

PNF INDUCED IRRADIATION ON THE CONTRALATERAL LOWER EXTREMITY WITH EMG MEASURING

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ABSTRACT

The aim of the study was to investigate how the cross-training effect to reach higher effectiveness in PNF (Proprioceptive neuromuscular facilitation) treatment can be increased. PNF techniques apply three-dimensional movement, stretch reflex, resistance to promote functional movement. [1] We looked for the answer to the following: how much does the abduction (straddle) positioning of the examined limb and hip flexion of contralateral limb influence the extent of irradiation during an isometric contraction. Irradiation is a spreading and increased strength of a muscle response. [1] Flexion PNF-pattern was applied on lower extremity to facilitate the muscles on the opposite side. This investigation is based upon a single electromyographic measurement. The electrical potential of the examined hip and knee muscles were detected with eight channel Zebris Bluetooth EMG equipment (Electromyograph) on the dominant lower extremity. 20 healthy

physiotherapist students did the exercises in determined settings. Our research show that the grade of irradiation is connection with the placing of the contralateral limb. The abduction setting of the unmoved limb and the hip flexion on the moved limb has a significant effect on irradiation. A hip abduction of a lesser degree and a hip flexion of a higher degree induced significantly stronger contralateral muscle activity

KEY WORDS

PNF, Irradiation = Cross-training effect, Electromyography (EMG)

1. Introduction

Irradiation may be important and effective when the aim of a rehabilitation program is to improve the knee muscle function of an immobilized and painful contralateral (opposite side) leg at the early postoperative period. This process is an indirect way to induce innervation

in the affected muscles, appears as isometric muscle contraction. Physical therapists often use cross-education effects to prevent a reduction in number of functioning motor units and muscle atrophy by exercising the sound limb or other healthy parts to stimulate muscle activity in the affected limb that can not be directly approached. [1-7] Cross education is an exercise applied to one side of the body to induce muscle activity on the contralateral unexercised part or parts. This phenomenon was first demonstrated by Scripture et al. [2] From a biomechanical view irradiation is an effort for the functional mechanical stability. [5] PNF (Proprioceptive neuromuscular facilitation) is a special functional treatment approach. Its aim is to make the motion more effective, to improve the functions for every day activities. PNF Method applies spiral-diagonal movement patterns. Manual resistance is used, which stimulates the neuromuscular system and proprioceptors. [1, 8] Some previous studies deal with the cross-training effect [2,3,4,6,13-17], but only a few with irradiation through PNF concept. Kofotolis et al investigated cross-training effect produced with PNF training program and how change torque and endurance during the training of knee extensor and flexor muscles. In this study cross-training effects after PNF exercise were restricted to the knee extensor muscles. [6] Arai et al studied what kind of resistive exercise of the sound limb causes the most effective cross-education, which is defined as the muscle activity of the unexercised limb during contralateral exercise by analyzing the force and electrical activity of the affected muscle. It was found that PNF movement combined with hip internal rotation was significantly the most effective for inducing cross-education. [2] Grzebellus and Hering observed the effect of PNF

patterns at first on healthy subjects then on patients who outcome knee arthroscopy. Besides recording the EMG activity during contralateral limb, PNF patterned exercise, they compared the maximal voluntary force development and the range of movement of the affected leg before and after the testing series. With respect to EMG quantity, researchers found that with the exception of one muscle the PNF pattern with hip internal rotation has had the strongest effect on all muscles of the contralateral side. [3,4]

2. Materials and Methods

Subjects

20 healthy physiotherapist student: 15 females and 5 males took part in a single electromyographic measure. They have already known the PNF technique. The examined persons' average age: 21,6 years ($\pm 2,5$), average height: 169 cm (± 17), average weight: 66 kg ($\pm 19,5$)

Measurement instruments

Eight muscles of lower extremity have received a pair of electrodes (Figure 1.): m. gluteus medius, m. gluteus maximus, m. rectus femoris, m. vastus lateralis, m. adductor longus, m. biceps femoris, m. semitendinosus, m. gastrocnemius lateralis. One electrode was put on the malleolus lateralis, it is the reference point.



Figure 1: Electrodes arrangement

The electrode pairs were stuck parallel with muscle fibers about 25 mm distance from each other. They were fixed to the widest part of the muscle, which can be fingered the best. The raw EMG signal (Figure 2.) was detected with an eight channel Zebris Bluetooth EMG equipment, while the subject was doing the PNF pattern. The measuring instrument detected the changes of electrical potentials against the time between the electrode pairs. It could be visualised with their own WINDATA software. [9-12]

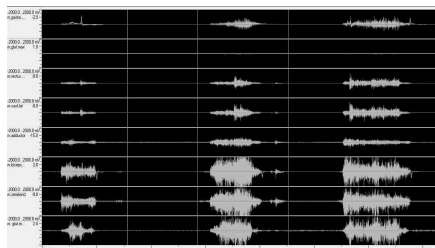


Figure 2: Raw EMG

The applied PNF pattern

The lower extremity has two diagonals named after the hip motion. Hip abduction is the leg movement from middle to the side and adduction means the contrary movement, toward the

middle. At internal rotation of the hip, knee point to middle and in external rotation to the side. In each pattern the three movement district are combined same to the functional human movements.

