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The Effects of Kinesio Taping application on the Pain, Weight-Bearing Distribution, and Walking Ability of Knee Osteoarthritis A Randomized Controlled Trial

This study aimed to identify the effects of kinesio taping (KT) applied in a proprioceptive neuromuscular facilitation (PNF) pattern on the pain, weight-bearing distribution (WBD), and walking ability of knee osteoarthritis (KOA) patients. Thirty women with KOA were randomly allocated to a control group (n=15) with KT at the quadriceps only, and a PNF pattern group (n=15) with KT at the quadriceps and gastrocnemius muscle. Pain intensity was measured using a visual analogue scale during walking. In addition, WBD, and walking ability were measured before and 30 minutes after KT application. The VAS significantly reduced in both groups after the intervention ($p<.05$). WBD ($p<.05$, ES=.32) and walking ability ($p<.05$, ES=.38) showed a significant change in the PNF pattern group, and in the inter-group comparison, the PNF pattern group showed a significant difference compared to the control groups. These results demonstrate that KT application with PNF pattern effectively attenuate the pain and improves WBD and walking ability in KOA patients.

Key words: *Kinesio Taping, knee osteoarthritis, walking ability, weight-bearing distribution*

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INTRODUCTION

Knee osteoarthritis (KOA) is a degenerative musculoskeletal disorder with symptoms that include severe pain and stiffness, which lead to limited mobility and disability [1]. Individuals with KOA often have impaired general health [2], poor quality of life [3], and reduced functional capacity [4]. Conservative and pharmacologic interventions are used to maintain quality of life in KOA patients by reducing pain and improving knee function. As pharmacologic interventions may cause adverse gastrointestinal and renal effects [5], conservative and alternative interventions are often used. Kinesio Taping (KT) is a commonly used, highly accessible conservative intervention that increases muscle flexibility and strength, and improves proprioception in patients with various musculoskeletal disorders [6-9], particularly for KOA patients [10,11].

Muscle synergy, functional coupling of muscle groups that constrains them to act as a single unit [12], is a pattern of muscle co-activation initiated by a single neural signal [13]. If one muscle in a synergistic group is weak or produces pain, the other muscles become even more active. The lower limbs have multiple functions in posture, balance, and walking [14]. In the lower limbs, synergistic muscle action produces flexion and extension movement patterns through activation of muscles in a proprioception neuromuscular facilitation (PNF). The flexion pattern in PNF involves synergy of the hamstrings and tibialis anterior, while the extension pattern involves synergy of the quadriceps muscles (QM) and the gastrocnemius muscle (GM). In a previous study, QM-GM co-activation increased during activities of daily living such as walking, stair ascent, and stair descent [15]. KOA patients inevitably develop compensatory muscle activation to maintain joint function [16]. Studies investigating KT application in KOA patients involved only the QM [10, 11], and the benefits of KT application in PNF pattern for improving weight-bearing distribution (WBD) and walking in KOA patients are unclear.

This study was designed to investigate the hypothesis that KT application with PNF pattern (QM-GM) was improve pain, WBD, and walking ability in KOA patients more than KT application on the QM alone.

SUBJECTS AND METHODS

Participants

This study was a single-blind randomized clinical trial. Participants included thirty women with KOA recruited from local outpatient clinics (Inchon, Republic of Korea). The inclusion criteria of were osteoarthritis diagnosis, age greater than 40 years, symptoms in a single knee for at least 6 months, capable of walking independently, no ligament or soft tissue damage, and ability to understand and follow the experiment protocol. The exclusion criteria were history of surgery for KOA, previous neurologic or vestibular impairment, and contraindication for any of the measurement procedures. All participants signed an informed consent approved by the Gachon University Institutional Review Board. This study used a G-power of 3.1.9 for sample size calculation, which was determined to detect a clinically significant improvement in the outcome measures from a pilot study. Effect size (ES) was set at 0.8 with a significance level of .05.

