in observation of otoconia in the otolith organs of mice.

#### OP29-3

Imaging of the Inner Ear and Vestibular System

#### MRI ENDOLYMPLIC HIDROPS VISUALIZATION AND VEMP TESTING IN PATIENTS WITH MENIERE'S DISEASE

**Nicolas PEREZ<sup>1</sup>, Pablo DOMINGUEZ<sup>2</sup>, Jose Luis ZUBIETA<sup>2</sup>, Mey CABALLEROS<sup>2</sup>, Cecilia SALOM<sup>3</sup>, Raquel MANRIQUE<sup>1</sup>**

<sup>1</sup>*Department of Otorhinolaryngology, University of Navarra, Spain*

<sup>2</sup>*Department of Radiology, University of Navarra, Spain*

<sup>3</sup>*Department of Otorhinolaryngology, Hospital Universitario Central De Asturias, Spain*

**Objective:** To study the feasibility of vestibular endolymphatic hidrops visualization by conventional 1,7 mm thick T2-FLAIR MRI 4 hours after the administration of intravenous gadolinium in patients with Meniere's disease, and its correlation with vestibular evoked myogenic potential testing.

**Material and methods:** 30 patients with definite Ménière's disease. With a 3T MRI unit and a 32 channels head coil, T2-FLAIR imaging was performed 4 hours after intravenous gadolinium administration. The images were fused with a heavily T2-weighted sequence (3D-CISS) and then evaluated by one single reader, blinded to the final diagnosis. The laterality and grade (mild or moderate-severe) of vestibular endolymphatic hydrops was recorded in both ears and its relationship with vestibular functional tests was studied.

**Results:** Hydrops in 42% of the patients it was mild in the affected ear and not seen on the non-affected ear; in 53% Hydrops was moderate-severe in the affected ear and, of them in the non-affected ear it was normal in 26% and mild in 27%.

**Vemps:** Mean interaural asymmetry of the oVEMP(bc) and of the cVEMP(ac) were  $15\% \pm 17\%$  and  $30\% \pm 20\%$ . The cVEMP(ac) asymmetry was significantly greater in patients with a moderate-severe Hydrops in the affected ear (Mann-Whitney U,  $p = 0.008$ ); also when the non-affected ear results were considered (Kruskal-Wallis,  $p = 0.034$ ).

**Conclusions:** This technique allows vestibular endolymphatic hydrops visualization that correlates with vestibular information.

## OP29-4

Imaging of the Inner Ear and Vestibular System

**NEURAL CORRELATES FOR AUDITORY-VESTIBULAR INTERACTION: AN FMRI PARAMETRIC ANALYSIS**

**Sun-Young OH<sup>1,2,3</sup>, Rainer BOEGLE<sup>4,5</sup>, Matthias ERTL<sup>3,4</sup>, Peter ZU EULENBURG<sup>3,4</sup>, Marianne DIETERICH<sup>3,4,5,6</sup>**

<sup>1</sup>Department of Neurology, Chonbuk National University School of Medicine, Korea

<sup>2</sup>Department of 2 research Institute of Clinical Medicine of Chonbuk National University-biomedical Research Institute of Chonbuk National University Hospital, Korea

<sup>3</sup>Department of Neurology, Ludwig-maximilians University, Munich, Germany

<sup>4</sup>Department of 4 graduate School of Systemic Neuroscience, Ludwig-maximilians University, Munich, Germany

<sup>5</sup>Department of 5 german Center For Vertigo And Balance Disorders (ifblmu), Ludwig-maximilians University, Munich, Germany

<sup>6</sup>Department of 6 munich Cluster For Systems Neurology (synergy), Munich, Germany

**Objectives:** Distinguishing sound perception from linear acceleration perception in the brain has been rarely explored previously. In the present study, we want to investigate neural correlates for the interaction of auditory and vestibular linear acceleration and whether this auditory-vestibular interaction can be decomposed into two types of the regions that may support different mechanisms of that using a task based by block fMRI methods.

**Methods:** We will specifically investigate the response behavior of various areas using brief tone burst sound stimuli, in a parametric design, with six different stimulus intensities ranging from low intensity, (which might elicit auditory perception only), to high intensity, (which might be involved in auditory and linear acceleration perception).

**Results:** Properties of low pressure sound stimuli are captured by a network specialized in auditory representation and high pressure sound stimuli leading to vestibular-evoked myogenic potentials (VEMPs) electrophysiological amplitudes modulate areas that are either vestibular or auditory-vestibular interaction specific.

