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Effect of Kinesio Taping on Gait in Total Knee Replacement

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Abstract

Objective: This study was to evaluate the effect of kinesio taping on gait in total knee replacement.Methods: To achieve the goal of this study, the medical opinion was obtained regarding 15 female patients with advanced degenerative arthritis of knee joint and knee joint was replaced with total knee replacement. The average age of the study group was 62.27 years. Optogait and electromyographic activity(EMG) were measured. The conclusion obtained on the basis of the result of comparative analysis on the time consumed at the time of walking by the no taping group and the taping group. Total knee replacement patient's radiological evaluations were done with tibiofemoral angle on knee standing anteroposterior view. Gait analysis was done with optogait and EMG technique to get the data of gait features of the study group. Knee flexion angle and gait parameters, muscle activity and prolonged time analyses were done. The gait of the each participant was assessed on the treated limb in three consecutive trials at fast speed and comfortable speed. Results: This study showed that the stride length, step length, speed, stance phase(%) was significantly increased in taping group ($p<.05$) at comfortable speed. The results of this study showed that the stance phase(%), gait cy-cle, speed, cadence was significantly increased in taping group ($p<.05$) at fast speed. The results of this study showed that the knee flexion angle of loading response, mid stance, pre swing was significantly increased in taping group ($p<.05$) at comfortable speed and the knee flexion angle of loading response was significantly increased in taping group ($p<.05$) at fast speed. The rectus femoris offset time was significantly decrease in taping group ($p<.05$) and the rectus femoris du-ration time was significantly decrease in taping group ($p<.05$) at comfortable speed. The rectus femoris, tibialis anterior, medial gastrocnemius duration time was significantly decrease in tap-ing group ($p<.05$) at fast speed. Conclusions: Regarding EMG on rectus femoris, the taping helped the flexion of a knee at the time of supporting a weight, effectively progressed the weight movement, and made a transmission of proper gravity. the taping supported the role of assisting a stability which antagonistic muscle had, reduced the movement to the previous direction, and decreased the load upon the muscle.

Keywords: *total knee replacement, athletic tape, gait, electromyography, quadriceps muscle, aged, female*

1. Introduction

Knee osteoarthritis is a muscular skeletal disease that frequently breaks out in the aged [1]. Especially, this disease arouses a pain and impedes joint function so obstructs everyday life and walking function [2][3].

It was reported that most patients of total knee arthroplasty walk slower than people with a normal speed, and knee flexion is restricted in all sections of stance and swing phases [4]. A

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walking cycle has shorter swing phase walking pattern, and stance phase uses more excessive flexion moment than swing phase [5]. At present, a cross-sectional study on walking measurement of total knee arthroplasty patients has been conducted [6][7], and a cross-sectional study on muscle contraction [4] has been conducted with walking measurement. However, pre-post comparison studies through intervening total knee arthroplasty patients are insufficient [8]. The most common interventions for total knee arthroplasty patients are treatment interventions such as kneepan joint dirigible operation, continuous movement of the knee joint, ice massage to reduce edema, and muscle quadriceps femoris exercise [9]. However, the first purpose is muscle restoration of muscle quadriceps femoris that is the most important thing for functional training [10].

Therefore, proper strengthening of muscle quadriceps femoris is essential for conduct functional activities successfully [11], and has been the most important goal and mean of rehabilitation. Muscle strengthening exercises of total knee arthroplasty patients are bicycle ride, sitting and rising from chair, isometric exercise of muscle quadriceps femoris, going up and down the stairs [9], and Kinesio taping method [12].

According to advanced researches, Slupik et al. observed contraction change of muscle activity by applying Kinesio taping to muscle vastus medialis [12]], and Chen et al. reported that contraction time of muscle vastus medialis changes by applying the taping [13]]. In addition, Crossley et al. suggested the application of the taping to patients with knee meralgia syndrome, and observed invigoration promotion of muscle vastus medialis by applying the taping to the outer kneepan [14].

However, there are few studies analyzing an exercise phenomenological effect by applying Kinesio taping to total knee arthroplasty, and the suggestion of an objective result is not conducted until the present. Therefore, based on previous studies, this study is to examine an effect on walking when Kinesio taping is applied to muscle quadriceps femoris of old women with total knee arthroplasty.

2. Method

2.1. Participants

This study was conducted targeting 15 old women who received total knee arthroplasty and are hospitalized in S General Hospital in Daejeon. Standards for selection are objects are diagnosed with osteoarthritis, receive total knee arthroplasty, and are more than a month from an operation, and operation condition does not affect walking or balance, and objects can walk for themselves more than 10m. In addition, the researcher selected old women with evagination range whose muscle guadricepsfemoris is from 3° to 8° in radiological evaluation.

