Smyrna Tıp Dergisi ***Araştırma Makalesi***

The Acute Effects of Proprioceptive Neuromuscular Facilitation (PNF) Techniques on Shoulder Pain, Chest Expansion, Vital Signs and Mobility in Stroke Patients: A Randomized Controlled Trial

İnmeli Hastalarda Proprioseptif Nöromüsküler Fasilitasyon (PNF) Tekniklerinin Omuz Ağrısı, Göğüs Ekspansiyonu, Vital Bulgular ve Mobilite Üzerindeki Akut Etkileri: Randomize Kontrollü Bir Çalışma

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Summary
Objective: The aim of the study is to investigate the acute effects of proprioceptive neuromuscular facilitation (PNF) techniques on shoulder pain, chest expansion, vital signs and mobility in stroke patient.
Material and Method: Thirty eight stroke patients were allocated two groups: PNF and BOBATH methods group (n:20, mean age:62.90±9.59 year) and BOBATH method group (n:18, mean age:58.67±12.68 year). The upper extremity exercises to be compatible with the natural development of human mobility were applied in BOBATH method group. PNF and BOBATH methods group performed PNF exercises that include scapula, neck, upper extremity patterns by using facilitation and rhythmic initiation techniques in addition to BOBATH method. PNF and BOBATH methods were applied in single session (30 minutes). The pain (Visual Analog Scale-VAS), chest expansion (measuring of the chest circumference with a tape measure axillary, epigastric, subcostal region), vital signs (heart rate, blood pressure, respiratory rate), mobility (Functional Reach Test) were evaluated before and after the intervention.
Results: The heart rate (p=0.026) and respiratory rate (p=0.024) scores were significantly increased in PNF and BOBATH methods group. The diastolic blood pressure (p=0.026), respiratory rate (p=0.049) and functional reach test scores (p=0.011) were significantly increased in PNF and BOBATH methods group. There were statistically significant differences in VAS score (p=0.043) between two groups in favor of the PNF AND BOBATH methods group.
Conclusion: It appears that PNF techniques have immediate effects on mobility and reducing pain in stroke patients. It is thought that PNF techniques are one of the safe and useful rehabilitation component to increase upper extremity function.
Key words: Mobility, pain, proprioceptive neuromuscular facilitation, stroke

Özet
Amaç: Bu çalışmanın amacı inmeli hastalarda proprioseptif nöromüsküler fasilitasyon (PNF) tekniklerinin omuz ağrısı, göğüs ekspansiyonu, vital bulgular ve mobilite üzerindeki akut etkilerini araştırmaktır.
Gereç ve Yöntem: Otuz sekiz inmeli hasta, PNF ve BOBATH yöntemleri grubu (n:20, ortalama yaş:62,90±9,59 yıl) ve BOBATH yöntemi grubu (n:18, ortalama yaş:58,67±12,68 yıl) olmak üzere iki gruba ayrıldı. BOBATH yöntem grubuna insan hareketliliğinin doğal gelişimine uygun üst ekstremite egzersizleri uygulandı. PNF ve BOBATH yöntemleri grubu, BOBATH yöntemine ek olarak fasilitasyon ve ritmik başlatma teknikleri kullanarak skapula, boyun, üst ekstremite paternlerini içeren PNF egzersizlerini gerçekleştirdi. PNF ve BOBATH yöntemleri tek seans (30 dakika) uygulandı. Ağrı (Görsel Analog Skala-GAS), göğüs ekspansiyonu (mezura ile aksiller, epigastrik, subkostal bölge göğüs çevresi ölçümü), vital bulgular (kalp hızı, kan basıncı, solunum hızı), mobilite (Fonksiyonel Uzanma Testi) eğitim öncesi ve sonrası değerlendirildi.
Bulgular: Kalp hızı (p=0,026) ve solunum hızı (p=0,024) skorları PNF ve BOBATH yöntemleri grubunda anlamlı olarak arttı. Diyastolik kan basıncı (p=0.026), solunum sayısı (p=0.049) ve Fonksiyonel Uzanma Testi

skorları (p=0.011) PNF ve BOBATH yöntemleri grubunda anlamlı derecede yüksekti. İki grup arasında PNF ve BOBATH yöntemleri grubu lehine GAS skorunda (p=0.043) istatistiksel olarak anlamlı fark vardı.
Sonuç: PNF tekniklerinin inmeli hastaların mobilite ve ağrıyı azaltma üzerinde ani etkileri olduğu görülmektedir. PNF tekniklerinin üst ekstremite fonksiyonunu arttırmada güvenli ve faydalı rehabilitasyon bileşenlerinden biri olduğu düşünülmektedir.
Anahtar Kelimler: Mobilite, ağrı, proprioseptif nöromüsküler fasilitasyon, inme

