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PNF and manual therapy treatment results of patients with cervical spine osteoarthritis

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Abstract.
PURPOSE: The aim of this study was to evaluate the effectiveness of PNF and manual therapy methods in the treatment of patients with cervical spine osteoarthritis, especially their efficacy in reducing pain and improving functionality in everyday life. Long-term results were also compared in order to determine which method of treatment is more effective.
SUBJECTS AND METHODS: Eighty randomly selected females aged 45–65 were included in the study. They were randomly divided into two groups of 40 persons. One group received PNF treatment and the other received manual therapy (MAN.T). To evaluate functional capabilities, the Functional Rating Index was used. To evaluate changes in pain, a shortened version of the McGill Questionnaire was used.
RESULT: The PNF group achieved a greater reduction in pain than the MAN.T group. The PNF group showed a greater improvement in performing daily activities such as sleeping, personal care, travelling, work, recreation, lifting, walking and standing as well as decreased intensity and frequency of pain compared to the MAN.T group.
CONCLUSION: The PNF method proved to be more effective in both short (after two weeks) and long (after three months) term.

Keywords: Chronic pain, neck pain, rehabilitation

1. Introduction

Chronic cervical spine pain is a social as well as therapeutic problem. According to scientific reports, treatment by physiotherapy is quite difficult and complicated, because there are a multitude of causes of neck pains, as well as the variety of methods of treatment [1]. Many studies have searched for effective treatments, but only a few have been proven. This is due to an insufficiency in the number of clinical trials evaluating each therapeutic method and the fact that very few methods have been scientifically verified [2]. Kaltenborn [3], Rakowski [4] and Lewit [5] expressed a belief in the legitimacy of using manual therapy when the cause of neck pain is disordered joint play. Orthopedic Manual Therapy is used for evaluation and treatment of joints and soft tissues around. The basic therapeutic tool is mobilization [6]. A method which is increasingly being recommended for the treatment of back pain is proprioceptive neuromuscular facilitation (PNF) [7–12].

PNF is primarily the stimulation of nervous and muscular system with the aim of achieving the high-

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est possible functional level. In order to achieve the highest functional level motor control as well as motor learning principles are used by the therapist. This involves treatment on different levels: body structure, activity and participation. Positive approach is used in therapy, which means using activities which patient can already do. Functional approach is the most effective way to stimulate the patient and to achieve the best therapeutic results [13]. PNF evolved to a complete rehabilitation approach for a variety of indications of neurological and musculoskeletal origin [14]. Treatment according to PNF goes with general guidelines used for non-specific low back pain and neck pain where the goal is to improve general strength, range of motion and activity more than pain [15].

Neck pain is a common problem, 60% to 90% of people in their middle age complain about it [16]. Many authors mention neck pain as a second after lower back pain as the most common musculo-skeletal pain [17]. According to Carpenter this problem concerns more than one in five people [18]. The most common reason are degenerative changes of cervical spine and 50–60% patients suffers from that [19]. The prevalence of neck pain in the general population is between 10%–15% [20–22]. Women claim on neck pain more often than man. In 1996 in the Netherlands they estimated that costs of neck pain treatment were about 1% of the overall health system spending [23].

Bearing in mind that pain of cervical spine is a problem for a general population it appears advisable to determine treatment which is effective in reducing pain and improving patients' functionality in everyday life. There is also a need to assess the long-term treatment effects of rehabilitation. The aim of this study was to evaluate the effectiveness of PNF and manual therapy methods in the treatment of patients with cervical spine osteoarthritis, especially their efficacy in reducing pain and improving functionality in everyday life. Long-term results were also compared in order to determine which method of treatment is more effective form of therapy for patients with cervical spine osteoarthritis.

2. Subject and methods

Eighty randomly selected female patients aged 45–65 were included in this study. They were randomly assigned to treatment groups by drawing a sealed envelope: an envelope with an even number meant PNF treatment and an odd number indicated manual therapy. Patients participating in the study knew only at the start of the therapy that they would receive physiotherapy. They did not know at the beginning the exact method used in their case. The researcher responsible for monitoring the research outcomes, measuring at T0, T1 and T2 was unaware of patient allocation.

