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The Effects of Two Interventions between Elastic Therapeutic Taping with Exercise and Sham Taping with Exercise on Pain Intensity, Knee Disability Reduction, Leg Strength, and Functional Ability Improvement for Gonarthrosis Patients at the Moderate Level

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ABSTRACT

OBJECTIVE: To investigate the effects of elastic therapeutic taping with exercise on the pain, disability, muscle strength, and functionality of knee in patients with moderate knee osteoarthritis (OA) compared with the sham taping technique with exercise.

METHODS: Eighty patients with moderate knee OA (Kellgren-Lawrence grade II-III) were randomized and separated into 2 groups, including an elastic therapeutic taping group and a sham taping group. Both groups received the same homework exercise. The assessments were performed at baseline, and 2 weeks and 12 weeks after the elastic therapeutic taping application. Pain level, the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) scale, muscle strength, Time Up and Go and Sit-to-Stand were used for the evaluation.

RESULTS: Patients that received elastic therapeutic taping and the sham taping technique with exercise demonstrated improvement in pain level, the WOMAC scale, muscle strength, Time Up and Go and Sit-to-Stand after 12 weeks of the applications, but the results showed a statistically significant difference in the outcome measurement of pain level, the WOMAC scale, and Time Up and Go between the 2 groups ($p < 0.01$, $p = 0.03$ and $p = 0.03$ respectively).

CONCLUSION: Elastic therapeutic taping with exercise can be an effective intervention for pain relief, reduced knee disability, and Time Up and Go in patients with moderate knee OA when compared with the sham taping technique with the exercise group.

KEYWORDS: elastic therapeutic taping, knee osteoarthritis, pain, Time Up and Go, WOMAC scale

INTRODUCTION

Knee osteoarthritis (OA) is a common joint disease found in the elderly. With an increasing prevalence, knee OA remains one of the major public health concerns[1-2]. According to systematic reviews and meta-analyses, the risk factors associated with the onset of knee OA are obesity, previous knee trauma, and the female gender and older age[3]. Knee pain, stiffness, and loss of functional ability reduce the quality of life and increase the risks of morbidity and mortality in knee OA patients[2].

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The core treatments of knee OA include nonpharmacologic, pharmacologic, and surgical management targeted at relieving pain, slowing disease progression, and improving functional ability in daily activities. For the non-surgical treatments, the Osteoarthritis Research Society International (OARSI) guidelines[4] addressed education, activities modification, weight management, transcutaneous electrical nerve stimulation, ultrasound diathermy, exercise, and muscle strengthening as the main rehabilitation protocols.

Elastic therapeutic taping is emerging as add-on treatment for knee OA[5] due to its safety, cost effectiveness, and immediate effect on pain alleviation. Elastic taping is preferred over rigid taping due to its causing less skin irritation[6]. The physiological effects of elastic taping include the facilitation of blood flow and lymphatic drainage by lifting the skin and increasing fascia space, encouraging pain relief, promoting normal biomechanics and neurofacilitation[7]. The tape adheres to the skin for three to five days on average or until it peels off.

Conservative management, including strengthening exercise, is recommended in moderate knee OA[4,8]. Better muscle strength results in the improvement of pain and physical function[8]. The exercises recommended by the OARSI[4] are squats and step-ups, evidencing better outcomes in quality of life and functional capacity over the non-exercise group[9]. However, the current data regarding elastic therapeutic taping with reference to knee OA are more difference studies[5]. Therefore, the purpose of this study is to investigate the efficacy of elastic therapeutic taping combined with exercise regarding pain, disability, and strength and function in moderate knee OA compared with the sham taping technique with the exercise group. It is hoped that the study results can guide the clinical usage of elastic taping, which can be a form of therapy for knee OA.

METHODS

This study was a randomized controlled trial with a double-blinded design.

The objective of the study was to investigate the efficacy of elastic therapeutic taping with exercise in moderate knee OA patients in relation to pain, disability, and strength and functional movement in daily activities. All of the patients gave informed written consent to participate in the study. Ethics committee approval for the study was obtained from the Bangkok Metropolitan Administration Human Research Ethics Committee (Project ID: 015h/63).

The participants were enrolled in the study from the outpatient rehabilitation clinic at Ratchaphiphat Hospital. The inclusion criteria were age greater than 50 years with moderate knee OA (Kellgren-Lawrence grade II-III)[10-11] diagnosed by an orthopedic surgeon or physiatrist, a pain score of 3-7 out of 10[12], body mass index (BMI) below 30 kg/m^2, and being able to do homework exercise as prescribed. The exclusion criteria were being allergic to elastic taping, having a rash or wound or infection in the taping region, sciatica sign[13], having taken opioid or steroid medication during the past 6 months, or knee injection during the past year, having a history of lower extremity fracture or surgery in the past year or scheduled in the next 12 weeks, gout, diabetic neuropathy, and rheumatoid arthritis. The drop-out criteria were pain having increased more than 3 levels on the visual analog scale (VAS) from baseline during the research and other treatment results in the VAS increasing more than 3 levels from baseline. The participants were requested to stop other treatments or medications, except for using paracetamol when they experienced pain.