People who receive an orthopedic operation of lower extremity, have a cardiac disorder or a lung disease, and whose neurosurgery, sight, or operation condition affect walking or balance were excluded from objects.

2.2. Procedure

Objects of the study wore clothes that are easy to walk. After attaching 15mm reflexive marker to the center of greater trochanter, outer thigh, and outer ankle bone, the study was conducted barefoot. Two web cams(Logitec Webcam Pro 9000) were located in front and on side of movement to take the angle of the knee joint on sagittal plane, and walking movement was shot.

The measurement of muscle activity was conducted while walking in walking analyzer. After foreign substance of skin surface in electrode-attached points of muscle was removed by

sandpaper and cleaned by alcohol to prevent measurement errors, the distance between surface electrodes stayed 2cm in the most advanced venter, and then these electrodes were attached. Electromyographic Signal on particular sections from load reaction period to preswing phase of affected side was calculated as %Reference Voluntary Contraction (%RVC) and used. At this moment, RVC Measurement made objects keep standing in a comfortable position for five seconds, and was measured in five muscles.

The study was divided into normal speed walking and high speed walking, so three times were conducted and then average value was obtained.

The application of Kinesio taping was evaluated depending on normal speed walking and high speed walking after attaching it to the origin and the end point of muscle vastus mediais, rectus femoris muscle, and muscle vastus lateralis. At this moment, a small hole is pierced in rectus femoris muscle taping to attach a surface electromyogram to skin.

2.3. Statistics

For all works and statistics of this study, average and standard deviation were calculated by using SPSS ver. 18.0. Descriptive statistics were used to examine age, stature, weight and TFA of objects. A test of normality of variables was conducted through Shapiro-Wilk Test, and matching sample t-test was conducted to compare before and after the application of taping in a group. All statistical significance levels of data were below .05

3. Results

On normal speed walking, stance phase rate of old women with total knee arthroplasty is 64.13% before the taping and 60.92% after the taping, so a statistically-significant difference is showed($p<.05$). Walking length shows a significant difference because walking length of old women with total knee arthroplasty is 33.10cm before the taping and 42.40cm after the taping($p<.05$), and stride length shows a meaningful increase because stride length is 73.17cm before the taping and 83.20cm after the taping($p<.05$). Walking cycle is 1.59s before the taping and 1.54s after the taping so time after the taping is shorter than time before the taping but there is no meaningful difference. Walking speed of old women with total knee arthroplasty is 0.50 ㎧ before the taping and 0.63 ㎧ after the taping so shows a significant difference ($p<.05$). The number of steps is 0.59 step/s before the taping and 0.69 step/s after the taping so increases but there is no significant difference (Table 1).

Table 1. Walking ability according to walking speed whether the taping is applied or not

	Speed	before	after	*t*(*p*)
stance phase (%)	normal	64.13 ± 9.89	60.92 ± 8.20	2.650(0.019)
	fast	65.20 ± 8.31	60.95 ± 8.56	2.643(0.019)
step length (㎝)	normal	33.10 ± 6.21	42.40 ± 6.67	-6.022(0.000)
	fast	36.97 ± 8.84	39.67 ± 9.79	-1.359(0.196)
gait cycle (s)	normal	1.59 ± 0.31	1.54 ± 0.72	0.443(0.664)
	fast	1.36 ± 0.41	1.16 ± 0.32	2.614(0.020)
stride length (㎝)	normal	73.17 ± 12.14	83.20 ± 13.01	-2.980(0.010)
	fast	75.17 ± 14.99	77.53 ± 16.03	-0.899(0.384)
gait velocity (㎧)	normal	0.50 ± 0.14	0.63 ± 0.26	-2.844(0.013)
	fast	0.68 ± 0.25	0.83 ± 0.30	-4.621(0.000)
Cadence (step/min)	normal	0.59 ± 0.19	0.69 ± 0.30	-2.099(0.054)
	fast	0.91 ± 0.52	1.05 ± 0.55	-4.487(0.001)

Value are presented as mean ± standard deviation

On normal speed walking, muscle activity value of rectus femoris muscle is 19.07%RVC before the taping and 13.03%RVC after the taping so shows a significant difference($p<0.05$), and muscle activity value of muscle tibialis anterior is 28.32%RVC before the taping and 17.96%RVC after the taping so shows a significant decrease($p<0.05$). Activity value of muscle semitendinosus is 24.49%RVC before the taping and 24.22%RVC after the taping so decreases but there is no meaningful difference. Activity value of muscle biceps femoris is 18.76%RVC before the taping and 17.27%RVC after the taping so there is no meaningful difference, and activity value of gastrocnemius medialis is 25.37%RVC before the taping and 22.37%RVC after the taping so there is no statistically-significant difference (Table 2).