The following eligibility criteria were used: pain of cervical spine connected with degenerative changes in the vertebral body and intervertebral disc confirmed by X-ray, chronic pain lasting longer than 13 weeks, full verbal abilities and no cognitive impairment and informed consent to participate in the research. The exclusion criteria were: developmental malformations of the cervical spine, acquired cervical spine defects, trauma of the cervical spine, osteoporosis, instability in the cervical spine area, cervical myelopathy, signs of C1-C8 radicular symptoms such as paresis, muscle atrophy, decreased reflexes or use of painkillers or anti-inflammatory or muscle relaxants. Patients were treated in an outpatient clinic. They were randomly divided into two groups consisting of 40 persons. One group received PNF treatment and the other received manual therapy. In addition, both groups received laser therapy and TENS current therapy for the cervical spine. The duration of treatment was two weeks – 10 rehabilitation units of 45 minutes once a day. All the qualified subjects were evaluated with body mass, height and BMI. Personal data were collected (age, sex, profession) as well as results of spine imaging tests, information concerning onset of pain and its course until that moment. The Functional Rating Index seems to have the best clinical utility among all the available instruments measuring spine conditions. It is reliable, valid and responsive for changes [24,25]. Psychometric qualities of the Functionl Rating Index were: Intraclass correlation coefficient was excellent ($ICC_{3k} = 0.99$); Item efficiency was good, ranging between 0.54 and 0.82, with a moderate correlation among all items; Cronbach's alpha was excellent (0.92). Validity: The Functional Rating Index correlated with the Disability Rating Index (0.76), the Short Form-12 Physical Component Score (0.76), and the Short Form-12 Mental Component Score (0.36). Responsiveness: Overall, the size effect was 1.24, which is commendable. Clinical utility: Time required by the patient and staff averaged 78 seconds per administration, which is noteworthy [24,25].

Short form of McGill Pain Questionnaire is sensitive enough to detect which therapeutic approach is effective and decreases pain [26]. In this study modified McGill Pain Questionnaire was used. It consists of 15 descriptors (first 11 evaluate type of pain, last 4 eval-

uate emotional aspect) rated with 4-point scale: 0 = none, 1 = mild, 2 = moderate, 3 = severe [27].

The evaluation was performed prior to treatment (T0), after 2 weeks of treatment (T1) and 3 months after the end of treatment (T2).

In the first group the PNF rehabilitation approach was implemented which consists of three main sections: PNF Philosophy, PNF Basic principles and procedures and PNF techniques. PNF philosophy is defined in five subheadings: positive approach, functional approach, mobilize reserves, treating the whole person and use of motor learning and motor control principles [15]. Basic principles are tools in therapist hands which enable optimal, meaningful and comprehensive stimulation of patients Central Nervous System which is directed to restore or improve function. Different starting positions of exercises were used: supine, side lying, prone on elbows and in sitting. Therapy started from indirect approach to use strong and pain free body parts for strengthening affected areas. Intensity was adapted to mobilize reserves without causing pain and fatigue [13]. For PNF therapy the following techniques were used: combination of isotonics, rhythmic stabilization, stabilizing reversals, rhythmic initiation, dynamic reversals and hold-relax. The goal was to enhance muscle strength, improve stability and mobility, and to reduce pain in the cervical spine [13].