All of the participants were divided into 2 groups by computer randomization; the experimental group was assigned to applied elastic therapeutic taping using the technique of Van Den Dries[14] (the tension around patella, figure 1) but was not applied to tension in the control group, which had the same color and design followed by the same exercise. The physiotherapists (PT) that applied the tape in both groups were blinded and were given an explanation of both new techniques (the same PT in each group with no crossing). On the first day, the participants were assigned to always keep the tape on and to re-visit for re-taping if it peeled off until the 12th week.

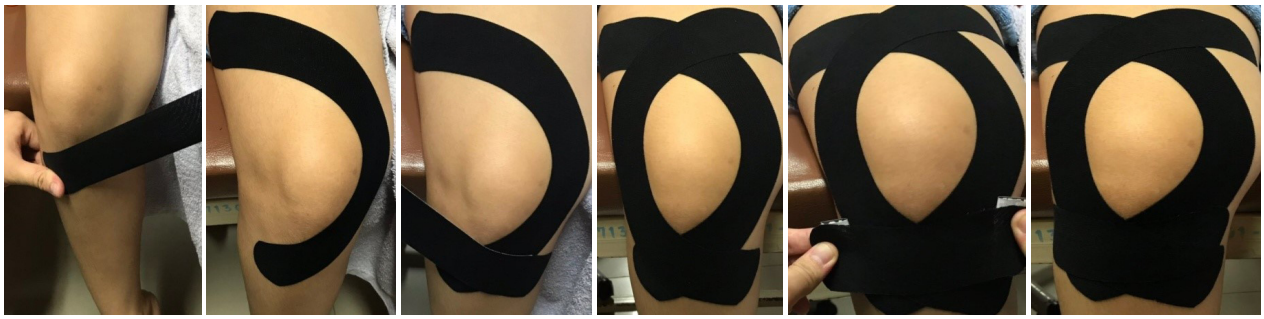

Figure 1 Taping technique by Van Den Dries[14]

Each exercise, including squats, step-ups, and quadricep muscle exercise[9] (figure 2), was prescribed by the 3rd PT in both groups for homework exercise until the 12th week (12 repetitions per set, 2 sets a day, and 3 days a week[15]). The outcome was collected by the blinded PT and included the VAS[16] at the 0, 2nd, and 12th week. The outcome was collected the modified the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC scale)[2], leg strength[12], Time Up and Go (TUG)[17-18], and the Sit to Stand (STS) test[19-21] at the 0 week.

The VAS[16] was used for assessing pain. The pain scale ranged from 0 to 10 where 0 represented no pain and 10 represented maximum pain. Knee disability was assessed by the modified Thai WOMAC scale[2] measuring pain, joint stiffness, and functional limitation. Leg maximum isometric strength was tested with leg dynamometers. TUG[17-18] and STS[19-21] were assessed functional ability and the mean time of the two tests was used in study.

The statistical package for the social science for windows was used in the analysis of the study results. The sample size used in this study was calculated and referenced from the study of Lu et al. in 2018[22]. The research design includes type I error set to 0.025, power of rest at 0.84, delta at 0.43,

Squat 1 Squat 2 Step-up 1 Step-up 2

Quadriceps muscles exercise

Figure 2 Homework exercise (The photos are granted permission to publish.)

and standard deviation[1]. The ninety-six subjects were calculated from an eighty minimal sample size and a dropout rate of twenty percent. The demographic data were identified as mean with standard deviation and compared by t-test. The treatment outcomes (VAS, WOMAC, leg strength, TUG, and STS) were analyzed by t-test. The statistical significance of the study was set at $p < 0.05$. The related factors were analyzed by logistic regression.

RESULTS

As indicated, ninety-six participants were recruited and eighty participants completed the study. Eighty moderate knee OA participants with demographic characteristics were described in Table 1. There were no statistically significant differences between the two groups. Comparing the two groups, the pain score showed a statistically significant reduction after taping by week 0, 2, and the 12th week ($p < 0.01$, $p = 0.018$ and $p < 0.001$ respectively). The pain was significantly reduced in the experimental group ($p < 0.001$, $p < 0.001$ and $p < 0.001$) and in the control group ($p < 0.001$, $p < 0.001$ and $p = 0.05$). The experimental group had a difference in the VAS score (1.49, 2.13 and 0.71), greater than the control group (0.57, 1.14 and 0.23) by the week 0, 2 and 12 as presented in Table 2.