Experimental procedure

Randomization was intended to minimize order effect. Baseline measures were taken of the outcomes prior to randomization. Subsequently, each participant was allocated to 1 of the 2 groups via consecutively numbered, sealed opaque envelopes containing the allocation code. Simple randomization was conducted using Microsoft Excel for Windows software (Microsoft Corporation, Redmond, Washington) by a researcher who was not involved in participant recruitment. Participants were randomly assigned into a control group (n = 15) and an PNF pattern group (n = 15). No differences between baselines of two groups were detected for primary outcome measures of pain, WBD, and walking ability (paired t tests, all $p > .05$). Baseline characteristics were recorded for all patients, and the protocols for measuring pain, WBD, and walking ability were reviewed before the tests. Kinesio Tape was applied to the affected knee, and pain, WBD, and walking ability were measured again after 30 minutes.

Intervention

KT with dimensions of 5 cm × 5 m (3NSCo., Republic of Korea) was applied by a physiotherapist with at least 5 years of experience who had received KT training. With the QM in a maximally extended position, the tape was fixed from the anterior superior iliac spine to the tibial tuberosity, medially from the lower part of the intertrochanteric line to the medial superior aspect of the patella, and laterally from the femoral greater trochanter to the lateral superior aspect of the patella 11). In the MP group, additional tape was fixed to the GM first from the femoral medial epicondyle to the insertion point of the Achilles tendon into the calcaneus, then from the femoral lateral epicondyle to the insertion point of the Achilles tendon with foot in maximum passive ankle dorsiflexion (figure 1). KT was performed such that the tape could stretch by 10-15% of its total length.

Fig. 1. Application of the KT
KT applied quadriceps (a), gastrocnemius (b)

Outcome measures

WBD was measured while participants performed double-leg standing with open eyes. The measurement device used was BioRescue (RM Ingenierie, Rodez, France), consisting of a 610 mm × 580 mm × 10 mm platform equipped with 1600 pressure sensors, software, and a monitor. The BioRescue evaluates asymmetry in weight-bearing by measuring the difference in left/right standing pressure with the participant standing barefoot in a neutral position (30° angle for each foot, and a 9 cm distance between the heels). Arms were held comfortably at participant's sides while standing with eyes open for 60 seconds. A larger left/right standing pressure difference, expressed in a percentage, indicated a greater weight-bearing asymmetry.

Walking ability was measured by assessing functional mobility with the timed up-and-go test (TUGT). The validity and reliability of the TUGT are high (ICC = .80) [17], and it has been used to examine outcomes in KOA patients [18]. The participants stood up from a chair, walked 3 meters, turned around, and returned to a seated position without using the arm of the chair for assistance. Participants performed three trials, and the average time to complete the test was recorded.

Pain intensity was measured using a visual analogue scale (VAS) during the TUGT. The VAS consisted of a 100 mm linear scale, ranging from "no pain, 0" to "the most severe pain, 100." Participants indicated their perceived pain intensity after completing the TUGT.

Statistical analyses

SPSS 21.0 software was used for all statistical analyses. The normal distributions of the results were tested by the Shapiro-Wilk test. The subjects were normal distribution, parametric tests were used for statistical analysis. Differences before and after the intervention were compared using a paired samples t test and the differences between the two groups were compared with an independent samples t test. The ES was calculated, and each parameter was expressed as mean (SD). Results were statistically significant at $p < .05$.

RESULTS

The baseline characteristics of the 30 participants with KOA are displayed in Table 1.

Table 1. Baseline characteristics of the participants.

Variable	Control group	PNF pattern group
Age (years)	53.00(6.15)	51.90(4.75)
Height (cm)	157.90(4.30)	158.20(3.42)
Weight (kg)	57.60(3.62)	56.80(5.20)
Injured leg(left/right)	9/6	8/7

PNF: Proprioceptive neuromuscular facilitation

There were no statistical differences between the groups at baseline. There was a significant decrease in the VAS score for pain in both groups after the intervention ($p < .05$), and there was a significant difference between the two groups ($p < .05$, ES = 1.03) (table 2).

WBD on the affected and unaffected sides changed significantly after the intervention in the PNF pattern group ($p < .01$). Comparison of the groups showed a significant difference in pressure on the affected ($p < .05$, ES =1.24) and unaffected sides ($p < .01$, ES = 1.34). The left/right pressure changed significantly in the PNF pattern group ($p < .01$), and the difference in the PNF pattern group was greater than in the control group ($p < .05$, ES = 1.29) (table 3).