PNF patterns copy functional activities which are task-oriented, that is why scapula patterns (anterior elevation and posterior depression) and neck patterns (flexion, extension, both to the right and left) were used [28,29]. PNF movement patterns are functional movements which are found in activities of everyday living. The PNF patterns are characterized by three-dimensional diagonal movements as a result of synergistic muscle activation. The rotational component in the pattern is the key for maximum muscular activity [13]. In the study during each therapeutic session treatment was focused on facilitation of neck stabilizers, improving neck stability, ROM, coordination, endurance, decreasing pain and improving postural control. Treatment for the second group based on manual therapy (MAN.T). Mobilization of joints with Manual Therapy according to Kaltenborn-Evjenth was used. Joints were mobilized with low-velocity passive movements in the whole or end range. No spinal manipulations were applied [30]. Kaltenborn-Evjenth manual therapy is a safe procedure which uses the convex concave rule (traction or gliding on side being treated) [31,32]. Therapy included post-isometric muscle relaxation, cervical segmental traction, cervical segmental mobilization (flexion, extension, coupling movement), isometric exercises for neck muscles and gliding therapy grade III. Joint mobilization was applied in limited passive segmental motion [33]. The treatment based on activating the motion of cervical spine segment joints and cervicothoracic junction. The aim of articular mobilization was to restore normal joint play while post-isometric muscle relaxation was performed to reduce muscle tension [4]. The MAN.T group also received re-education for postural control. To restore proper curvature of the thoracic and cervical spine mobilization of the cervicothoracic junction was applied in prone and in sitting. Furthermore, isometric exercises for the muscles of the neck were applied.

Table 1
Characteristics of the subjects: age and body mass index (BMI) of the subjects and the types of work they performed

	PNF		MAN.T	
	x	± SD	x	± SD
Age [years]	56.3	± 5.3	55.8	± 6.4
BMI [kg/m^2]	24.4	± 3.0	24.9	± 3.2
Type of work:	n	%	n	%
Pensioner	3	7.5%	5	12.5%
Intellectual work	33	82.5%	28	70.0%
Physical work	4	10.0%	7	17.5%

Values are expressed as the mean ± SD; n – the number of people; ± SD – standard deviation; x – mean; % – percentage of patients; PNF – Proprioceptive Neuromuscular Facilitation; MAN.T – Manual Therapy.

The study protocol was approved by the Regional Medical Ethics Board of Physicians in Krakow, Poland (No. 36/KBL/OIL/2011).

The distribution of qualitative variables is described by using numbers and percentages. Distribution of quantitative variables is described using mean values and standard deviations. The significance of differences between the two distributions of qualitative variables was calculated by McNemar's test; the chi-square test was used for comparison between the groups and for comparison within groups. The significance of differences between the two groups of quantitative variables was tested by using Student's t-test and within groups using the paired samples t-test. Results were considered to be statistically significant when the probability value of the test (p-value) was lower than 0.05. No adjustments to the p-value were made for multiple testing. The calculations were performed using R 3.0 software [34].

3. Results

The average age of patients with osteoarthritis of the cervical spine in the PNF group was 56.3 years and

Table 2
The functional rating index results of the PNF and MAN.T groups in the period at T0, T1 and T2