**Conclusions:** The parametric analysis revealed a non-linear modulation of the BOLD signal with sound intensities of below and above the vestibular thresholds in the superior temporal gyrus, insula, primary and supplementary motor cortex, somatosensory and visual cortex such as cuneus/precuneus and middle occipital area, thalamus, and posterior cingulate. We conclude that high pressure sound stimuli leading to VEMP modulate areas that are either vestibular or auditory-vestibular interaction specific and the transformation of information from the low to high intensity stimulation identifies network-functions in relation to the psychophysics and electrophysiology.

## OP29-5

Imaging of the Inner Ear and Vestibular System

**THE OBSERVATION OF GD ENHANCED MRI OF BILATERAL INNER EARS HYDROPS IN PATIENTS WITH UNILATERAL MENIERE'S DISEASE**

**Jun YANG<sup>1</sup>, Yupeng LIU<sup>1</sup>, Huan JIA<sup>1</sup>, Jun SHI<sup>1</sup>**

<sup>1</sup>Department of Otorhinolaryngology-head & Neck Surgery, Xinhua Hospital, Shanghai Jiaotong University School of Medicine, China

**Objective:** To evaluate the clinical value of endolymphatic hydrops detected by MRI after intratympanic administration of Gadolinium in both ears in unilateral Meniere's Disease patients and to explore the clinical manifestation of the endolymphatic hydrops by the correlation study between image results and auditory-vestibular examinations.

**Methods:** 31 patients with unilateral Meniere's disease were enrolled in this study. They underwent auditory-vestibular examinations and 3D-FLAIR MRI. The images were graded in accordance with the severity of endolymphatic hydrops. The scores of the images and results of auditory-vestibular examination results, the significance test of the age, duration of the disease and the hearing level of the affected ears between the group with contralateral endolymphatic hydrops and the group without contralateral endolymphatic hydrops were analyzed respectively.

**Results:** PTA, the SP/AP ratio and the degree of the cochlear hydrops, interaural amplitude difference and the degree of the vestibular hydrops showed a significant correlation, respectively. The duration of the disease and the hearing level of the affected ear showed a significant difference between the group with contralateral endolymphatic hydrops and the group without contralateral endolymphatic hydrops.

**Conclusion:** The results suggested that MRI image can reflect the auditory-vestibular function in patients with Meniere's Disease. Endolymphatic hydrops and hearing loss are closely related, but not necessarily result in Meniere's disease symptoms. Patients with longer duration of the disease and worse hearing in the affected ears are more likely to develop bilateral endolymphatic hydrops.

**Key words:** Meniere's disease, Membranous labyrinth hydrops, Magnetic Resonance Imaging, Gadolinium

OP29-6

Imaging of the Inner Ear and Vestibular System

#### DETECTING MENIERE'S DISEASE IN CONVENTIONAL MRI-SCANS USING RADIOMICS

**R. VAN DE BERG**<sup>1,2</sup>, E. L. VAN DEN BURG<sup>3</sup>, M. VAN HOOF<sup>1</sup>, A. A. POSTMA<sup>4</sup>, M. JANSSEN<sup>5</sup>, R. J. STOKROOS<sup>1</sup>, H. KINGMA<sup>1,2</sup>

<sup>1</sup>Department of Otorhinolaryngology And Head & Neck Surgery, Division of Balance Disorders, Maastricht University Medical Center, Maastricht, Netherlands

<sup>2</sup>Department of Physics, Tomsk State University, Tomsk, Russia

<sup>3</sup>Department of Health, Medicine And Life Sciences, University of Maastricht, Maastricht, Netherlands

<sup>4</sup>Department of Radiology, Maastricht University Medical Center, Maastricht, Netherlands

<sup>5</sup>Department of Methodology And Statistics, School For Public Health And Primary Care (caphri), Maastricht University, Maastricht, Netherlands

**Introduction:** Meniere's disease can be difficult to diagnose using the current criteria. Imaging techniques using invasive contrast agents are nowadays investigated as a possible diagnostic tool. Here, an alternative approach is investigated using readily available and conventional MRI scans. Lately, the evidence is increasing that with new imaging processing and analysis techniques, more information can be gathered from standard imaging modalities. This so called radiomics approach relies on the extraction and analysis of quantitative image features.

**Objective:** To investigate whether a quantitative image analysis of the labyrinth in conventional MRI scans using a radiomics approach showed differences between patients with Meniere's disease and the control group.

**Methods:** The 1,5T and 3T MRI scans of the affected labyrinths of 24 patients with Meniere's disease were compared to the MRI scans of labyrinths of 29 patients with an asymmetrical sensorineural hearing loss. 3D Slicer 4.4 was used to extract substructures of the labyrinth from the original MRI scans. A quantitative analysis of the normalized radiomic image features was performed in Mathematica 10. The image features of the two groups were statistically compared.

