Original Article

The effect of knee joint Mulligan taping on balance and gait in subacute stroke patients

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Abstract. [Purpose] This study aimed to determine the effects of Mulligan taping on balance and gait in subacute stroke patients. [Subjects] Thirty patients with subacute stroke were randomly divided into two groups: the experimental group (n = 15) and the control group (n = 15). Mulligan taping was applied to the knee joints of participants in the experimental group while placebo taping was applied to knee joints of subjects in the control group. Biodex was used to assess their balance ability and the GAITRite System was used to test gait. All measurements were performed before and after the intervention. [Results] Dynamic standing balance of the experimental group significantly improved after taping. Gait, gait cadence, velocity, step length, and stride length also improved significantly. However, no significant differences in standing balance or gait were observed for the control group. Furthermore, significant differences in dynamic standing balance, cadence, and velocity were found between the two groups after the intervention. [Conclusion] Our results demonstrate that Mulligan taping is effective for improving balance and gait in subacute stroke patients. Thus, this technique is a potential method for actively facilitating rehabilitation programs for hemiplegia patients.
Key words: Stroke, Mulligan taping, Balance

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INTRODUCTION

Stroke is a neurological disorder that occurs abruptly due to loss of brain function followed by an abnormal decrease in blood supply, and is often accompanied by profound memory and attention impairments[1)]. Stroke victims often exhibit symptoms such as spasticity along with sensory and motor dysfunction. Additionally, gait dysfunction and balance disruption are frequently observed. Stroke patients often appear to have their center of gravity shifted to the unaffected side due to the instability of the affected side. Stride length of these individuals is also decreased, with shortening of the stance phase on the affected side and swing phase on the unaffected side. During the stance phase of the affected side, genu recurvatum, talipes equinus, and other symptoms are observed, while dynamic varus and foot drop can be seen during the swing phase[2)]. Therefore, one of the rehabilitation goals for stroke patients is to recover balance and restore gait[3)].

For improving the balance and gait of stroke patients, various treatment methods are currently in use in clinics and studies. These techniques include weight shift training using visual feedback[4)], virtual reality exercises[5)], lower trunk strengthening training[6)], stair gait exercise[7)], task orientation training[8)], and traditional ankle-foot orthosis (AFO). Taping is also used to improve motor function. The application of tape supports the joint and enables functional movement by providing soft-tissue protection. This type of external support increases joint stability by enhancing ligament strength and restricting undesirable movement[9)]. Such taping can help stroke patients improve their gait and increase activities of daily living (ADL) performance[10)].

Mulligan taping with non-elastic tape has been applied to provide increase motor function and stability in joints. The tape is attached parallel or vertically to the joint for limiting normal physiological movement that causes pain. Additionally, Mulligan taping can continuously increase dynamic stability during active exercise, such as dynamic stability[11)].

Previous studies of taping interventions were conducted with healthy people and patients with musculoskeletal disorders[9, 10)]. Other investigations were performed to evaluate taping as a way to increase upper limb functioning of neurological patients[11)]. However, the application of Mulligan taping for treating hemiplegia patients has not been assessed. Thus, the purpose of the present study was to demonstrate that Mulligan taping of the knee joint improves the dynamic balance and gait of individuals who have suffered subacute strokes.

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SUBJECTS AND METHODS

Thirty stroke patients treated at K rehabilitation hospital located in Incheon city (Republic of Korea) agreed to participate in this study. The following selection criteria were used. First, the subacute stroke patients were recruited 3 to 6 months after their stroke and were diagnosed with hemiplegia. Second, the patients were capable of walking over 10 m with a cane or other ambulatory devices. Third, individuals without orthopedic disease were selected. Fourth, patients needed to score two points or lower on the Modified Ashworth Scale (MAS). Fifth, patients with over 21 points on the Korean version of the Mini Mental Status Examination (MMSE-K) were included. The researcher described the objective of the experiment to all participants to receive informed consent. The study was conducted only after sufficient information about the experimental procedures had been provided. The experimental procedure was approved by the Institutional Review Board of Gachon University.

The 30 stroke patients who met the selection standards were randomly assigned to the experimental or control group (15 patients per group). Mulligan taping was applied to the knee joint for the experimental group while placebo taping was applied to the same knee joint for the control group. A pre-test to evaluate cadence, gait velocity, step length, and stride length was performed before taping. A post-test was conducted using the same method 30 minutes after taping the knee joint. A practice session was performed with the subjects before evaluation. Non-elastic Endura-sports tape (OPTP, Minneapolis, MN, USA) and elastic Endura-fix tape (OPTP, Minneapolis, MN, USA) was used for the taping.

To apply Mulligan taping to the knee joint, while the participant was in the standing posture, inversion of the foot was done at the femur by bending the knee on the affected side about 10°. The upper center portion of the tape with a width of 5 cm and length of 35 cm was placed right under the knee joint starting from the exterior of the lower leg. The tape was wrapped diagonally toward the femur by crossing the lower leg. Maximum tightness of the tape was maintained[12]. Placebo taping involved the tape being placed in a manner similar to that as Mulligan taping, but the pressure generate by the tape was not maintained.

To measure dynamic standing balance ability, a balance system SD (Biodex Medical Systems Inc., USA) was used to assess posture imbalance, which was recorded as the anterior-to-posterior postural sway and the medial-to-lateral sway for 30 seconds. The evaluation was conducted twice and the average was calculated. GAITRite (CIR System Inc., USA) was used to measure the gait ability. The gait of the participants was analyzed before and after taping. A comparative analysis of cadence, gait velocity, step length, and stride length was performed to evaluate temporal and spatial elements of the gait.