TUGT was significantly different in the PNF pattern group ($p < .01$) and the control group ($p < .01$). There was a significant difference in the inter-group comparison ($p < .01$, ES = 1.96) (table 4).

Table 2. Changes in the visual analog scale (VAS) score

		Control group	PNF pattern group	Difference(95% CI)	P value	ES
VAS score	Before intervention	39.50(12.23)	40.50(8.32)			
	After intervention	26.00(10.64)	18.50(4.74)			
	Change	-13.50(9.14)	-22.00(7.23)*	8.50(3.81)	.039	1.03
	(95% CI)	(-20.26~-6.75)	(-27.39~-16.62)	(.47~16.52)		
	p-value	.011	.000			

PNF: Proprioceptive neuromuscular facilitation

Table 3. Changes in weight–bearing distribution

Variable		Control group	MP group	Difference(95% CI)	P value	ES
Pressure to the affected side (%)	Before intervention	48.58(1.15)	45.71(3.50)			
	After intervention	48.76(.82)	47.76(2.81)			
	Change	0.18(1.09)	2.05(1.83)	1.69(.62)	.014	1.24
	(95% CI)	(–.59~.96)	(.73~3.37)	(2.99~.38)		
	p–value	.613	.006			
Pressure to the non–affected side (%)	Before intervention	51.42(1.16)	54.29(3.50)			
	After intervention	51.28(.83)	52.14(2.54)		.011	1.34
	Change	–.14(1.00)	–2.15(1.86)	1.73(.63)		
	(95% CI)	(–.86~.58)	(–3.48~–.82)	(.45~3.00)		
	p–value₩	.671	.005			
affected/non–affected side pressure differ–ence (%)	Before intervention	2.84(2.31)	8.58(7.00)		.013	1.29
	After intervention	2.52(1.64)	4.38(5.34)			
	Change	–.32(2.09)	–4.20(3.68)	3.76(1.36)		
	(95% CI)	(–1.82~1.18)	(–6.84~–1.56)	(.91~6.60)		
	p–value	.640	.006			

PNF: Proprioceptive neuromuscular facilitation

Table 4. Change in the timed up and go test (TUGT) measurement

		Control group	MP group	Difference(95% CI)	P value	ES
TUGT (s)	Before intervention	10.18(1.29)	9.73(.77)			
	After intervention	9.86(1.29)	8.67(.79)			
	Change	–.31(.26)	–1.07(.48)	.75(0.17)	.002	1.96
	(95% CI)	(–1.35~.94)	(–1.41~.48)	(.39~1.11)		
	p–value	.004	.000			

PNF: Proprioceptive neuromuscular facilitation

DISCUSSION

This study aimed to confirm the effects of KT with PNF pattern on pain, WBD, and walking ability in KOA patients, and found that KT with MP is more effective than QM alone in reducing pain and improving WBD and walking ability. Pain decreased significantly in both the PNF pattern and control groups, indicating that KT has a positive effect on KOA pain control and supporting the results of previous studies showing that KT is an effective way to decrease the pain [11, 19].

Weight–bearing is a useful objective method of assessing KOA pain intensity, because asymmetric weight–bearing is caused by pain on the affected side [20]. Pain decreased in the control group, but there was no significant change in WBD on the affected side. In the PNF pattern group, pain decreased and WBD increased significantly on the affected side. This change was also significantly greater than the change in the control group, indicating that 30 minutes of KT application to the skin overlying QM and GM increased muscle activity and body perception. Previous studies suggested that KT improved proprioception and muscle strength [8, 9], and external afferent stimuli may enhance body perception and influence body schema and midline orientation [21]. Tension in the GM maintains postural stability in normal standing [22], suggesting that MP taping activates QM and GM proprioception through external afferent stimuli, and improves the midline orientation of the body.