**Results:** In numerous image features in all substructures of the labyrinth, a statistically significant difference between the Meniere's disease group and the control group was found.

**Conclusion:** A quantitative analysis of the labyrinth on conventional MRI scans showed statistically significant differences between patients with Meniere's disease and the control group. This might imply that Meniere's disease could be detected in conventional MRI scans.

OP30-1

Central Vestibular Disorder II

#### CPC OF LATERAL MEDULLA STROKE WITH TRANSIENT VESTIBULAR SYMPTOMS

##### MIMICKING VESTIBULAR NEURITIS

**Jorge C KATTAH**<sup>1</sup>, Ali S SABER-TEHRANI<sup>1</sup>, Meena GUJRATI<sup>1</sup>, Sigrun ROEBER<sup>2</sup>, David E NEWMAN-TOKER<sup>3</sup>, Anja HORN-BOCHTLER<sup>2</sup>

<sup>1</sup>Department of Neurology, University of Illinois College of Medicine Peoria, USA

<sup>2</sup>Department of Neuropathology, Ludwig Maximilians Universitat Muenchen, De, Germany

<sup>3</sup>Department of Neurology, Johns Hopkins University, USA

**Background:** Unilaterally decreased horizontal vestibulo-ocular reflex (h-VOR) gain occurs with peripheral vestibular lesions or lateral pontine strokes involving the fascicle or medial vestibular nucleus (MVN). Vestibular reflexes are typically normal in lateral medullary stroke (LMS). We describe clinicopathologic findings in an unusual LMS presenting transient unidirectional nystagmus and decreased h-VOR gain, mimicking peripheral vestibulopathy.

**Methods:** 61 year-old man admitted to ICU with an acute vestibular syndrome accompanied by aphonia and respiratory distress. He had right-beating nystagmus obeying Alexander's law, an abnormal leftward head impulse test (HIT) confirmed quantitatively by video-oculography, and no skew deviation. He had severe axial lateropulsion and Horner's syndrome. MRI showed a left LMS extending rostrally to the ponto-medullary junction and dorsally to near the MVN. The nystagmus subsided within two days and the horizontal HIT normalized clinically. He was transferred to rehabilitation but died of sudden cardio-respiratory arrest three weeks after his stroke. An autopsy was performed. Brainstem sections were stained, examined and labelled. To explain the ocular motor and vestibular findings, we hypothesized that the MVN was involved pathologically.

**Results:** Neuropathological examination showed a left LMS whose extent matched that seen by imaging. Non-ocular motor signs correlated well with structures affected by the infarction. The nearby MVN, however, was spared.

**Conclusion:** We hypothesize that the ischemic penumbra of the LMS may have involved the MVN in the rostral medulla, leading to transiently abnormal h-VOR and unidirectional nystagmus. This is the first case of quantitatively proven abnormal HIT during transient brainstem ischemia without pathologic infarction.

#### OP30-2

Central Vestibular Disorder II

#### ANALYSIS OF VESTIBULO-OCULAR REFLEX IN PATIENTS WITH CEREBELLAR ATAXIA USING VIDEO HEAD IMPULSE TESTS

Sung-Sik KIM<sup>1</sup>, Sang-Hoon KIM<sup>1</sup>, Ki-Moon SONG<sup>1</sup>, Mina YOON<sup>1</sup>, Kyung Wook KANG<sup>1</sup>, Seung-Han LEE<sup>1</sup>

<sup>1</sup>Department of Neurology, Chonnam National University Hospital, Korea

**Purpose:** Video head impulse test (vHIT) allows objective and quantitative measurements of vestibulo-ocular reflex (VOR). We analyzed VOR gains in cerebellar ataxia using vHIT.

**Method:** We consecutively enrolled 32 patients with chronic cerebellar ataxia and 42 normal controls who had the VOR data measured by vHIT device (GN Otometrics). The cerebellar ataxia group consisted of 8 spinocerebellar ataxia (SCA), 13 cerebellar type of multiple system atrophy (MSA-C), 1 cerebellitis, and 10 idiopathic cerebellar atrophy. The VOR gains of each canal of cerebellar ataxia were compared with those of control. Furthermore, according to the ratio of VOR gains of anterior and posterior canals (AC/PC ratio), cerebellar ataxia group was classified into 3 subgroups (i.e., increased, normal, and decreased AC/PC ratio) and each subgroup was compared.