	T0 x/ ± SD	T1 x/ ± SD	T2 x/ ± SD	T1–T0	T2–T0	T2–T1	Diff. PNF – MAN.T – T0	Diff. PNF – MAN.T – T1	Diff. PNF – MAN.T – T2
Pain Intensity: PNF	1.96/ ± 0.57	0.94/ ± 0.34	0.98/ ± 0.37	−1.02∗	−0.98∗	0.04	> 0.05	< 0.05∗	< 0.05∗
Pain Intensity: MAN.T	2.06/ ± 0.68	1.79/ ± 0.63	1.82/ ± 0.59	−0.27∗	−0.24∗	0.03			
Sleeping: PNF	1.95/ ± 0.84	0.99/ ± 0.52	1.07/ ± 0.50	−0.96∗	−0.88∗	0.08∗	> 0.05	< 0.05∗	< 0.05∗
Sleeping: MAN.T	1.65/ ± 0.86	1.38/ ± 0.73	1.41/ ± 0.72	−0.27∗	−0.24∗	0.03			
Personal care: PNF	1.09/ ± 0.89	0.56/ ± 0.55	0.68/ ± 0.55	−0.53∗	−0.41∗	0.12∗	< 0.05∗	< 0.05∗	< 0.05∗
Personal care: MAN.T	1.55/ ± 0.81	1.27/ ± 0.67	1.35/ ± 0.69	−0.28∗	−0.20∗	0.08			
Travelling: PNF	1.99/ ± 0.76	0.86/ ± 0.47	0.98/ ± 0.54	−1.13∗	−1.01∗	0.12∗	> 0.05	< 0.05∗	< 0.05∗
Travelling: MAN.T	2.01/ ± 0.84	1.50/ ± 0.75	1.62/ ± 0.81	−0.51∗	−0.39∗	0.12∗			
Work: PNF	1.60/ ± 0.81	0.80/ ± 0.42	0.98/ ± 0.58	−0.80∗	−0.62∗	0.18∗	> 0.05	< 0.05∗	< 0.05∗
Work: MAN.T	1.73/ ± 0.82	1.25/ ± 0.84	1.40/ ± 0.84	−0.48∗	−0.33∗	0.15∗			
Recreation: PNF	1.71/ ± 0.76	0.80/ ± 0.45	1.00/ ± 0.48	−0.91∗	−0.71∗	0.20∗	> 0.05	< 0.05∗	< 0.05∗
Recreation: MAN.T	1.81/ ± 0.91	1.39/ ± 0.76	1.49/ ± 0.76	−0.42∗	−0.32∗	0.10∗			
Frequency of pain: PNF	1.51/ ± 0.75	0.74/ ± 0.39	1.02/ ± 0.45	−0.77∗	−0.49∗	0.28∗	< 0.05∗	< 0.05∗	< 0.05∗
Frequency of pain: MAN.T	1.92/ ± 0.79	1.43/ ± 0.65	1.50/ ± 0.69	−0.49∗	−0.42∗	0.07			
Lifting: PNF	1.77/ ± 0.88	0.94/ ± 0.56	1.05/ ± 0.61	−0.83∗	−0.72∗	0.11∗	> 0.05	< 0.05∗	< 0.05∗
Lifting: MAN.T	1.98/ ± 0.95	1.49/ ± 0.83	1.52/ ± 0.82	−0.49∗	−0.46∗	0.03			
Walking: PNF	0.78/ ± 0.89	0.38/ ± 0.42	0.49/ ± 0.50	−0.40∗	−0.29∗	0.11∗	< 0.05∗	< 0.05∗	< 0.05∗
Walking: MAN.T	1.26/ ± 1.10	1.10/ ± 0.98	1.25/ ± 1.03	−0.16∗	−0.01	0.15∗			
Standing: PNF	1.70/ ± 1.10	0.75/ ± 0.64	0.79/ ± 0.60	−0.95∗	−0.91∗	0.04	> 0.05	< 0.05∗	< 0.05∗
Standing: MAN.T	1.96/ ± 1.05	1.39/ ± 1.02	1.51/ ± 1.03	−0.57∗	−0.45∗	0.12∗			
Functional rating index: PNF	16.06/ ± 5.18	7.75/ ± 2.82	9.03/ ± 2.75	−8.31∗	−7.03∗	1.28∗	> 0.05	< 0.05∗	< 0.05∗
Functional rating index: MAN.T	17.94/ ± 6.22	13.97/ ± 5.22	14.89/ ± 5.23	−3.97∗	−3.05∗	0.92∗			

Values are expressed as the mean ± SD; x – mean; ± SD – standard deviation; $^*p < 0.05$; the time periods: P0 – Prior to treatment, P1 – after 2 weeks of treatment, P2 – 3 months after completion of therapy; after 2 weeks of treatment vs prior to treatment = T1–T0; 3 months after completion of therapy vs prior to treatment = T2–T0; 3 months after completion of therapy vs after 2 weeks of treatment = T2–T1; PNF – Proprioceptive Neuromuscular Facilitation; MAN.T – Manual Therapy.

in the MAN.T group was 55.8. The body mass index (BMI) of the PNF group was 24.4 and in MAN.T group 24.9. The percentage of patients performing intellectual work in the PNF group was 82.5% and 70% in the MAN.T group (Table 1). Statistical analysis of the overall scores of all variables of the Functional Rating Index showed that in both treatment groups the functioning of patients in everyday life improved. These results were statistically significant ($p < 0.0001$) at T1 and at T2 compared to T0.

