Effects of Quadriceps Muscle Taping Application on Quadriceps Muscle Strength and Walking Speed in Obese Patients with Knee Osteoarthritis

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Abstract: Obesity is well-known as a risk factor for knee osteoarthritis (OA). In such patients, weak quadriceps muscle and decreased walking speed are commonly found. The study aimed to prove whether taping application on quadriceps muscle in obese patients with knee OA affects quadriceps muscle strength and walking speed. This study is a single-blind randomized controlled trial. Subjects are overweight or grade-1 obese, knee OA (Kellgren-Lawrence 1-3) patients with Visual Analog Scale (VAS) of 1-4 who were admitted to our obesity clinic on August-September 2019. One group received aerobic exercise with static cycle and taping on quadriceps muscle, while the other received the same exercise, but with sham taping. Taping was changed regularly 2 times a week for 4 weeks. The pain scale was assessed before, regularly according to tape changed, and at the end of the study. While, quadriceps muscle strength and walking speed were assessed before, at 2 weeks, and the end of the study. The taping group showed significant improvement in pain, muscle strength, and walking speed ($p<0.05$). Improvement in pain also found in the sham taping group. Taping application on quadriceps muscle improves muscle strength and walking speed in obese patients with knee OA.

1 INTRODUCTION

Obesity is a condition in which the ratio of body weight and height exceeds the prescribed standard. The prevalence of obesity over the past four decades has almost tripled. In 2016, adult obesity in the world reached around 13% (WHO, 2018). In Indonesia, based on the 2018 Riskesdas data, the prevalence of obesity was has grown from 14.8% (2013) to 21.8% (2018) (Riskesdas, 2018). Based on data from the outpatient visits to the Medical Rehabilitation Department of Cipto Mangunkusumo Hospital, there were 2333 patient visits to the obesity clinic in 2018.

Excess body weight is a condition that is closely related to an increased risk for the emergence of osteoarthritis (OA), especially in the joints supporting the body, such as the knee. The excessive and repetitive burden on the knee joint as weight support will trigger biological changes that will cause changes in water content, proteoglycans, and collagen in the joint cartilage (King et al, 2013).

A cohort study by Reijmen et al (2007), showed an association between increased body mass index (BMI) and the incidence and progression of knee OA (Reijmen et al, 2007)
Several studies have shown that patients with knee OA have weak lower limb muscles, especially quadriceps muscles and this muscle weakness is correlated with the degree of knee pain and the level of physical disability. Quadriceps muscle weakness has been associated with functional disorders such as an increased risk of falls and slower walking speeds (Tani et al, 2018).

Individuals with knee OA have weaker quadriceps muscles and show a shorter stance phase during walking. In walking speed, the role of the quadriceps muscle is to control knee flexion during weight gain while the hamstring and gastrocnemius muscles are stationary. In conditions of quadriceps muscle weakness, hamstring and gastrocnemius

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muscle contractions may be needed to help control the knee (Tani et al, 2018).

Walking speed is one indicator that is very important to see a decrease in functional ability, which is associated with increased vulnerability, and also other disabilities. Early detection of a decrease in functional ability is very important to improve quality of life and reduce the level of one's dependence (Ferre et al, 2017). One method for measuring walking speed is 10-meters walking test (Graham, 2008).

Kinesiology tape (KT) is a commonly used elastic adhesive tape, this is developed by Kenzo Kase. Hypotheses for the effects of the use of KT include reduced pain, muscle strength facilitation, and inhibition, which also increased the range of joint motion. The manufacturer claims that KT can facilitate muscle contraction if applied from origin to insertion. This is presumably because the mechanism of the KT recoiling force can be transmitted to the fascia. This force can then help the muscle contraction if the muscle contraction and KT have the same pull direction. Another mechanism is that the recoil ability of KT can stimulate the skin's mechanical receptors. This effect will increase the excitability of the motor unit and cause the muscle spindle reflex if the direction of the pull matches the direction of the muscle contraction. Kinesio taping allows the strengthening of weakened muscles by stimulating gamma motor neurons (Yang *et al*, 2018).