**Result:** The cerebellar ataxia patients (men = 14, mean age = 56) had more decreased VOR gains in AC and PC than normal control ( $p = 0.02, 0.024$ , respectively). But the VOR gain of the horizontal canal was not different statistically. In the comparisons among three subgroups according to the AC/PC ratio, clinical diagnosis and disease duration were significantly different; the increased AC/PC ratio group ( $n = 7$ ) had longer disease durations and more SCA6 diagnosis, while the others had shorter durations and different types of cerebellar ataxia.

**Conclusion:** Cerebellar ataxia had lower VOR gain especially in vertical semicircular canal planes. The AC/PC ratio was different according to the subtypes of cerebellar ataxia. Analysis of VOR gain with vHIT may be helpful for the differential diagnosis of various cerebellar ataxias.

#### OP30-3

Central Vestibular Disorder II

#### SEPARATING CENTRAL FROM PERIPHERAL VESTIBULAR SYNDROMES USING MEDICAL HISTORY AND TEST RESULTS

**Christoph MAURER**

*Department of Neurology, Freiburg University, Germany*

A vestibular syndrome (sudden onset of dizziness, spontaneous nystagmus, imbalance, head motion intolerance and vegetative symptoms like nausea and vomiting, persisting for at least 24 hours) is a common symptom of posterior fossa stroke, sometimes in combination with other neurological deficits. However, obvious focal neurological signs such as gaze nystagmus or skew deviation are absent in more than half of posterior fossa strokes. In addition, the consequences of missing dangerous causes for vestibular syndromes, such as stroke, can be substantial. Numerous papers deal with bedside tests for separating central, stroke related, from peripheral vestibular syndromes. Specifi-

cally, a common combination of bedside oculomotor tests for isolating stroke as a cause for a vestibular syndrome is known as the HINTS battery [normal Head Impulse Test, (Gaze-) Nystagmus, Test of Skew (deviation)]. A normal Head Impulse Test, however, could also be associated with an unaffected peripheral vestibular system. False positive results of the hHIT indicating vestibular neuritis are reported for AICA syndromes and strokes involving the vestibular nucleus. By analyzing a database of more than 1000 cases in total, which were collected during an EC project (EMBalance) to develop a decision support system for diagnosing vertigo, we were able to isolate the most prominent differences in medical history, bedside tests, and additional technical examinations between stroke and peripheral causes of vertigo.

OP30-4

Central Vestibular Disorder II

#### **IMPROVING DIAGNOSTICS IN PATIENTS WITH VESTIBULAR PAROXYSMIA**

**Berina IHTIJAREVIC**<sup>1,2,3,4</sup>, Vincent VAN ROMPAEY<sup>1,2</sup>, Angelique VAN OMBERGEN<sup>1</sup>, Leen MAES<sup>1,3</sup>, Tony COX<sup>4</sup>, Katrien KETELSLAGERS<sup>4</sup>, Paul VAN DE HEYNING<sup>1,2</sup>, Floris WUYTS<sup>1</sup>

<sup>1</sup>Department of Antwerp University Research Centre For Equilibrium And Aerospace, Antwerp University Hospital, Belgium

<sup>2</sup>Department of Otorhinolaryngology & Head And Neck Surgery, Antwerp University Hospital, Belgium

<sup>3</sup>Department of Speech, Language And Hearing Sciences, Faculty of Medicine And Health Sciences, Belgium

<sup>4</sup>Department of Otorhinolaryngology & Head And Neck Surgery, Jessa Hospital Hasselt, Belgium

**Introduction and aim:** Vestibular paroxysmia (VP) is defined as short vertiginous spells frequently dependent on head position with an underlying hypothesis that there is a neurovascular conflict (NVC) with the VIII cranial nerve. Although the syndrome was first described more than 30 years ago by Jannetta, there is still a need for more specific diagnostic criteria to diagnose patients earlier.

**Material and methods:** A retrospective study was performed on 18 patients with complaints of vertigo, a NVC on MRI and improvement of symptoms with carbamazepine or oxcarbazepine. Anamnestic and clinical results were examined to determine significant similarities among these patients.

**Results:** In this study 55% of the VP patients complained of lightheadedness, while 44% experienced dizziness and 39% were unstable. The most common accompanied symptoms were hearing loss (55%), tinnitus (61%), headache (55%) and aural fullness (38%). Symptoms occurred daily in 81% lasting seconds or minutes (71%); triggered by positional changes (78%), specifically by head movement (50%). In 71% clinical examination showed a persistent positional non-BPPV type nystagmus. The Chavda Classification was used to specify the anatomy of the NVC. There was no correlation found between audiology, ENG and the type of loop. Several other misdiagnoses were made which led to a mean duration of 16 months and a maximum of 60 months before efficient treatment for VP.

