Turkish Journal of Sport and Exercise /
Türk Spor ve Egzersiz Dergisi
http://dergipark.gov.tr/tsed
Year: 2022 - Volume: 24 – Issue 3 - Pages: 233-237
10.15314/tsed.1078858

Turkish Journal of
Sport and Exercise
Türk Spor ve Egzersiz Dergisi
ISSN: 2147-5652
https://dergipark.org.tr/tr/pub/tsed

Demonstrating the Irridation and Reinforcement Effects of Proprioceptive Neuromusculer Facilitation Technics

Sevgi ÖZDİNÇ[1A] , Halit SELÇUK[1B]

[1] *Trakya University, Faculty of Health Science,Physical Therapy and Rehabilitation Department*
Address Correspondence to S. ÖZDİNÇ: e-mail: sevgiozdinc@yahoo.com
(Received): 25/02/2022 (Accepted): 21.12.2022
A:Orcid ID: 0000-0003-2655-4338: B:Orcid ID: 0000-0003-2760-4130

Abstract

Pupose of the study is demonstrate the irradiation and reinforcement principle of the proprioceptive neuromuscular facilitation (PNF) technique, which was expected to occur through the use of body segments together. Volunteers aged between 18 and 30 who did not have any orthopedic or neurological problems that could affect handgrip strength were included in the study. Using a hand dynamometer (Jamar), dominant-side handgrip strength was evaluated via two different methods, expressed as control and experimental. The control group measurement was done as a standard unilateral handgrip strength test and the experimental one included bilateral handgrip strength. Three consecutive repetitive measurements were taken for both control and experimental methods, and the average values were compared with the dependent t-test. Fifty-four individuals participated in the study. Sixteen (29.6%) of the participants were male and 38 (70.4%) were female, and the dominant side was the right for all participants. The means of hangrip strength was 27.08 ± 8.67 kg for control measurement and 29.08 ± 8.89 kg. for experimental measurement. The experimental handgrip strength was significantly higher than the control ($p < 0.001$). As a result of the study, we can the grip strength obtained by bilateral activity is more than that of unilateral activity; therefore, it supports the PNF irradiation effect principle. In addition, this information highlights the bilateral treatment approach in training programs for strengthening weak muscles and increasing skills in motor activity.

Keywords: Exercise Therapy, Handgrip Strength, Physiotherapy, Rehabilitation

Özet

Bu çalışmanın amacı, vücut segmentlerinin birlikte kullanımı ile gerçekleştiği ifade edilen Proprioseptif Nöromuskuler Fasilitasyon (PNF) tekniklerinden kuvvet yayılımı prensibinin araştırılmasıdır. Araştırmaya, 18 -30 yaşları arasında, kavrama kuvvetini etkileyebilecek herhangi bir ortopedik veya nörolojik problemi olmayan gönüllüler dahil edildi. El dinamometresi kullanılarak (Jamar), dominant taraf kavrama kuvveti, kontrol ve deneysel olarak ifade edilen, iki farklı yöntemle değerlendirildi. Kontrol kavrama kuvveti, unilateral kavrama kuvvetini, deneysel olan ise bilateral kavrama kuvvetini kapsamaktaydı. Aynı örneklem grubunda, önce kontrol, sonra deneysel olmak üzere ardışık 3 tekrarlı ölçüm yapılarak, ortalamaları alındı ve bağımlı gruplarda t testi ile karşılaştırıldı. Araştırmaya 54 gönüllü katıldı. Katılımcıların 16 (% 29.6) 'sı erkek, 38 (% 70.4)' i kadındı ve tamamı sağ dominanttı. Kontrol kavrama kuvvet ortalaması; 27,08±8,67 kg, deneysel kavrama kuvvet ortalaması; 29,08±8,89 kg idi. Deneysel kavrama kuvveti belirgin şekilde daha fazlaydı ($p< 0.001$). Bu çalışmanın sonucu olarak, bilateral aktivite ile elde edilen kavrama kuvvetinin unilateral aktiviteye oranla daha fazla olduğunu söyleyebiliriz. Dolayısıyla kuvvet yayılımı prensibini (İrridation effect) destekler niteliktedir. Ayrıca bu bilgi, zayıf kasların güçlendirilmesine ve motor aktivitede becerinin arttırılmasına yönelik verilen eğitim programlarında, bilateral yaklaşımı ön plana çıkartmaktadır.