- flexion-abduction-internal rotation with knee extension (Figure 3.)
- flexion-abduction-internal rotation with knee flexion
- flexion-adduction-external rotation with knee extension
- flexion-adduction-external rotation with knee flexion (Figure 4.)



Figure 3: PNF-pattern (knee ext.)



Figure 4: PNF-pattern (knee flex.)

The movement series was performed according to the principles of PNF in the right diagonal so the IPNFA determined that. The motion started with an initial stretch, it is a reflex, then our body movement followed the movement of the subject's limb, so a continuous resistance was being given.

The fact that the position of the immobilised limb meant a modification compared to the ones written down in the coursebook. [1] The hip was put into 5 and 15 degrees abduction with the help

of a goniometer in the different practices. The exercised limb his end situation at one of the halves of the practices 40, at his other half 70 degree of the hip flexion we defined it. On the duration of the examination the electrodes throughout the one in the calmness, fixed limb isometric muscle activity was detected.

On the end of employed PNF movement we asked for a maximal voluntary contraction to do the patient. It is

After the standardization with maximal voluntary contraction the percentage distribution of maximal muscle activity rates were compared. In the statistical analysis we performed an F-test Two-Sample for Variances and a t-Test: Two Sample Assuming Equal Variances. In every case the hipthesis was checked up $p=0.05$.

Each positions were in pairs compared after each muscles and PNF-patterns based on the following table 1.

PNF patterns	Exercises	Muscles	Average	Sd	$F_0 =$ (0,40-2,53)	$s_0 =$	$t_0 =$ ($\leq -1,69$)
t-adtf	1.ex 15/40 (A)	glut.med	56,75	22,04	1,49	20,15	2,14
	2.ex 5/40 (B)		70,40	18,07			
t-adtf	1.ex 15/40 (A)	glut.med	56,75	22,04	1,21	21,05	3,85
	3.ex 15/70 (B)		82,40	20,01			
t-adtf	3.ex 15/70 (A)	glut.med	82,40	20,01	1,66	17,92	-1,66
	4.ex 5/70 (B)		91,80	15,54			
t-adtf	2.ex 5/40 (A)	glut.med	70,40	18,07	1,35	16,85	4,02
	4.ex 5/70 (B)		91,80	15,54			

Table 1: Comparison of positions

occured static muscle function. The isometric muscle activity on the opposite side was signaled with EMG instrument.

Data analysis

Data processing, systematization and evaluation were made by Microsoft Excel. The raw EMG data were smoothed, rectificated and enveloped (RMS) using Reharob Manager software developed by L. Kocsis and M. Jurák. Then data standardization was performed.[9-12] The standardization was carried out according to contralateral muscle activity belonging to maximal voluntary contract (MVC). The reference rate (100%) of the muscle activity was derived from the subjects' own maximum activities in the four position of each diagonal. The subjects carried out four different settings of one PNF pattern, the maximum of these muscle activities was considered 100%.

3. Results

Between the examined positions 55% of the cases we received a significant opposite side muscle activity change. In the majority of the cases a hip abduction of a lesser degree and a hip flexion of a higher degree induced significantly stronger contralateral muscle activity.

The patterns carried out with extended knee it was a stronger irradiation. Except for the follow settings of the hip: abduction degree at 5° and the flexion at 70° position, where the knee flexion pattern induced a stronger activity on the opposite side.

We find that the abduction setting of the unmoved limb and the hip flexion on the moved limb has a significant effect on irradiation.

At the gluteal muscles can be observed in the most PNF-pattern the setting was correlate with the muscle activity change. Figure 6.: in the course of each

PNF-patterns between the different combinations of the flexion, abduction placement, arrows show the significant contact. The colour of the arrow changes according to the PNF-patterns, points into the direction that is a position creates a higher activity level on the opposite side. Visible the more arrows between the two squares, the more PNF-patterns can be made change in irradiation with the settings.

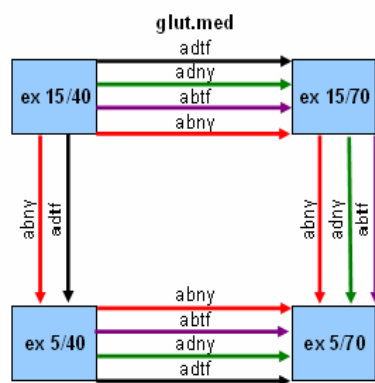


Figure 6: Patterns and positions

4. Conclusion

We may establish that the immobilised lower extremity position in abduction and the flexion end position of the moved limb have an effect on the level of the contralateral muscle activity based on the examinations. In practice irradiation can be used for example for the treatment of a painful limb in the early postoperative period. A faster recovery can be helped after a hip prosthesis implantation with the indirect innervation of the gluteal muscles.

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