Table 1 Demographic characteristics

Demographic data	Elastic taping group (n = 40)	Sham taping group (n = 40)	P-value
Gender: n (percent)			0.24
Male	5 (12.50)	2 (5)	
Female	35 (87.50)	38 (95)	
Age (years)	61.10 ± 11.64	62.60 ± 5.97	0.46
Body weight (kg)	67.91 ± 10.65	67.04 ± 12.66	0.74
Height (m)	1.56 ± 0.07	1.56 ± 0.06	1.00
BMI (kg/m^2)	27.96 ± 4.10	27.45 ± 3.88	0.57
Educational profile: n (percent)			0.68
Uneducation	4 (10)	6 (15)	
Elementary school	17 (42.50)	17 (42.50)	
Middle school	8 (20)	4 (10)	
High school	6 (15)	5 (12.50)	
Bachelor Degree	5 (12.50)	7 (17.50)	
Master/Doctoral degree	0	1 (2.50)	
Previous treatment of knee osteoarthritis: n (percent)			0.37
No previous treatment	24 (60)	20 (50)	
Previous treatment	16 (40)	20 (50)	

Abbreviations: kg, kilogram; m, meter; n, number

Table 2 Pain evaluations before and after treatment at week 0, 2nd, and 12th

VAS	Elastic taping group (n = 40)				Sham taping group (n = 40)				Difference 95% (CI)	P-value
	Before taping	After taping	VAS**	P-value	Before taping	After taping	VAS**	P-value		
0 week	5.94 ± 1.30	4.45 ± 1.40	1.49	< 0.001	5.88 ± 1.50	5.31 ± 1.40	0.57	< 0.001	0.86 (0.24, 1.47)	< 0.01
2nd week	5.94 ± 0.20	3.81 ± 0.20	2.13	< 0.001	5.88 ± 0.20	4.74 ± 0.00	1.14	< 0.001	0.93 (0.17, 1.70)	0.018
12th week	3.81 ± 0.20	3.10 ± 0.30	0.71	< 0.001	4.74 ± 0.30	4.51 ± 0.30	0.23	0.05	1.42 (0.62, 2.21)	< 0.001

Abbreviations: CI, confidence interval; n, number; VAS, visual analog scale
Statistical significance, p-value < 0.05

Comparing the efficacy, before at 0 week and after taping at week 12, the WOMAC scale showed a statistically significant reduction (p = 0.01 in the elastic taping group and p = 0.014 in the control group). The leg strength also showed a statistically significant increase (p < 0.01) in both groups. The TUG and STS tests showed a significantly decrease (p < 0.001) in both groups. Comparing the WOMAC scales and TUG showed a statistically significant reduction (p = 0.03 and p = 0.03 sequentially) as presented in Table 3. From the results, a history of no previous treatment of knee OA was found to be a pain related factor at the 12th week (p = 0.032) as described in Table 4.

Table 3 Comparing WOMAC scale, leg strength, TUG, and STS at week 0 and 12th

	Elastic taping group (n = 40)			Placebo taping group (n = 40)			Difference 95% (CI)	P-value
	Before taping at week 0	After taping at week 12th	P-value	Before taping at week 0	After taping at week 12th	P-value		
WOMAC	87.07 ± 6.60	76.77 ± 6.30	0.010	103.55 ± 4.60	94.55 ± 5.10	0.014	17.78 (1.60, 33.95)	0.03
Leg strength	9.32 ± 2.20	10.64 ± 2.80	< 0.01	8.88 ± 2.10	10.69 ± 2.00	< 0.001	0.05 (-1.03, 1.14)	0.93
TUG	19.58 ± 9.40	17.06 ± 7.90	< 0.001	16.41 ± 4.90	14.10 ± 3.70	< 0.001	-2.96 (-5.70, -0.22)	0.03
STS	16.60 ± 6.74	13.76 ± 2.92	< 0.001	16.14 ± 4.75	12.67 ± 3.59	< 0.001	-1.09 (-3.47, 1.28)	0.36

Abbreviations: CI, confidence interval; n, number; STS, Sit to Stand; TUG, Time Up and Go; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index
Statistical significance, p-value < 0.05

Table 4 Factors affecting the treatment efficacy of moderate knee osteoarthritis at week 12th