Anahtar Kelimeler: Egzersiz Tedavisi, El Kuvveti, Fizyoterapi, Rehabilitasyon

INTRODUCTION

Proprioceptive neuromuscular facilitation (PNF) is a rehabilitative approach that physiotherapists use in a variety of conditions, and this approach is included in the physiotherapy curriculum in many countries, including Turkey. This method stimulates proprioceptive organs in muscles and tendons to improve function (1), and it was first used in individuals with impaired motor activity to facilitate motor performance. PNF involves stretching, traction, and approximation (2). It also promotes a larger neuromuscular response in proprioceptors, thereby facilitating the biarticular muscle by applying maximum resistance to movement in a spiral and diagonal direction. As a result of synergistic muscle activation, extremities follow a three-dimensional diagonal movement axis in the PNF patterns (3-5). PNF patterns include functional movements based on activities of everyday living. This is based on the neurophysiology principles of successive induction, innervations, reciprocal inhibition, and irradiation (6).

Movement is the way to interact with the environment. There are five basic principles of the philosophy of PNF that aim to improve movement: (a) the positive approach, (b) the functional approach, (c) mobilizing reserve, (d) the highest functional level, and (e) the use of motor learning and motor control principles (7, 4).

The PNF method is used in patients with various motor problems and offers several methods and techniques. The PNF concept is applied in a variety of indications in clinical practice (8-10), such as low back pain, respiratory rehabilitation, dynamic balance, gait disorders, and muscle weakness and shortness (9-11). Studies that examine the effectiveness of the PNF technique mostly focus on muscle activity (8). The intensity can be adapted to prevent the causing of pain and fatigue while mobilizing reserve.

One of the basic processes used in the mobilization of potentials is a technique called irradiation and reinforcement. This technique is practiced in two ways. The first way increases the response of weak muscles by applying appropriate resistance to the stronger muscles to produce facilitation or inhibition effect of the synergistic muscles. The second is based mainly on the notion that normal motor activities in our life require the combined use of body segments (4,7). PNF is also used to produce a contraction of the weak muscles and to promote strength by applying resistance to the stronger muscles. Treatment methods intended to promote the muscles of the weaker side by applying exercise training on the stronger side are referred to as irradiation. The mechanism of irradiation is still unknown. It is based on research that finds that an exercise training on one side promotes the opposite side, and it is also known as the cross-training effect or contralateral effect (12).

Our study aimed to prove the force irradiation principle of the PNF technique, which was expected to occur through the use of body segments together.

Although the PNF concept is included in the physiotherapy education curriculum, scientific studies in this field and the level of evidence are very limited (4,7).

We believe that this research will contribute to filling the gaps in the literature and will be a reference for applications in bilateral, exercise-based treatment approaches and different rehabilitative study.

MATERIALS AND METHODS

This study was carried out on healthy young participants and with students of the Physiotherapy and Rehabilitation Department. We performed the study between September and December 2018. It was approved by the Trakya University Faculty of Medicine Scientific Research Ethics Committee (approval # TÜTF/BAEK 2018/254). Informed consent was obtained from the participants.

We included participants between the ages of 18 and 30 who volunteered to participate in the study and who did not have any orthopedic or neurological problems that could affect grip strength.

After the participants were informed about the study, their demographic information was recorded. Their dominant-side grip strength was evaluated using two different methods with a valid and reliable hand dynamometer (Jamar hand dynamometer, Sammons Preston, Rolyon, Bolingbrook, IL) (13,14).

The measurement sequence was in the form of standard (control) and then experimental measurement. The grip part of the hand dynamometer was wiped with wet and dry wipes after each volunteer. To prevent possible soft tissue injury, we performed a pre-grip warm-up application using a handgrip strength test, a reliable and valid method for muscle strength measurement. It produces a measure of isometric strength that allows for the identification of not only muscle weakness of

the upper limb, but also indications of overall strength, an important health indicator. (14-16).

Standard (Control) Measurement Method

The participant sat in a chair with back support, with hips and knees flexed about 90 degrees and feet in contact with the ground. The dominant-side elbow was in 90 degrees flexion, the forearm and wrist in the neutral position and the nondominant extremity extended at the side of the body. The participant was asked to grip the Jamar hand dynamometer with his or her maximum force, and the grip strength was recorded in kilograms (kg). We took three consecutive repetitive measurements with a one-minute interval, and we recorded the average of the three measurements (13,14).

Experimental Measurement Method

The participant was placed in the same starting position as the control measurement. Alternatively, the nondominant upper extremity was also placed in the same position as the dominant side, and a tennis ball was placed in the nondominant hand. In this position, the participant was asked to squeeze the ball on the nondominant side and the hand dynamometer on the dominant side at the same time with maximum force. The grip strength was recorded in kilograms. We took three consecutive repetitive measurements with a one-minute interval, and we recorded the average of the three measurements (13,14).

