



Original Article

The immediate effect of neuromuscular joint facilitation on the rotation of the tibia during walking

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Abstract. [Purpose] The aim of this study was to investigate the change in tibial rotation during walking among young adults after neuromuscular joint facilitation therapy. [Subjects and Methods] The subjects were twelve healthy young people (6 males, 6 females). A neuromuscular joint facilitation intervention and nonintervention were performed. The interventions were performed one after the other, separated by a 1-week interval. The order of the interventions was completely randomized. The rotation of the tibia during walking was evaluated before and after treatment. [Results] The neuromuscular joint facilitation group demonstrated increased lateral rotation of the tibia in the overall gait cycle and stance phase, and decreased medial rotation of the tibia in the overall gait cycle, stance phase, and swing phase after the neuromuscular joint facilitation intervention. In the control group, there were no significant differences. [Conclusion] These results suggest neuromuscular joint facilitation intervention has an immediate effect on the rotational function of the knee.

Key words: Neuromuscular joint facilitation, Knee, Rotation function

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INTRODUCTION

Proprioceptive neuromuscular facilitation (PNF) is a technique used to improve lower-limb muscle strength and gait function. Neuromuscular joint facilitation (NJF) is a new therapeutic exercise based on kinesiology, which is used to increase strength, flexibility, and range of motion (ROM). NJF integrates the facilitation element of PNF and the joint composition movement, with the aim to improve the movement of the joint through passive exercise, active exercise, and resistance exercise¹⁾.

Tibial rotation occurs at the time of knee bend. The characteristics of NJF emphasize the final rotation movement to improve the function of the knee joint. The proximal resistance is applied at the tibial plateau.

In clinical research, NJF intervention has an immediate effect on knee muscle force and iEMG reaction time^{2, 3)}, and it not only decreased pain severity but also improved the walking ability of elderly subjects with knee osteoarthritis⁴⁾.

The aim of this study was to investigate the change in tibial rotation function during walking in younger persons after neuromuscular joint facilitation treatment.

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Table 1. Subject characteristics (n=12)

Age (yrs)	Height (cm)	Weight (kg)
21.3 ± 2.5	165.8 ± 9.6	59.8 ± 10.3
21.2 ± 2.7	166.2 ± 6.2	58.0 ± 9.3

Values are mean ± standard deviation

SUBJECTS AND METHODS

The subjects were 12 healthy young adults (6 males, 6 females). The subjects' characteristics are detailed in Table 1. All of the subjects were right-handed. The purpose and contents of this research were explained to the subjects, and they gave their informed consent to participate in the study. The study was approved by the Research Ethics Committee of the International University of Health and Welfare (IUHW 12-197).

To measure the rotational function of the tibia during walking, subjects were asked to walk at a self-determined velocity. The angular velocity of tibial internal and external rotation was measured over the gait cycle. Eight-channel small wireless motion recorders (MVP-RF8-BC, Microstone Inc.) were used to collect the tibial internal and external rotation data. Six-axis motion sensors were set on the proximal portion of the femur lateral condyle and the fibula head of the right lower limb. Strong double-sided tape and an elastic bandage were used to affix the 6-axis motion sensor to subjects' skin. In addition, two pressure sensors set on the heel and toe of the right foot were used to separate the stance phase and swing phase of the gait cycle.

In the control measurement, the subjects were asked to walk at a self-determined velocity, and the degree of tibial internal and external rotation over 10 seconds was measured. Then after a 5-minute rest, the subjects were asked to repeat the walk. The same measurements were carried out.

In the NJF intervention measurement, 1 week after the control measurement, the same subjects were asked to walk, and the degree of tibial internal and external rotation over 10 seconds was measured. Two knee patterns of NJF were used: the knee extension-tibial external rotation (E-ER) pattern and the knee flexion-tibial internal rotation (F-IR) pattern. Each pattern was performed three times at random as a passive exercise and as a resistance exercise. In the NJF intervention group, both proximal resistance and distal resistance were performed by a physiotherapist.