At T1 and T2 statistically significant improvement was found in the PNF and in the MAN.T group in daily activities ($p < 0.05$), such as sleeping, personal care, travelling, work, recreation, lifting, walking, and standing, as well as, pain intensity, and frequency of pain (Table 2).

Walking showed a statistically significant ($p = 0.004$) improvement at T1, but at T2 no statistically significant difference was observed for this variable ($p = 0.850$) in the MAN.T group (Table 2).

The results obtained for the PNF and MAN.T groups differ and these differences were statistically significant ($p < 0.05$) at T1 and at T2. In the PNF group greater improvement was shown in performance of daily activities of sleeping, personal care, travelling, work, recreation, lifting, walking, standing and decreased intensity and frequency of pain when comparing to the MAN.T group.

Based on the results of McGill pain questionnaire it can be stated that in both PNF and Manual therapy group the level of pain experienced by the patients decreased. These results were statistically significant ($p < 0.0001$) at T1 and at T2 compared to T0 (Table 3).

The results for the PNF and MAN.T groups differ from each other and were statistically significant ($p < 0.05$) at T1 and at T2. Therefore, the PNF group showed a greater reduction in pain than the MAN.T group.

4. Discussion

Problems occurring in osteoarthritis tend to encourage patients to use physiotherapy. Due to the irreversibility of degenerative lesions the treatment barely alleviates the symptoms. Therapy aims to reduce the

Table 3
The McGill pain questionnaire results of the PNF and MAN.T groups in the period at T0, T1 and T2

	T0 x/ ± SD	T1 x/ ± SD	T2 x/ ± SD	T1–T0	T2–T0	T2–T1	Diff. PNF – MAN.T – T0	Diff. PNF – MAN.T – T1	Diff. PNF – MAN.T – T2
McGill: PNF	10.47/ ± 4.16	4.29/ ± 1.60	4.85/ ± 1.64	−6.18∗	−5.62∗	0.56∗	< 0.05∗	< 0.05∗	< 0.05∗
McGill: MAN.T	13.93/ ± 6.40	10.88/ ± 5.86	11.64/ ± 5.49	−3.05∗	−2.29∗	0.76∗			

Values are expressed as the mean ± SD; x – mean; ± SD – standard deviation; $^{*}p < 0.05$; The time periods: T0 – prior to treatment, T1 – after 2 weeks of treatment, T2 – 3 months after completion of therapy; after 2 weeks of treatment vs before treatment = T1–T0; 3 months after completion of therapy vs before treatment = T2–T0; 3 months after completion of therapy vs after 2 weeks of treatment = T2–T1; PNF – Proprioceptive Neuromuscular Facilitation; MAN.T – Manual Therapy.

incidence, duration and intensity of severe pain which tends to appear periodically in osteoarthritis. Drug-free treatment is a priority in the treatment of patients with degenerative joint diseases. At the same time, physiotherapeutic treatment is considered to be complicated and rather difficult by many authors [35,36].

There were differences in outcome measurements at the baseline in favor of the PNF group when it comes to Functional Rating index (personal care, frequency of pain, walking) and McGill Questionnaire but no statistically significant changes were observed in relation to type of occupation, age and BMI index. The fact that patients from PNF group initially had less symptoms might have influenced the results and therapy effects.