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Introduction

Stroke is a brain injury caused when a blood vessel to the brain becomes blocked or bursts, cutting off blood flow and oxygen to the brain (1). According to the data of American Heart/Stroke Association, every seconds someone has a stroke. In addition, they reported that eighty percent of all strokes could be prevented (2).

The motor, sensorial, cardiovascular and pulmonary, emotional and cognitive problems are seen more common in all stroke patient (3). Morever, stroke patients shows decrease in respiratory functions which are reflected by a restrictive ventilator pattern. Weakened respiratory functions consequently decrease the ability to perform physical functions (4). Because of these problems, stroke patient usually face activity limitations, participation restrictions in their daily life. The effective stroke rehabilitation is likely to remain an essential part of the continuum of stroke care for the foreseeable future. The stroke rehabilitation including physiotherapy interventions, cognitive rehabilitation, speech and language therapy, cardiopulmonary rehabilitation, occupational therapy is comprehensive (5). One of the post stroke patient specific deficit is upper limb (UL) disfunction and up to 80% of stroke survivors report residual UL deficits. Improving upper limb function is a core element of rehabilitation after stroke to maximise recovery. A wide range of interventions categorized as pharmacologic, assitive devices and modalities, neuromuscular, musculoskeletal, cardiopulmonary and cognitive-perceptual-sensory interventions can be delivered in an attempt to improve the function of upper limbs after stroke (6).

Proprioceptive neuromuscular facilitation (PNF) techniques is a rehabilitation approach or concept which is one of the neuromuscular interventions, widely used by physiotherapists and based upon four theoretical mechanisms, referred to as autogenic inhibition, reciprocal inhibition, stress relaxation, and the gate control theory, that enhance range of motion and muscle activation in rehabilitation. Recently; various systematic reviews and an evidence based clinical practice guideline have evaluated the efficacy of stroke rehabilitation interventions, including PNF techniques (7). However, none were specifically focused on PNF, and only one narrative review assessed PNF as the principal topic. The literature appears to contain a limited number of studies examining the effect of PNF techniques in obtaining upper extremity functional independence compared to lower extremity functional independence in stroke rehabilitation (8). However; any studies demonstrating the acute effects of PNF that consist of neck scapular and upper extremity techniques on pain, chest expansion and vital signs and mobility couldn't be found. Based on these opinions, the purpose of the study is to investigate the acute effects of PNF techniques on shoulder pain, chest expansion, vital signs and upper extremity mobility in stroke patients.