For data processing, one gait cycle was randomly selected from all data. The relative angular velocity was calculated from angular velocity. When the heel of the right lower limb was on the ground, the angle of the knee joint was set at 0°. The maximum relative angular velocities of tibial internal and external rotation were measured over one gait cycle.

Two-way repeated-measures analysis of variance (ANOVA) was used to test for statistically significant differences, and the factors were intervention and measurement (control or NJF). If any significant interaction was found, a paired t-test was performed to compare the outcome indicators before and after the intervention. Data were analyzed using SPSS software ver. 17.0 for Windows (SPSS, Chicago, IL, USA). The threshold for statistical significance was set to 0.05.

RESULTS

The maximum relative angular velocities of tibial internal and external rotation are shown in Table 2. Two-way ANOVA revealed significant interactions among the time of one gait cycle, the degrees, and the maximum relative angular velocities of tibial internal and external rotation. The degrees of tibial internal rotation were reduced, and the degrees of tibial external rotation were increased by the NJF intervention. The control measurement showed no change.

DISCUSSION

In this study, novel angular velocity sensors were used to calculate the relative angular velocities of tibial internal and external rotation, and the immediate effects of NJF intervention on the knee movement pattern were demonstrated by objective data.

Compared with that in the control group, the degree of tibial internal rotation was significantly reduced in the NJF group, the degree of tibial external rotation was significantly increased, and the time of a gait cycle was significantly decreased. These results may be attributable to the improvement of periarticular muscle function by the application of proximal resistance. The alignment of the knee joint capsule, the function of periarticular muscles of the knee joint, and the knee position sense were improved; therefore, the maximum relative angular velocities of tibial internal and external rotation and the time of the gait cycle changed significantly.

These results suggest that NJF with proximal resistance training can be used as a novel form of exercise to improve knee joint function and walking ability.

Table 2. Comparison of each measurement item before and after intervention (n=12)

			Before	After
One gait cycle		Maximum degrees of tibial internal rotation (°)	19.1 ± 5.9	16.3 ± 7.4**
		Maximum degrees of tibial external rotation (°)	3.6 ± 2.9	5.4 ± 3.2*
		The total degrees of tibial rotation (°)	22.7 ± 6.7	21.6 ± 8.0
NJF	Stance phase	Maximum degrees of tibial internal rotation (°)	18.9 ± 5.9	15.7 ± 7.6**
		Maximum degrees of tibial external rotation (°)	1.3 ± 2.2	3.2 ± 2.8*
		The total degrees of tibial rotation (°)	20.2 ± 7.2	18.9 ± 8.5
Swing phase		Maximum degrees of tibial internal rotation (°)	16.4 ± 8.1	13.4 ± 8.7**
		Maximum degrees of tibial external rotation (°)	3.1 ± 2.7	4.3 ± 3.7
		The total degrees of tibial rotation (°)	19.5 ± 7.9	17.7 ± 7.6
One gait cycle		Maximum degrees of tibial internal rotation (°)	19.5 ± 6.3	18.6 ± 7.2
		Maximum degrees of tibial external rotation (°)	3.3 ± 2.2	2.7 ± 2.6
		The total degrees of tibial rotation (°)	22.8 ± 6.8	21.3 ± 7.9
Control	Stance phase	Maximum degrees of tibial internal rotation (°)	19.0 ± 6.4	18.1 ± 7.4
		Maximum degrees of tibial external rotation (°)	1.0 ± 2.0	1.1 ± 1.5
		The total degrees of tibial rotation (°)	20.0 ± 7.5	19.2 ± 7.9
Swing phase		Maximum degrees of tibial internal rotation (°)	17.1 ± 8.1	16.5 ± 7.6
		Maximum degrees of tibial external rotation (°)	2.9 ± 2.0	2.2 ± 2.6
		The total degrees of tibial rotation (°)	20.1 ± 8.1	18.7 ± 8.2

Values are mean ± standard deviation.

Comparison before and after intervention: *p<0.05; **p<0.01

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