Tamin et al (2018), conduct a randomized controlled trial study with 12 participants in the intervention group and 11 participants in the control group to find the correlation between quadriceps muscle strength and pain improvement with functional disability status in obese with knee OA after taping application. All participants were given aerobic, knee strengthening exercises, and balance exercises for 2 sessions per week for 3 weeks. This study suggested that correlation with functional activities was greater in pain than quadriceps strength (Tamin et al, 2018).

A study was held by Tani et al (2018) to evaluate the walking speed after applying Kinesio tape on quadriceps femoris muscle in patients with knee OA, hows the results that applying KT facilitated muscle activation by increasing walking speed. This is thought to be caused by stimulation of the proprioceptive sense, muscle spindles, and strengthened the muscle in the affected part (Tani et al, 2018). But this study only conducted in 3 days, which is not enough for increasing muscle strength theoretically (Kisner, 2002).

Therefore, this study aims to see the effect of kinesiology tape applications to quadriceps muscle strength and walking speed in obesity and knee osteoarthritis patients four weeks after application.

2 METHODS

This is a single-blind randomized controlled trial study held in August 2019 until September 2019 involving 22 patients in our outpatient obesity clinic in the Department of Medical Rehabilitation, Cipto Mangunkusumo National General Hospital, Indonesia. Consecutive sampling was performed to recruit subjects. The subjects were divided into two groups randomly. One group (n = 11) received aerobic exercise with static cycle and taping on quadriceps muscle, while the other (n = 11) received the same exercise, but with sham taping. The inclusion criteria were as follows: (1) overweight/obese grade 1 patients with knee osteoarthritis KL 1-3, (2) patient age ≥ 40 years old, (3) no history of surgery in knee, (4) not have exercise program at least within 2 weeks, (5) no history of neurologic disorders and unstable heart failure, (6) ability for walking without ambulatory aid, (7) understand the command and instruction that given, (8) not have allergic history of using kinesiology taping, and (9) willing to participate in this study. Exclusion criteria applied including: (1) Patients who had a cognitive impairment, (2) had knee deformity (knee varus/knee valgus) ≥ 15^0, (3) had balance disorders, (4) had visual disorders that were not corrected, (5) had unstable cardiopulmonary disease, and (6) not have a willingness to participate the study.

In the intervention group (group A), Kinesiology Tape (Leukotape®K Essity) was applied with a facilitation technique, a 40% stretch, in quadriceps muscle based on the standard used in Obesity polyclinic of Medical Rehabilitation Department of Cipto Mangunkusomo Hospital. Kinesiology Tape was applied on rectus femoris muscle in Y strip that starts from 10 cm below anterior superior ischiatic spine until the superior border of the patella and on vastus medial muscle that starts from 10 cm below intertrochanter line until the medial border of patella with the knee flexed 45^0 for both sides of the leg. The kinesiology tape was changed every 3 days for 4 weeks. In the sham taping group (group B), kinesiology tape was applied horizontally on quadriceps muscle. Aerobic exercise using a static cycle was given for both groups. The quadriceps strength was assessed using a hand-held

dynamometer by other clinicians. Walking speed was measured using the 10-meter walk test with marked in 2 meters and 8 meters. Patients walked in comfortable speed for 2 trials, and the average speed between 2 meters and 8 meters was calculated in m/s.

Pain scale (VAS) was assessed before, every week according to tape changed, and at the end of the study. While, quadriceps muscle strength and gait speed were assessed before, at 2 weeks, and the end of the study. The conduction of this study had been previously approved by the Ethical Committee of the Faculty of Medicine, Indonesia University.

The analysis was conducted using SPSS version 20.0. Statistical significance was considered to be the value of $p \leq 0.05$. Descriptive analysis was used to calculate the mean and standard deviation. The intergroup comparison of demographic details was performed using independent's t-test and non-parametric Mann-Whitney U test and for intragroup comparison paired t-test and Wilcoxon signed-rank test was used.

3 RESULTS

No significant differences were determined between the groups in respect of age, body weight, body height, BMI (Body Mass Index), and VAS pain in the baseline values. While there were differences in the number of types of OA grade in both groups.

Table 1: Baseline characteristics of patients.