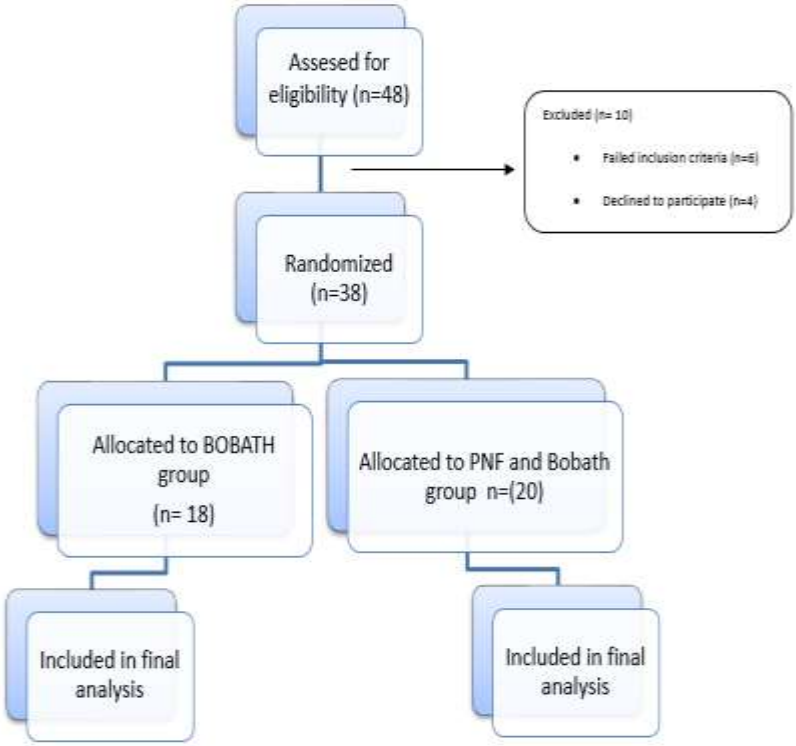
Material and Methods

Thirty eight stroke patients registered at the Department of Physical Medicine and Rehabilitation Department Outpatient Clinic of Baskent University Medical Faculty were included in the study. Inclusion criteria were, age between 18-80 years old, have been stroke diagnosis for more than 6 months and diagnosis of shoulder pain by. All patients scored at least 24 points in the mini-mental status examination, at most 2 points in modified ashworth scale 2, at most 3 points in modified rankin scale. All patients gave their informed consent before participation and written consent was obtained.

Study Design:
The study was carried out in Department of Physiotherapy and Rehabilitation of Baskent University. Study was conducted based on institutional guidelines and the principles of the Declaration of Helsinki. All patients provided informed consent before the study began.

G*power was used to conduct statistical power analyses and calculate saple size. The sample size was determined as 15 subjects in each group with the alpha level set at .05 to achieve 85% power. The patients were randomly assigned to either the PNF and BOBATH methods group (n:20) and BOBATH method group (n:18) by using a randomization computer program followed by measurement of baseline variables (Figüre 1). The clinical assessments were conducted by a physiotherapist, followed by treatment interventions that were administered by a different physiotherapist assigned to the treatment arm of the study.

Figure 1. *Flow diagram of the study participants*



PNF: proprioceptive neuromuscular facilitation

Participants in the PNF and BOBATH methods group were performed PNF exercises that include scapula, neck, upper extremity patterns by using facilitation and rhythmic initiation techniques in addition to BOBATH method. The upper extremity exercises to be compatible with the natural development of human mobility were applied in BOBATH method group. PNF techniques and Bobath were applied in single session (30 minutes). Patient rested two minutes when they exahusted. Breathing exercises and control at resting period, were performed.

PNF Interventions

PNF exercises were applied that include scapular, neck and upper extremity pattern by using rhythmic initiation, dinamic revearsal and repeated stretch through range to facilitate normal movement in addition to BOBATH method. Scapular pattern was applied in just one diagonal as an anterior elevation and posterior depression with 10 repetitions.

PNF pattern for the neck was applied in two diagonals with 10 repetitions for each techniques. One of the diagonal was flexion with right lateral flexion and right rotation, extension with left lateral flexion and left rotation. The other diagonal was flexion with left lateral flexion and left rotation, extension with right lateral flexion and right rotation. Upper extremity pattern was applied in a bilateral symmetrical patterns of flexion–abduction-external rotation with 10 repetitions for each techniques. The patients were in the

lying position during all applications except the neck patterns.

Bobath Interventions

Bobath method, optimising activity and participation require an understanding of the relationship between the patient's health condition, personal factors, environmental, and individual contexts (9). After the problem-solving process, meaningful goals, specific to the needs of the patient are determined and an exercise program is planned. Therefore, a specific exercise program was planned for each patient. In addition, attention was paid to the quality of movement. Each of the exercises determined according to the Bobath method was performed with 10 repetitions.

Outcome Measurements

The patients were evaluated before and after the single session order to show the acute effect of the applications.

Pain Severity: The Visual Analog Scale (VAS) was used to indicate the severity of pain on the shoulders during rest and activity. The patients were asked to determine the pain with the 'X' mark on a 100 mm scale. According to this scale, '0' indicates no pain and '100' indicates the most severe pain. The distance between the point marked and the beginning of the line was measured in millimeters, and the value found was recorded as the severity of pain experienced at rest and activity (10).

Vital Signs: The heart rate, blood pressure, oxygen saturation (SpO_2) and respiratory rate measurements were recorded before and 30 minutes after the applications.