Statistical Analysis

We carried out analyses using IBM SPSS Statistics 21.0 (IBM Corp. Armonk, NY). The variables were investigated using the Kolmogorov–Smirnov test to determine whether they were normally distributed. We calculated descriptive statistics for all variables, and the data were shown as mean ± standard deviation, minimum-maximum, frequencies, and percentages.

The handgrip strength test results were normally distributed for experimental and control measurements. Therefore, to compare the results of two different measurement methods, we used a dependent t-test. The statistically significant level was set as $p < 0.05$. Also, a post hoc analysis was performed using G*Power software (version 3.1.9.4, Düsseldorf, Germany) to assess the power of the study.

RESULTS

Fifty-four individuals participated in the study. Sixteen (29.6%) of the participants were male and 38 (70.4%) were female, and the dominant side was the right side for all participants. The mean BMI of the participants was 21.87 ± 3.13 kg/m2. Table 1 shows the demographic data. The average grip strength was 27.08 ± 8.67 kg for the control measurement and 29.08 ± 8.89 kg for the experimental measurement. When comparing the differences for the experimental and control measurements results; the experimental grip strength was significantly higher than the control grip trengt ($p < 0.001$) (shown in Table 2) .

"A post hoc analysis was performed using G*Power software (version 3.1.9.4, Düsseldorf, Germany) to assess the power of the study. With an effect size of 0.83 for hand grip strength, 54 sample size, and 0.05 margin of error, the power of the study was found to be 99%."

DISCUSSION

Facilitating weak muscles by stimulating strong muscles is based on the irradiation principle of PNF (18). The definition of reinforce is “to strengthen by fresh addition, make stronger.” The therapist directs the reinforcement of the weaker muscles by the amount of resistance given to the strong muscles (4). There are different approaches in PNF techniques to generate irridation and reinforcement effects;

It is emphasized that irridation and reinforcement can be generated as follows: 1.Within the same pattern between relatively weak and strong muscle groups. 2. by combining patterns or body parts (between relatively weak and strong patterns or body parts). 3. Using timing for emphasis.

It is based on the premise that the brain directs the movement as a whole, not the muscles one by one (17). So that, effort on one side promotes the opposite side. For facilitation purposes, it can be used alone or in combination with PNF facilitation techniques. So that, this principle is a useful aspect for patients with muscle weakness in areas that cannot be directly worked (strengthened). Thus, these weak muscles can develop an increase in the duration and/or intensity by the spread of the response to stimulation or by the synergistic muscle inhibition (18). Although there are not many publications on PNF approaches, in the limited number of publications related to the irritation principle, there is no consensus on which muscle groups (agonist and/or anatagonist) occurs (10,18,19).

In this study, we measured grip strength with two different methods (control and experimental). Grasping force reflecting peripheral muscle strength is a fast, easy, and inexpensive evaluation method. Because of these features, it has a wide range of applications from use in healthy people to use in individuals with critical illness in intensive care [16]. In the current study, the experimental handgrip strength was significantly higher from the control measurement and effect size (cohen's d for paired samples t test) was 0,825. Cohen's d value of 0.8 and above is considered a strong effect (21). We think that results of the current study was be an indicator of the irradiation and reinforcement principle of the PNF technique. Also, in our study, that effect is shown to occur between bilateral and agonist muscle groups.

It was demonstrated with electromyograms that resistance training on one side of the body similarly increased the muscular strength of the other side (10).

Morales et al. examined the muscle irradiation effect in the upper limb after using PNF and found increased electrical activity of the contralateral muscles on electromyography. These studies provide a scientific basis showing that the possible effects related to irradiation are not only in the muscles of the trained side but also in the bilateral activation of the anatomical structures (10).

In a study examining the effect of trunk movements on the strength of ankle muscles, increased dorsiflexion with trunk flexion and increased plantarflexion strength with trunk extension were shown. This information further strengthened the direct treatment effect and the irradiation principle of PNF (22).

A study by Nakada et al. revealed that the coping pattern on the right side increased dorsiflexion activity on the right side but not on the left side. On both the right and left sides, the flexion-abduction-external rotation pattern of PNF was shown to increase dorsiflexion activity on both sides (20).