Variable	Group A (n=11)	Group B (n=11)	p
Age	63.18±6.90	63.36±3.80	0.94 *
KL grade			
Grade 2	4	8	
Grade 3	7	3	
Bodyweight	61.36±5.20	63.59±8.45	0.47 *
Body height	149.45±4.89	154.05±4.98	0.41 *
IMT	27.43±2.33	26.76±2.20	0.49 *
VAS	3.82±0.41	3.55±0.52	0.18 **

*Unpaired t-test, **Mann-Whitney U test

At two weeks and the end of the study, there were significant differences between the group in the improvement of quadriceps muscle strength. Walking speed showed significant differences between the group at the end of the study (p=0.03).

Table 3 showed a comparison within the group in VAS, quadriceps muscle strength, and 10 MWT. VAS was significantly decreased in both groups at 2 weeks and 4 weeks. Quadriceps muscle strength and walking speed at 2 weeks and 4 weeks significantly improved in group A.

4 DISCUSSIONS

In knee OA patients there is a decrease in walking speed associated with quadriceps muscle weakness and pain experienced on the knee when walking. A decrease in walking speed will cause a decrease in one's functional abilities (Tani et al, 2018).

Many studies have researched to see the effects of increased muscle tone after the application of Kinesio tape. But there were no studies that have done taping alone without exercise to see an increase in muscle strength caused by taping application. This raises the question of whether an increase in muscle strength occurs due to the effect of taping application or the effect of exercise.

A study by Tani et al, 2018, showed that taping application in facilitation technique increase walking speed in patients with knee OA. This study was conducted in three days (Tani et al, 2018). Perhaps this is caused by a decrease in pain, but not an increase in muscle strength. Because based on theory, improvement of muscle strength can be seen for 2 weeks, and more real for 4 weeks of training.

In this study, there was a significant improvement of quadriceps muscle strength and walking speed after taping application (facilitating technique) on quadriceps muscle in obese patients with knee OA after 2 weeks and 4 weeks. While the pain scale decrease in both groups. Walking speed suggested improving because of the reduction of the pain scale, and the increase of quadriceps muscle strength.

The decrease in pain after KT can be attributed to the reduction in mechanical stress on free nerve endings within the fascia through fascia unloading. The application of KT created convulsions on the skin which increased the interstitial spaces between the sheets of fascia (Added A et al,2013). The cutaneous stretch stimulation provided by KT interferes with the transmission of mechanical and painful stimuli leading to pain reduction (Morris et al, 2013).

Taping over the skin constantly stimulates cutaneous mechanoreceptors, thus providing more

sensory signals to the central nervous system for information integration, thus facilitating contraction of inactive muscles. Besides, reduction of motor neuron threshold induced by cutaneous stimulation would influence the recruitment of the motor unit, which can facilitate muscle contraction, and ultimately improve muscle strength (Kouhzad et al,2014; Donec V et al, 2012).

A meta-analysis study conducted by Yam et al, 2019 concluded that kinesiotape is effective in the population with muscle fatigue and chronic musculoskeletal diseases, but not in the population without disabilities. Because KT will increase blood circulation recovery by increasing nutrient and waste change. KT may decrease pain by gate control theory mechanism. KT provides tactile stimulation. This stimulation may lead to the firing of large-diameter afferent fibers, which close the gait to pain signals transmitted by small-diameter afferent fibers. This stimulation then decreased muscle soreness and musculoskeletal pain and enhances muscle strength. KT facilitates muscle strengthening by transmitting a pulling force to the muscle fascia. KT may stimulate mechanoreceptors. If the direction in which KT is pulling matches the direction of muscle contraction, KT could enhance the muscle spindle reflex and increase the excitability of the motor units. If applying in the opposite direction, KT will stretch the Golgi tendon organs and will reduce the activity of the motor neuron. But there is an insufficient study that researches the physiological mechanism of KT that affects muscle contraction (Yam et al, 2019).

The limitation of this study was a small number of recruited samples. For future studies, it is important to look for an increased motor unit recruitment effect by taping applications by using an objective measurement such as electromyography.

5 CONCLUSIONS

KT is effective for increasing muscle strength and improve walking speed in obese and knee OA patients in 4 weeks and also reduces pain scale immediately. This study could be applicated in obese and knee OA patients that restricted for exercise because of their pain.

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Figure 1: Kinesiology taping application in group A.

Figure 2: Kinesiology taping application in group B.