Loading of the degenerative portion in KOA causes further deterioration of physical activities, such as walking [23]. Because the mid-stance requires weight-bearing on one foot during walking, KOA can cause secondary changes in gait [24] and reduce walking speed [25]. A previous study suggested that TUGT can evaluate walking function since it requires the ability to stand up from a sitting position, walk, and maintain balance [18]. KOA requires the body's weight to shift more rapidly from the contralateral limb to the support limb, which appears to be successful in reducing the load at the arthritic knee [24]. In this study, both groups significantly improved in the TUGT, but the effect on the PNF pattern group was greater than on control group. This indicates that KT with PNF pattern has a positive effect on walking ability by increasing weight-bearing on the affected side, supporting a previous study showing that interventions for KOA should consider the mechanics of all lower extremity joints [24]. This was a large ES, suggesting that functional activation of muscles using KT with PNF pattern improved lower limb functions, including sit-to-stand and walking. These results could also be interpreted as a consequence of decreased pain and improved weight-bearing.

Learning skilled tasks tends to reduce variability in distal joint movements more than in proximal joint movements [26]. This means that the proximal joints are more active than the distal joints when performing tasks. When walking, the knee joint is more active than the ankle joint; if the muscles of the knee joint do not work properly, as with KOA, the ankle joint becomes more active [27]. Rather than simply performing interventions for the knee joint, appropriate MP interventions should be applied to all associated affected muscles. KT application with PNF pattern improves functional ability, and PNF pattern application is crucial in lower extremity disabilities.

This study confirmed that application of KT with PNF pattern decreases pain and improves WBD and walking ability in KOA patients. While we propose that KT with PNF pattern is an effective method for treating KOA patients, there are limitations to this study. The relatively small number of participants makes it difficult to generalize the results. The short-term effects of KT with PNF pattern were investigated, as the tests were conducted immediately after applying the tape; the long-term effects and mechanical changes during walking are not clear. It is also unclear whether KT with PNF pattern influences other disabilities, such as muscle weakness or balance deficits. Future studies should investigate the effect of KT with PNF pattern on several symptoms, such as decreased motor function and balance and gait disabilities, as well as the long-term effects and mechanical changes in walking, pain, and movement to correlate these parameters with functional activity in the lower limbs.

CONCLUSION

This study aimed to confirm the effects of KT with PNF pattern on pain, WBD, and walking ability in KOA patients, and found that KT with PNF pattern is more effective than QM alone in reducing pain and improving WBD and walking ability. Pain decreased significantly in both the PNF pattern and control groups, indicating that KT has a positive effect on KOA pain control. These results demonstrated that KT application with PNF pattern, it was effectively attenuates of pain and improves WBD and walking ability in KOA patients.

REFERENCES

1. Kauppila A-M, Kyllpila E, Mikkonen P Ohtonen P, Laine V, Siira P, Niinimaki J, Arokoski JP. Disability in end-stage knee osteoarthritis. Disabil Rehabil. 2009;31(5):370-80.
2. O'Connell M, Farrokhi S, Fitzgerald GK. The role of knee joint moments and knee impairments on self-reported knee pain during gait in patients with knee osteoarthritis. Clin Biomech. 2016;31:40-6.
3. Shi D, Dai J, Xu Z , Chen D, Jiang Q. Update on basic and clinical aspects of osteoarthritis. Ann Transl Med.. 2015;3(10).
4. Peters TJ, Sanders C, Dieppe P, Donovan J. Factors associated with change in pain and disability over time: A community-based prospective observational study of hip and knee osteoarthritis. Br J Gen Pract. 2005;55(512):205-11.
5. Filardo G, Kon E, Longo UG, Madry H, Marchettini P, Marmotti A, Van Assche D, Zanon G, Peretti GM. Non-surgical management of early knee osteoarthritis. Knee Surg Sports Traumatol Arthrosc. 2016;24(6):1775-85.