VAS at week 12th	Coefficient	Standard error	T-test	P-value	Difference 95% (CI)	
Age (years)	0.0106057	0.0250297	0.42	0.673	-0.0393145	0.0605259
BMI (kg/m^2)	-0.0608154	0.0584244	-1.04	0.301	-0.1773392	0.0557084
Female gender	1.015899	0.8090033	1.26	0.213	-0.5976071	2.629405
Education profile						
Elementary school	-0.3643198	0.6974061	-0.52	0.603	-1.755252	1.026613
Middle school	-0.2311001	0.8642506	-0.27	0.790	-1.954794	1.492593
High school	-0.2086383	0.8547513	-0.24	0.808	-1.913432	1.496064
Bachelor Degree	-0.0856019	0.8257467	-0.10	0.918	-1.732502	1.561298
Master/Doctoral degree	2.500807	2.04882	-1.22	0.226	-1.585436	6.587049
Previous treatment of knee OA						
No previous treatment	0.9953422	0.4538784	2.19	0.032	0.0901103	1.900574
Previous treatment	3.662506	2.510733	1.46	0.149	-1.344992	8.670005

Abbreviations: CI, confidence interval; kg, kilogram; m, meter; OA, osteoarthritis

DISCUSSION

The eighty participants in this study were mostly moderate knee OA female patients in both groups. Corresponding to previous studies, knee OA is mostly diagnosed in women aged over 50 years, with pronounced symptoms at age over 60 years[23], and obesity was one of the causative factors[3]. The logistic regression analysis demonstrated a relationship between a history of no previous knee OA treatment and pain level at the 12th week (p = 0.032). Consistent with the study of Neogi in 2013[24] and Teixeira et al. in 2020[25], osteoarthritis is a disease that cannot be resolved and that results in chronic pain. Mood and general health condition affect pain intensity in knee OA. The pain score significantly improved at the 0, 2nd, and 12th weeks in both groups as shown in Table 2. Sham taping might have some psychological benefits through the placebo effect as individuals may feel more confident and thus perform better because the tape provides a protective barrier of sorts or psychological acupressure for treating pain. However, our study did not investigate the psychological factors that effect pain level in knee OA participants. Elastic taping activates the mechanoreceptor and stimulates the large-diameter A-alpha and A-beta nerve fibers, resulting in pain inhibition according to gate control theory[26]. Moreover, the tape improves circulation, enhances the healing process, and allows a full range of motion that is not demonstrated in rigid tape[14,27]. The elastic taping technique depends on the objective and area of treatment. Size, length, direction, and the tension of the tape must be considered[28]. In this study, we applied Van Den Dries's technique, which is similar to the study of Hinman et al.[29]. According to medial gliding, and the medial and anteroposterior tilt of the patella, the tape brings the patella into proper alignment (unloading of the patellofemoral joint), resulting in pain reduction. The study of Huang et al.[30] reported the improvement of knee joint alignment and loads during standing and walking in knee OA led to pain reduction. Further, the study of Wageck et al.[31] reported ineffective pain reduction using different taping techniques. The corrected taping techniques were related to knee OA treatment results. Pain reduction can provide effectiveness of muscle action that can improve knee disability (WOMAC), physical abilities (TUG, STS), and leg muscle strength, consistent with the results shown in Table 3. In this study, the WOMAC, TUG, STS, and leg strength were improved in the control group. The WOMAC scale, which has some parts of pain assessment, and leg strength in sham taping, might be some psychological effects while the TUG and STS might have some psychological effects and homework exercise program. There was a significant difference in the WOMAC and TUG, but no significant differences in leg strength or STS between the experimental and control group. Because leg strength was measured in the sitting position, it might have affected tape efficiency rather than muscle strength. The STS was used for balance assessment. Other outcomes were also improved after taping in both groups. Several studies have reported that strengthening exercise can reduce knee pain and improve function in knee OA. Fukaya et al.[32] for example reported that weakness in knee extensor muscles in knee OA patients contributes to walking limitations; and the study of Alnahdi et al.[33] showed that quadricep, hamstring, and hip muscle deficiency is associated with knee OA and has an effect on physical function[34-36]. However, our study did not investigate the minimal clinically important difference (MCID)[37-38] or substantial clinical benefit[39] of the WOMAC scale.

The limitations of this study were that it did not measure pain level at rest or during activities which could demonstrate the efficacy of elastic taping. Balance training was not included in this study so the STS, measuring both leg strength and balance, showed no difference between the groups. Finally, the effect of the home program might not be clear as only quadricep strength was measured.

CONCLUSION

Elastic taping therapy with exercise could be used as an effective intervention for pain relief, reduced knee disability, and Time Up and Go in patients with moderate knee OA when compared with the sham taping technique with the exercise group[40].

CONFLICT OF INTEREST

The authors report no conflict of interest for this article.

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DATA AVAILABILITY STATEMENT

All of the data generated or analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

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