Table 2. Muscle activity according to walking speed whether the taping is applied or not

	Speed	before	after	*t*(*p*)
rectus femoris	normal	19.07 ± 11.68	13.03 ± 6.16	2.631(0.020)
	fast	19.25 ± 8.89	13.20 ± 5.66	2.858(0.013)
tibialis anterial	normal	28.32 ± 12.50	17.96 ± 9.49	3.669(0.003)
	fast	20.39 ± 9.42	19.55 ± 9.91	0.270(0.791)
semitendinosu	normal	26.49 ± 17.54	24.22 ± 15.88	0.824(0.424)
	fast	21.90 ± 10.72	25.43 ± 24.56	-0.658(0.521)
biceps femoris	normal	18.76 ± 8.18	17.27 ± 7.97	0.710(0.489)
	fast	18.96 ± 8.05	17.76 ± 7.78	0.499(0.625)
medial gastrocnemius	normal	25.37 ± 15.94	22.37 ± 14.30	2.038(0.061)
	fast	23.70 ± 14.17	24.75 ± 17.42	-0.263(0.796)

Value are presented as mean ± standard deviation

4. Discussion

Total knee arthroplasty patients show reduction of the number of steps with slow walking speed, reduction of flexion angle of the knee joint on stance and swing phases, and walking with long contraction of rectus femoris muscle, hamstring, gastrocnemius and muscle tibialis anterio [4]. In addition, they are under mechanical stress in the joint on walking [15] so a grade of functional activities such as getting up and walking test, test of walking up stairs and 6m walking test gets lower [16]. Therefore, they are restricted in everyday life and the quality of their life is reduced [17]. Especially, the reduction of a functional activity grade reported that weakened muscle quadriceps femoris is the primary cause[18]. Therefore, total knee arthroplasty patients receive muscle strength improvement training of muscle quadriceps femoris after an operation, and receive stimulation training of knee joint proprioceptor and walking practice[4]. Liminal stimulus of the knee joint decreases depending on operation history of the knee joint and establishment of joint working range, and a stimulus decrease accelerates with advancing years [19]. Therefore, proper intervention is needed to solve problems such as liminal stimulus reduction of proprioceptor, continuous time of abnormal contraction in lower extremity muscle, and reduction of knee joint flexion angle and the number of steps of total knee arthroplasty patients.

Therefore, this study applied the taping to muscle quadriceps femoris of old women with total knee arthroplasty based on advanced researches, so examined biodynamical changes of knee according to walking speed.

Most studies of functional improvement targeting total knee arthroplasty patients apply therapeutic interventions such as passive dirigible practice of kneepan joint, continuous move-

ment of the knee joint, ice massage to reduce edema, muscle strengthening exercise of muscle quadriceps femoris, and going up and down the stairs [18]. Independent walking is possible without the aid from the second week to the fifth week after an operation in principle, so functional activity program such as stair exercise is started [9]. In addition, control training of a pain that is frequently showed by knee with flexion restriction on walking is emphasized [9]. Lately, several studies report that Kinesio taping is effective in functional improvement such as pain relief, muscle strength improvement [20], and increase of joint working range [21].

This study measured muscle activity by using an electromyogram according to the application of Kinesio taping. When Kinesio taping was applied to muscle quadriceps femoris with weakened muscle strength, muscle activity of total knee arthroplasty patients similarly decreased in all muscles on normal speed walking. The application of taping to muscle quadriceps femoris helps muscle action so contributes to extension and flexion of the knee joint. Janwantanakul and Gaogasigam reported that Kinesio taping does not significantly affect muscle activity in muscle activity evaluation with an electromyogram. However, as a result of electromyogram analysis by muscles, a difference between integration electromyogram values said that the taping offers motility of lower extremity and contributes to muscle functions. In addition, expansibility and elasticity of a tape itself are contrary concepts, but these concepts soften muscle contraction and reduce muscle damage according to unexpected strong extension or contraction together. The taping applied to muscle quadriceps femoris also enhances stability of the body so offers a momentum of lower extremity.

The application of Kinesio taping is effective in improvement of time and spatial walking characteristics of old women with total knee arthroplasty. In addition, this application reduces abnormal simultaneously-continuous contraction time of muscle quadriceps femoris and hamstring. Therefore, knee flexion restriction improves on load reaction period, so vector direction of the knee joint is suggested and stability is offered for a momentum on stance phase [22]. Total knee arthroplasty patients have a loss of proprioceptor before and after an operation [23]. This study increases contact pressure of the kneepan, and stimulates mechanical receptor and sensory receptor of skin surface through the application of Kinesio taping, so induces walking improvement and promotion of weight supporting rate of lower extremity in affected side. A mechanically-objective study such as inner and outer power, and moment of the lower extremity joint will be needed through the application of Kinesio taping.

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