6. Thelen MD, Dauber JA, Stoneman PD. The clinical efficacy of kinesio tape for shoulder pain: A randomized, double-blinded, clinical trial. j J Orthop Sports Phys Ther. 2008;38(7):389-95.
7. Gonz389-89-389-paedic & sports physical therapyacy of ki, Huijbregts P, Del Rosario Gutiérrez-Vega M. Short-term effects of cervical kinesio taping on pain and cervical range of motion in patients with acute whiplash injury: A randomized clinical trial. J Orthop Sports Phys Ther. 2009. 2009;39(7):515-21.
8. Williams S, Whatman C, Hume PA, Sheerin K. Kinesio taping in treatment and prevention of sports injuries. Sports Med. 2012;42(2):153-64.
9. Halseth T, McChesney JW, Debeliso M, Vaughn R, Lien J. The effects of kinesio taping on proprioception at the ankle. J Sports Sci Med. 2004;3(1):1-7.
10. Anandkumar S, Sudarshan S, Nagpal P. Efficacy of kinesio taping on isokinetic quadriceps torque in knee osteoarthritis: A double blinded randomized controlled study. Physiother Theory Practice. 2014;30(6):375-83.
11. Cho HY, Kim EH, Kim J, Yoon YW. Kinesio taping improves pain, range of motion, and proprioception in older patients with knee osteoarthritis: A randomized controlled trial. Am J Phys Med Rehabil. 2015;94(3):192-200.
12. Shumway-Cook A, Williams MW. Motor control: Theory and practical applications.
13. Torres-Oviedo G, Macpherson JM, Ting LH. Muscle synergy organization is robust across a variety of postural perturbations. J Neurophysiol. 2006;96(3):1530-46.
14. Cappellini G, Ivanenko YP, Poppele RE, Lacquaniti F. Motor patterns in human walking and running. J Neurophysiol. 2006;95(6):3426-37.
15. Smith SL, Woodburn J, Steultjens MP. 182 the effects of self-reported knee joint instability on muscle co-activation in osteoarthritis of the knee. Rheumatology. 2016;55(suppl 1):i136-i.
16. Hortob 1):i136-i.terkamp L, Beam S, Moody J, Garry J, Holbert D, DeVita P. Altered hamstring-quadriceps muscle balance in patients with knee osteoarthritis. Clinical Biomech. 2005;20(1):97-104.
17. Podsiadlo D, Richardson S. The timed alance in patients with knee osteoarthritis. Cliniility on muscle co-activa Am Geriatri Soc. 1991;39(2):142-8.
18. Kennedy DM, Stratford PW, Wessel J, Gollish JD, Penney D. Assessing stability and change of four performance measures: A longitudinal study evaluating outcome following total hip and knee arthroplasty. BMC Musculoskelet Disord. 2005;6:3.
19. Mutlu EK, Mustafaoglu R, Ozdincler ARI. The effects of kinesio taping on pain, muscle strenght and function in subjects with knee osteoarhritis: Pilot study. Osteoarthritis Cartilage. 2015;23(A82eA416):A391.
20. Sch eA416):A391.O-G, Ä-G, A416):A3 K, Hammarström G, Dalsgaard CJ, Brodin E. Weight bearing as an objective measure of arthritic pain in the rat. J Pharmacol Toxicol Methods 1994;31(2):79-83.
21. Laessoe U, Barth L, Skeie S, McGirr K. Manipulation of the body schema-unilateral manual stimulation of lower extremity influences weight distribution in standing position. J Bodyw Mov Ther. 2017, 21(3):612-617.
22. Di Giulio I, Maganaris CN, Baltzopoulos V, Loram ID. The proprioceptive and agonist roles of gastrocnemius, soleus and tibialis anterior muscles in maintaining human upright posture. J Physiol. 2009;587(Pt 10):2399-416.
23. Hurwitz DE, Ryals AR, Block JA, Sharma L, Schnitzer TJ, Andriacchi TP. Knee pain and joint loading in subjects with osteoarthritis of the knee. J Orthop Res. 2000;18(4):572-579.
24. Mundermann A, Dyrby CO, Andriacchi TP. Secondary gait changes in patients with medial compartment knee osteoarthritis: Increased load at the ankle, knee, and hip during walking. Arthritis Rheum. 2005;52(9):2835-44.
25. Brinkmann JR, Perry J. Rate and range of knee motion during ambulation in healthy and arthritic subjects. Phys Ther. 1985;65(7):1055-60.
26. Nguyen HP, Dingwell JB. Proximal versus distal control of two-joint planar reaching movements in the presence of neuromuscular noise. J Biomech Eng. 2012;134(6):061007.
27. van den Hoorn W, Hodges PW, van Dieen JH et al. Effect of acute noxious stimulation to the leg or back on muscle synergies during walking. J Neurophysiol. 2015;113(1):244-54.