Chest Expansion: The expansion of the thorax was interpreted by measurement of the chest circumference performed in the sitting position with a measuring tape, as axillar (4th rib), epigastric (xiphoid process), and subcostal (9th rib) measurements. The differences between maximal inspiration and maximal expiration score were repeated 3 times and the best results were recorded in centimeters (11).

Mobility: The mobility was evaluated by Functional Reach Test (FRT) before and after the intervention. The FRT measures the distance between the first and last positions while standing comfortably, raising an arm 90° from the torso, and reaching out without losing balance (12).

Statistical Analysis

Statistical analysis was performed using SPSS 22 (IBM Corp.Armonk, NY, USA). Only the data from participants who completed the trial were considered. Homogenity and normality tests were used as the actual statistical methods. Wilcoxon signed-rank test was used to compare two related samples. Mann-Whitney U test was used to compare the differences between two independent groups (13).

Results

Sociodemographic and clinical characteristics of the patients are shown in Table 1.

Changes in Pain

Relative to baseline values, VAS scores were not significantly changed in the BOBATH method group and PNF combined BOBATH at the end of the intervention period ($p>0.05$). The magnitude of the change over the study period significantly differ between two groups ($p=0.043$) (Table 2).

Changes in Vital signs

Changes in vital signs before after interventions are shown in Table 2. The heart rate ($p=0.026$) and respiartory rate ($p=0.024$) scores were significantly increased in BOBATH methods group. The diastolic blood pressure ($p=0.026$), respiartory rate ($p=0.049$) were significantly increased in PNF combined BOBATH methods group. The changes in heart rate, respiratory rate, systolic and diastolic blood pressure over intervention periods were not significantly differ between the two groups ($p>0.05$).

Changes in Chest Expansion

Changes in chest expansion before and after interventions are shown in Table 2. None of the chest expansion changes was observed in the BOBATH method group and PNF combined BOBATH group over the intervention period ($p > 0.05$). Differences between the two groups in axillary chest circumference assessment (ΔAxillary) and subcostal chest circumference assessment (ΔSubcostal) and epigastric chest circumference assessment (ΔEpigastric) was not statistically significant ($p>0.05$).

Changes in Mobility

The functional reach test scores (p=0.011) were significantly increased in PNF combined BOBATH methods group. The changes functional reach test scores over intervention periods were not significantly differ between the two groups (p>0.05) (Table 2).

Table 1. *Sociodemographic and clinical characteristics of the patients*

	PNF + BOBATH group (n=20) X±SD	**BOBATH group (n=18) X±SD**	**p**
Age X±SD (year)	62.90 ± 9.59	58.67 ± 12.68	0.670
BMI (Kg/Cm²)	27,52±3,921	26,18±2,886	0.127
Gender Female/male, n	10/10	9/9	

**p<0.05 X: mean. SD:standart deviation.*

Table 2. *Comparison of chest expansion, vital signs, pain,and mobility between groups*

Measurements	Bobath Group (n=18) X±SD			PNF and Bobath Group (n=20) X±SD			P^{β}
	Pre-treatment	After-treatment	p^{α}	Pre-treatment	After-treatment	p^{α}	
Subcostal Chest Circumference measurements (CCM)	2,33±1,53	2,33± 1,53	1,000	2,70±0,71	3,05±0,86	0,141	
Epigastric CCM	3,08±1,59	3.08±1,59	1,000	2,95±1,06	2,90±0,80	0,916	0,296
Axillary CCM	2,16±1,36	2,50±1,67	0,317	3,15±1,10	3,40±1,14	0,380	0,299
Heart Rate	73,00±7,12	76,00±6,84	0,026*	72,20±9,90	75,10±9,52	0,135	0,913
Sistolic Blood pressure	126,66±15,05	131,66±17,51	0,063	127,00±12,73	129,50±17,39	0,507	0,533
Diastolic Blood Pressure	79,17±6,64	81,67±7,52	0,180	79,00±7,74	85,00±4,71	0,026*	0,351
Respiratory Rate	21,33±2,06	23,50±2,16	0,024*	20,80±2,52	23,00±2,53	0,049*	0,614
VAS	2,70±2,34	3,56±2,70	0,078	1,12±3,14	1,35±3,14	0,130	0,043*
Functional Reach Test	22,58±14,47	21,75±13,86	0,273	33,85±16,16	37,65±15,45	0,011*	0,57