Falla suggest the need to strengthen deep neck flexors. According to these authors the activation of the deep flexors is impaired in people with spinal pain in this area [37]. According to Jull training of deep neck flexors leads to reduction of pain in the cervical spine [38]. Fariba revealed in the study that stabilization exercises have influence on endurance of deep neck flexors, significantly decrease pain and disability in patients with chronic neck pain [39]. In this present study deep neck muscle exercises were performed in both groups. The difference was that in the first group of patients resistance used in PNF patterns for strengthening neck muscles was three-dimensional while in the second group applied resistance was only one-dimensional.

This may explain the results of pain reduction in this first group. Our present results correspond with data reported by Borisut, who used exercises to strengthen deep neck flexors in females with chronic pain of the cervical spine and observed pain reduction after 12 weeks [40].

Waling's randomized research is definitely worthy of attention as he evaluated the efficacy of exercises that improve muscular strength, endurance and coordination of three groups of patients. All groups recorded pain reduction of comparable extent [41]. Our present results also show that the PNF-based rehabilitation had a statistically significant impact on decreasing pain. At the same time patients showed statistically significant improvement in all items of the Functional Rating Index. Lee's research also confirmed the effectiveness of the PNF method. Patients with pain in the cervical spine whose treatment was based on the concept of PNF showed a statistically significant decrease in pain and improved functioning in everyday life [10].

According to many authors one of the most effective therapies for patients with pain in the cervical spine is manual therapy [42–46]. The present results of McGill Questionnaire reveal that in comparison to the PNF group pain reduction was half as much in the MAN.T group at T1 (an average of 6.2 points in the PNF group and an average of 3.1 points in the MAN.T group) and at T2 (an average of 5.6 points in the PNF group and an average of 2.3 points in the MAN.T group).

Analysis of the Functional Rating Index results indicated there was a statistically significant outcome in the quality of everyday life in females in the MAN.T group. Improvement was observed in all the tested variables, but as in the case of pain relief the declared quality of life of the PNF group was twice as high as in that of the MAN.T group: averages of 8.3 and 4.0 points in the PNF and MAN.T groups respectively at T1 and averages of 7.0 and 3.1 points in the PNF and MAN.T groups respectively at T2.

Most therapeutic interventions in the treatment of pain syndromes of the cervical spine bring improvement only for a short time [47,48]. In a review of the literature Gross confirmed that components of manual therapy such as mobilization and manipulation are commonly used in the treatment of pain of the cervical spine and elicit a rapid but short-term improvement [49]. Also use of stretching and strengthening exercises of neck muscles showed moderate evidence of their efficacy in the long-term effects of therapy [50]. This was also seen in the present study in which both groups of patients with chronic pain underwent two-week rehabilitation and both groups showed reduction in the incidence of pain but not its complete elimina-

tion. In the assessment of quality of daily life of the subject better results were reported by patients who received PNF therapy and this group of patients reported better results 3 months after the completion of therapy.

According to O'Riordan's review of the literature it should be noted that rehabilitation should take place at least 3 times a week and therapeutic interventions should last 30–60 minutes in order to decrease pain and have positive effects on disability. According to O'Riordan therapy is effective when achieved results are maintained between 6 to 12 weeks after treatment [51]. Ylinen argue that long-term benefits in terms of reduced pain, improved range of motion and muscle strength can be achieved if exercises are performed at least 2 times a week for 1 year [47]. In the present study both the PNF and MAN.T group treatments lasted 45 minutes and took place every day, from Monday to Friday for a period of 2 weeks. The results obtained after 3 months were better than those before the therapy and the differences were statistically significant.

A limitation of this study was that it evaluated only woman treated in one hospital.

5. Conclusion

Analysis of the results confirmed that rehabilitation of patients using both PNF and manual therapy had a statistically significant impact on reducing pain and improving the performance of daily activities of females with cervical spine pain. However, both in the short (after two weeks) and the long term (after three months) PNF method proved to be more effective. When treating patients with degenerative changes pain free therapy based on indirect treatment and active participation of the client is recommended. Principles of motor learning, treatment on levels of body structures and activity should be considered. It is useful to work with PNF patterns which mimic functional ADLs.

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Conflict of interest

The authors report no conflict of interest.

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