All statistical analyses were conducted with SPSS (18.0 version). A paired t-test was used to compare changes before and after the taping intervention within each group. In order to compare differences in dependent variables according to the taping protocol, an independent t-test was performed. P-values less than 0.05 were considered statistically significant.

Table 1. General characteristics of the subjects

		Experimental group (n = 15)	Control group (n = 15)
Gender	Male	9 (60%)	4 (26.7%)
	Female	6 (40%)	11 (73.3%)
Lesion side	Left	10 (61.7%)	7 (46.7%)
	Right	5 (33.3%)	8 (53.3%)
Lesion type	Infarction	10 (66.7%)	12 (80%)
	Hemorrhage	5 (33.3%)	3 (20%)
MAS	Grade 0	1 (6.7%)	3 (20%)
	Grade 1	9 (60%)	7 (46.7%)
	Grade 1+	5 (33.3%)	5 (33.3%)
Age (years)		56.2 ± 13.7	48.9 ± 10.4
Height (cm)		165.5 ± 6.8	167.8 ± 10.9
Weight (kg)		62.3 ± 10.1	69.3 ± 15.6

MAS: Modified Ashworth scale

RESULTS

No significant differences between the general characteristics of the two groups were observed at baseline ($p > 0.05$) (Table 1). The cadence, gait velocity, step length, and stride length of the experimental group were all significantly altered after Mulligan taping ($p < 0.05$). In contrast, no significant changes in dynamic standing balance or gait were found for the control group when comparing data acquired before and after tape application ($p > 0.05$). When the two groups of patients were compared, there was a significant difference ($p < 0.05$) in dynamic standing balance, cadence, and gait velocity (Table 2).

DISCUSSION

This study was conducted to assess the influence of Mulligan knee joint taping on the dynamic standing balance and gait of subacute stroke patients. The application of Mulligan taping effectively improved the balance of the patients. Additionally, Mulligan taping effectively improved the gait of these individuals.

Ernst et al.[13] reported that taping the knee joint with proper patella alignment effectively improves balance and lower limb function. Kramer et al.[14] reported that the application of non-elastic tape to the patella of arthritis patients enhances balance as a result of immediately softening the affected tissues and improving the alignment. This method was effective for alleviating the symptoms of patella arthritis and provided pain relief. Similar to the results of previous studies, findings from the present investigation demonstrate that Mulligan taping significantly improves dynamic standing balance.

Unlike placebo taping, we applied Mulligan taping with proper pressure on the joint. We assumed that this could enhance joint stability. However, no significant change in balance was observed, although placebo taping was applied to the same area. Simple stimulation of proprioceptors through taping has been determined to be ineffective for im-

Table 2. Effect of Mulligan taping on dynamic balance and gait

		Experimental group (n = 15)	Control group (n = 15)
Dynamic balance (score)	Pre	3.60 ± 1.54	2.94 ± 1.77
	Post	2.35 ± 0.90*	2.71 ± 1.09
	Difference	1.25 ± 0.79#	0.23 ± 0.60
Cadence (steps/min)	Pre	70.34 ± 19.31	64.00 ± 11.59
	Post	78.65 ± 18.33*	65.83 ± 12.72
	Difference	8.31 ± 9.55#	1.83 ± 4.95
Velocity (cm/sec)	Pre	37.01 ± 17.14	33.70 ± 11.39
	Post	44.53 ± 19.29*	34.87 ± 11.45
	Difference	7.51 ± 9.00#	1.17 ± 2.78
Step length (cm)	Pre	31.51 ± 9.95	30.41 ± 6.88
	Post	35.68 ± 10.09*	32.41 ± 7.37
	Difference	4.17 ± 4.40	2.00 ± 3.62
Stride length (cm)	Pre	61.97 ± 20.75	61.79 ± 13.27
	Post	68.34 ± 22.93*	63.66 ± 13.07
	Difference	6.37 ± 8.31	1.86 ± 4.49

*significant difference within the group, #significant difference between the two groups

proving the standing balance of stroke patients. In addition, knee joint stabilization with pressure taping was determined to be an important factor that influences dynamic standing balance. This is based on the same concept as the use of assistive ambulatory devices to improve the balance of stroke patients, and results from the provision of lower limb joint stability[15].

Lin et al.[16] performed a study on the correlation between gait performance, motor function of the lower limbs, and positioning sensation of the joint for 25 stroke patients. The results of this investigation indicated that changes in positioning sensation of the ankle joint brings about significant differences in gait velocity and stride length. Chae et al.[17] measured the changes of gait ability following somatosensory training in 24 stroke patients. A statistically significant increase in gait velocity (from 38.06 cm/s to 41.68 cm/s), cadence (from 74.67 steps/min to 76.49 steps/min), and step length for the paralyzed side (from 27.39 cm to 31.58 cm) were observed in the experimental group. In the present study, Mulligan taping resulted in a significant difference in cadence, step length, stride length, and change in gait velocity ($p < 0.05$). No statistically significant differences in variables of gait function were found after tape application in the placebo group ($p > 0.05$).

Mulligan taping was used in the current study to improve joint function through a complete range of motion. This taping is an effective intervention to recover joint re-alignment and to help with postural adjustment[18]. Also, this modality promotes prompt recovery by relieving pain by changing the direction of weight load on the affected parts and reinforcing the tendons[12]. In summary, the findings from the present study demonstrated that Mulligan taping significantly increases the dynamic standing balance and gait of hemiplegia patients. This technique can also help improve asymmetric body alignment.

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