**p<0.05. X: mean. SD: standart deviation. P^{β} The values of Differences between the NDT-Bobath group and the PNF and Bobath group, β: Mann-Whitney U test . p^{α}: The values of the differences between the Bobath group and the PNF and Bobath group before and after treatment. α: Wilcoxon signed rank tests.*

Discussion

The acute effects of PNF techniques on shoulder pain, chest expansion, vital signs and upper extremity mobility in stroke patient were investigated in this study. The results of the study showed that there were improvements in upper extremity mobility and decrease in shoulder pain with PNF techniques for stroke.

Stroke is a complicated neurological disease that contains many problems and also defined as a restrictive lung disease. After stroke, patients face functional problems in the upper extremity, which affect daily life. Increasing upper extremity and respiratory functions play an important role in the recovery of low functional level due to stroke (6,7). In a review on stroke rehabilitation, they determined that PNF can and should be included in any functional training by stroke survivors (14).

A very few studies about upper extremity PNF for stroke patient rehabilitation has been found in the literature. In the study by Joshi et al., the effect of scapular PNF application in addition to conventional therapy revealed that the scapular PNF has positive impact on poststroke shoulder pain and range of motion. It helps the strengthening of proximal muscles of upper extremity and improves the upper extremity function in stroke patients (15). Similar to this result, significant improvements in VAS score between groups was found in the present study. No difference was found before and after VAS score both BOBATH and PNF combined BOBATH methods group. This may be due to the acute effect instead of long-term effects of the study.

In one of the studies carried out in different populations, Çömük et al evaluated the acute effects of the PNF techniques and classic exercises in adhesive capsulitis. Similar to existing study, they observed that the difference values of VAS score between two groups were significant and the value was changed in favour of PNF group and there were no statistically significant differences functional mobility between group. Presented study showed that functional mobility increased in only PNF group (16).

Hyouk Bang et al, investigated the effects of a modified constraint induced movement therapy using PNF on the upper extremity function and activities of daily living in patients with subacute stroke. Each group underwent twenty sessions for 4 weeks. They showed that significant improvements in the patients' upper extremity function and activity daily life in PNF combined with on straint induced movement therapy. Similar to this, performed study found significant improvements in functional mobility increased in only PNF combined bobath group (17).

Sushma et al., investigated the effect of shoulder PNF techniques applied for 2 weeks on respiratory functions in chronic bronchitis patients. It was reported that the patients in the PNF group had similar SpO_2 and FEV_1/FVC values with the patients in the conventional treatment group (18). These results are similar to the results of chest expansion, which is included in the respiratory parameters in the study.

Morevover, Khatri Shilpa, et al., investigated the effect of chest PNF technique applied for 1 week, 5 days and 30 minutes in Parkinson's patients on chest expansion. They showed the increase in chest expansion compared to the control group (19). Increase of chest expansion in this study is due to the effect of the chest PNF techniques instead of the upper extremity, which cause a greater increase in trunk mobility. The changes in vital signs in the performed study are thought to be a possible outcome in direct proportion to the normal acute physiological response after exercise.

Only one study comparing the effect of the NDT-Bobath and PNF methods could be found. This study also examined the effects on the field support and total path length measure foot pressure in patients after stroke (8).

Even though there are few studies showing the effects of upper extremity PNF in stroke patient, it was speculated that this study will contribute positively to the literatüre; that shows the effectiveness of acute upper extremity and scapular PNF techniques on shoulder pain, chest expansion, vital signs and upper extremity mobility in stroke patient.

Limitations

One limitation of this study was that, it evaluated only the initial effects of PNF and NDT- Bobath exercises. Another limitation of the study was that additional evaluation parameters such as range of motions, respiratory muscle strength assessments were not applied.

Conclusion

Findings of the study highlight the immediate effectiveness of PNF techniques on mobility and reducing pain in stroke patients. PNF can be an integral part of exercise and rehabilitation programme especially to increase upper extremity function and pain in stroke rehabilitation. However, more studies with larger samples and longer follow up periods are needed.

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