The results of the above literature and the results of this study show that the movements of body parts together and in certain directions reveal force transfer to each other and facilitation in goal-directed movement. This information should always be remembered in rehabilitation studies because we think that it can be adapted to many different situations. However, research and information on the neurophysiological basis of the irradiation and reinforcement principles is insufficient (22). Further research is required to establish more concrete information on this subject.

CONCLUSSIONS

As a result of our study, we showed that the bilateral grip strength was higher from unilateral grip strength, which therefore provides evidence for the PNF irradiation principle. In addition, this information highlights the bilateral approach as a treatment option in training programs aimed at strengthening muscles and increasing skills in motor activity.

Conflicts of interest and Funding

The authors declare no conflict of interest and funding.

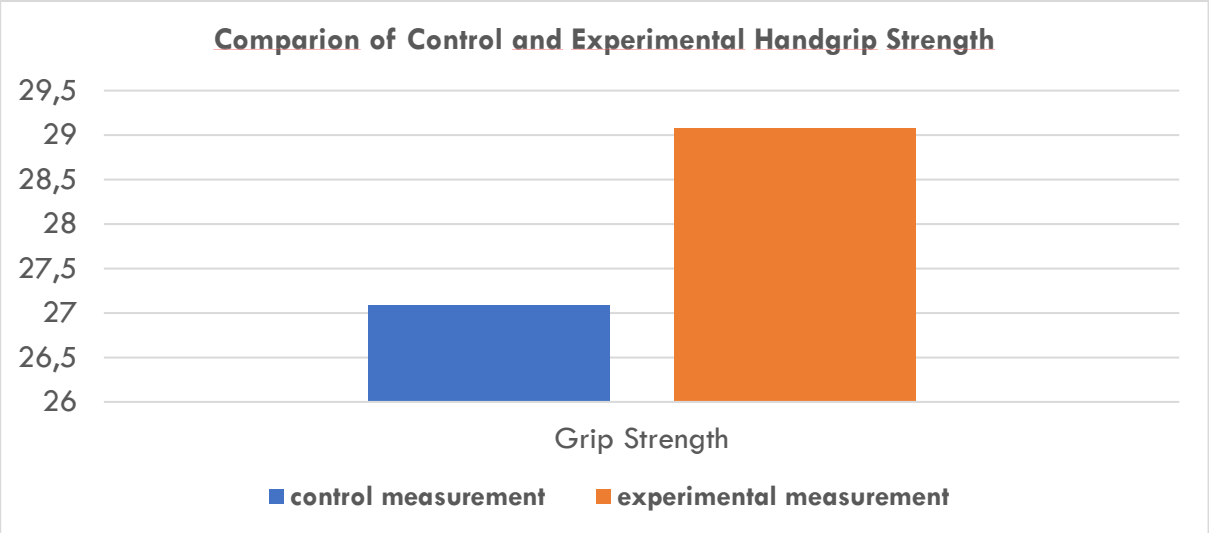

Figure 1. Comparison of control and experimental handgrip strength.

Table 1. Characteristics of the study sample (N= 54)		
	X±SD	**(Minimum-Maximum)**
Age (years)	20. 53 ±1.56	19.0-26.0
Weight (kg)	63.20 ±11.27	45-93
Height (m)	1.69±0,08	1.55 - 1.90
Body Mass Index (kg/m2)	21.87±3.13	17.57- 32.56

Table 2. Comparison of control and experimental handgrip strength				
	Mean±SD	Min-Max	t	P**
Standard Grip Strength (kg)	27,08±8,67	12,67- 49,33		
Experimental Grip Strength (kg)	29,08±8,89	16,00 -56,00	-6,06	<0.001