**Conclusions:** A combination of history taking, clinical examination and imaging is necessary to diagnose VP and to differentiate it easily from other vestibular pathologies as Meniere's disease, BPPV and vestibular migraine.

OP30-5

Central Vestibular Disorder II

#### **EVALUATING LISTING'S PLANE FROM INFRARED VIDEO-OCULOGRAPHY IN PATIENTS WITH SPINOCEREBELLAR DEGENERATION**

Takamori TAKEDA<sup>1</sup>, Akihisa TASAKI<sup>1</sup>, Yuichiro INABA<sup>1</sup>, Yusuke KIYOKAWA<sup>1</sup>, Taro FUJIKAWA<sup>1</sup>, Yasuhiro SUZUKI<sup>1</sup>, Takeshi TSUTSUMI<sup>1</sup>

<sup>1</sup>Department of Otolaryngology, Tokyo Medical And Dental University, Japan

**Background:** Spinocerebellar degeneration (SCD) is a progressive ataxia disease that can affect the spine, the cerebellum, the nervous system and the muscles. Including sporadic and hereditary, there are 30,000 SCD patients in Japan approximately. Recently, we've been challenging to evaluate gravitational recognition, as a function of Listing's plane. The purpose of the present study is to evaluate thickness of the listing's plane, as a parameter representing gravitational recognition, in patients with SCD.

**Methods:** During the experiments, the subjects were wearing infrared CCD-mounted goggles in the spine position, leaving both eyes unobstructed. 50 cm in front, we placed a screen on which were 9 fixation points. The subjects

were instructed to fixate for 1 s on each of the 9 fixation points consecutively, and the eye position was recorded as a video of 9 s in duration. We digitized the video recording using a macro program for ImageJ and calculated thickness of the listing's plane on each SCD subjects and healthy controls.

**Results:** We identified a tendency of more thickened listing's plane on SCD patients than healthy controls.

**Conclusion:** Our procedure could be useful in evaluating central modification of gravity recognition, as well as otolithic pathway function.

OP30-6

Central Vestibular Disorder II

#### MISSENSE VARIANTS IN ELF2 & CNTNAP2 GENES SUPPORT PHENOTYPIC VARIABILITY & GENETIC HETEROGENEITY IN FAMILIAL CANVAS

H AHMAD<sup>1</sup>, J JALDO<sup>2</sup>, C MARTIN-SIERRA<sup>2</sup>, T REQUENA<sup>2</sup>, Jose A LOPEZ-ESCAmez<sup>2,3</sup>, Adolfo M BRONSTEIN<sup>1</sup>

<sup>1</sup>Department of Neuro-otology, Division of Brain Sciences, Imperial College London, Charing Cross Hospital, United Kingdom

<sup>2</sup>Department of Otology & Neurotology Group Cts495, Centre For Genomics And Oncology Research, Granada, Spain

<sup>3</sup>Department of Otolaryngology, Complejo Hospitalario Universidad De Granada,, Spain

Cerebellar Atrophy, peripheral Neuropathy and Vestibular Areflexia was described by Bronstein et al in 1990 (Brain) and further characterised and labelled CANVAS by Szmulewicz et al in 2011 (Neurology). A characteristic oculomotor sign is the severely "broken up" visually enhanced vestibulo-ocular reflex (VVOR) however considerable phenotypic variation has been observed. Although most cases are sporadic, affected sibling pairs have been reported, suggesting a familial recessive disorder, but the genes involved have not yet been elucidated. Here, we describe a unique family with three affected cases of CANVAS in the same generation: the proband; a 78 year old man with manifest CANVAS (cerebellar signs, abnormal VVOR, absent vestibular responses, axonal sensory neuropathy); his maternal first cousins, a 74 year old woman with manifest CANVAS and a 78 year old female exhibiting a 'forme frustre' of CANVAS, suggesting an autosomal recessive disorder with variable expressivity. Using exome sequencing and bioinformatics analyses, two heterozygous missense variants in the coding regions of ELF2 and CNTNAP2 genes were revealed which segregated with the affected CANVAS patients. Results reveal a novel variant in ELF2 (E74-like factor 2) gene and a rare variant in the CNTNAP2; (contactin-associated protein like-2(rs150918383) gene, indicating these variants of putative pathogenic significance in CANVAS are likely to affect protein function. Functional validation of these variants in mutant-transfected BE(2)-M17 cells is underway to demonstrate their causality. A detailed family history and examination of suspected cases in relatives of CANVAS patients is advisable, both for diagnostic clarity and to further explore phenotypic variability.