REFERENCES

1. Seo K, Lee J, Lee S. Impact of PNF-based walking exercise on a ramp on gait performance of stroke patients. J Phys Ther Sci. 2012; 24(12):1243-6.
2. Kumari C, Sarkar B, Banerjee D, Alam S, Sharma R, Biswas A. Efficacy of muscle energy technique as compared to proprioceptive neuromuscular facilitation technique in chronic mechanical neck pain: A randomized controlled trial. Int J Health Sci. 2016; 6:152-61.
3. Ribeiro TS, Silva WHS, de Alencar Caldas VV, Silva DLA, Cavalcanti FAC, Lindquist ARR. Effects of a training program based on the proprioceptive neuromuscular facilitation method on post-stroke motor recovery: a preliminary study. J Bodyw Mov Ther. 2014;18(4): 526-32.
4. Adler SS, Beckers D, Buck M. PNF in practice: an illustrated guide. Springer; 2007.ss7-21.
5. Maicki T, Bilski J, Szczygieł E, Trąbka R. PNF and manual therapy treatment results of patients with cervical spine osteoarthritis. J Back Musculoskelet Rehabil. 2017; 30(5):1095-101.
6. Escobar-Hurtado C, Ramírez-Vélez R. Proprioceptive neuromuscular facilitation (PNF) and its impact on vascular function. Colomb Med. 2011; 42(3): 373-8.
7. Smedes F, Heidmann M, Schäfer C, Fischer N, Stępień A. The proprioceptive neuromuscular facilitation-concept; the state of the evidence, a narrative review. Phys Ther Rev. 2016; 21(1): 17-31.
8. Wang J-S, Lee S-B, Moon S-H. The immediate effect of PNF pattern on muscle tone and muscle stiffness in chronic stroke patient. J Phys Ther Sci. 2016; 28(3): 967-70.
9. Park K, Seo K. The effects on the pain index and lumbar flexibility of obese patients with low back pain after PNF scapular and PNF pelvic patterns. J Phys Ther Sci. 2014; 26(10): 1571-4.
10. Areas G, Borghi-Silva A, Lobato AN, Silva AA, Freire Jr RC, Areas FZ. Effect of upper extremity proprioceptive neuromuscular facilitation combined with elastic resistance bands on respiratory muscle strength: a randomized controlled trial. Braz J Phys Ther. 2013; 17(6): 541-6.
11. Stępień A, Fabian K, Graff K, Podgurniak M, Wit A. An immediate effect of PNF specific mobilization on the angle of trunk rotation and the Trunk-Pelvis-Hip Angle range of motion in adolescent girls with double idiopathic scoliosis—a pilot study. Scoliosis Spinal Disord. 2017; 12(1): 29.
12. Ju S-k, Yoo W-g. Comparison of anterior gluteus medius fiber activation during general exercises and PNF exercises. J Phys Ther Sci. 2017;29(3):476-7.
13. Roberts HC, Denison HJ, Martin HJ, Patel HP, Syddall H, Cooper C, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. Age Ageing. 2011; 40(4): 423-9.
14. Savva C, Mougiaris P, Xadjimichael C, Karagiannis C, Efstathiou M. Test-retest reliability of handgrip strength as an outcome measure in patients with symptoms of shoulder impingement syndrome. J Manipulative Physiol Ther. 2018; 41(3): 252-7.
15. Amaral CA, Amaral TLM, Monteiro GTR, Vasconcellos MTL, Portela MC. Hand grip strength: Reference values for adults and elderly people of Rio Branco, Acre, Brazil. PloS one. 2019; 14(1): e0211452.
16. Özyürek S, Aktar B. Sağlıklı Kişilerde Kavrama Kuvveti ile Öksürme Kuvveti Arasındaki İlişkinin İncelenmesi/Investigation of the Relationship between Handgrip Strength and Cough Strength in Healthy Individuals. Sağlık Bilimleri ve Meslekleri Dergisi.5(1):39-43.
17. Livanelioglu A, Erden Z, Günel Kerem M.Proprioseptif Nöromusküler Fasilitasyon Teknikleri. Ankamat Matbaacılık. Ankara. 1998. pp:122.
18. Gupta S, Hamdani N, Sachdev H. Effect of irradiation by proprioceptive neuromuscular facilitation on lower limb extensor muscle force in adults. J Yoga Phys Ther. 2015;5(2):1-7.
19. Meningroni, P. C., Nakada, C. S., Hata, L., Fuzaro, A. C., Marques Júnior, W., & Araujo, J. E. Contralateral force irradiation for the activation of tibialis anterior muscle in carriers of Charcot-Marie-Tooth disease: effect of PNF intervention program. Braz J Phys Ther. 2009;13, 438-443.
20. Nakada CS, Meningroni PC, Ferreira ACS, Hata L, Fuzaro AC, Júnior WM, et al. Ipsilateral proprioceptive neuromuscular facilitation patterns improve overflow and reduce foot drop in patients with demyelinating polyneuropathy. J Exerc Rehabil. 2018;14(3):503.
21. Kılıç S. Etki Büyüklüğü. J. of Mood Disord. 2014; 4(1) : 44-46.
22. Gontijo LB, Pereira PD, Neves CDC, Santos AP, Machado DdCD, Bastos VHdV. Evaluation of strength and irradiated movement pattern resulting from trunk motions of the proprioceptive neuromuscular facilitation. Rehabil Res Pract. 2012; 1-6 doi:10.1155/2012/281937