

Immediate effects of kinesiology tape on pain and quadriceps muscle strength in individuals with patellofemoral pain syndrome

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KEYWORDS

Anterior knee pain;
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Squatting;
Lower extremity
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Muscle strength.

ABSTRACT

Patellofemoral pain syndrome (PFPS) is a common condition causing anterior knee pain during performing activities, such as squatting, running, and stair climbing. A kinesiology tape (KT) is often used to reduce pain and improve muscle functions, but its immediate effects remain unclear. This study investigated immediate effects of KT on pain and muscle strength in individuals with PFPS. Thirty-two male participants diagnosed with PFPS from Thailand National Sports University, Samut Sakhon campus, were recruited and randomly assigned into two groups using a simple randomization method. The placebo group ($n = 16$; age 20.0 ± 1.4 years) received I-shaped KT applied 7 cm above and below the patella without tension. The intervention group ($n = 16$; age 20.2 ± 1.4 years) received KT using a Y- and I-shaped application technique for quadriceps facilitation and patellar correction. Outcomes were measured before and immediately after KT application, including pain intensity assessed using the visual analog scale (VAS), squat range of motion (ROM) measured by goniometer, and quadriceps muscle strength measured using a hand-held dynamometer. There were no significant differences between the groups at baseline. Within-group analysis showed that the placebo group demonstrated significant improvements in pain (p -value = 0.002) and muscle strength (p -value = 0.012). In the intervention group, significant improvements were observed in pain (p -value = 0.001), squat ROM (p -value = 0.001), and muscle strength (p -value = 0.005) after KT application. However, no significant differences were found between the intervention and placebo groups in post-test outcomes (p -value > 0.05). KT may be used as an alternative treatment option to reduce pain, and improve squat ROM and quadriceps muscle strength in individuals with PFPS. However, the immediate outcomes were not significantly better than the placebo taping applications.

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Introduction

Patellofemoral pain syndrome (PFPS) is one of the most common musculoskeletal disorders and is often referred to as anterior knee pain. Patients with PFPS typically report pain and discomfort in the anterior aspect of the knee, particularly around the medial border of the patella^(1,2). The symptoms are commonly aggravated during performing functional activities that increase stress on the patellofemoral joint, such as running, ascending and descending stairs, squatting, jumping, or prolonged sitting with the knee flexed⁽¹⁻³⁾.

The exact cause of PFPS remains unclear; however, it has been associated with abnormal lateral tracking of the patella⁽¹⁾. Several factors may also contribute to PFPS, including tightness of the iliotibial band⁽²⁾, muscular weakness, patellar malalignment, and neuromuscular dysfunction⁽³⁾. In addition, abnormal patellar positioning due to an imbalance of muscular forces acting on the patella may result in altered patellar tracking. The vastus medialis oblique (VMO) and vastus lateralis (VL) muscles are important dynamic stabilizers of the patella, particularly during the final 30 degrees of knee extension. Therefore, weakness of the VMO has been suggested as an additional contributing factor to abnormal patellar tracking in individuals with PFPS⁽¹⁾.

Conventional treatments for PFPS include stretching and strengthening exercises for the muscles surrounding the knee joint, activity modification, therapeutic ultrasound, thermotherapy, cryotherapy, knee bracing, and patellar taping. The primary goals of these treatments are to restore normal patellofemoral joint biomechanics, reduce joint stress, and improve quadriceps muscle strength^(2,4). Recently, a kinesiology tape (KT), developed in the late 1970s by Dr. Kenzo Kase and colleagues in Japan⁽⁵⁾, has become increasingly popular as an adjunct treatment for PFPS. This elastic therapeutic tape contains embedded elastic fibers that allow it to stretch and recoil when applied to the skin. KT

also allows a relatively full range of joint motion while providing support to the underlying tissues. Some characteristics of KT include its thickness, which is similar to that of human skin, its ability to stretch up to approximately 120%-140% of its original length, and its ability to remain applied to the skin for up to 3-4 days^(6,7).

Although KT has been widely used in clinical practice for the management of PFPS, previous studies have reported inconsistent findings regarding its effectiveness in reducing pain and improving muscle function^(8,9). In addition, most previous studies have focused on functional outcomes or kinematic changes, while limited research has specifically examined the immediate effects of KT on pain, squat range of motion (ROM), and quadriceps muscle strength in individuals with PFPS. Furthermore, evidence regarding the short-term neuromuscular effects of KT in young adults with PFPS remains limited. Therefore, the purpose of this study was to investigate the immediate effects of KT on anterior knee pain, squat ROM, and quadriceps muscle strength in young adults with PFPS.

Materials and Methods

Participants

This randomized controlled trial was conducted in young males diagnosed with PFPS by an experienced musculoskeletal physical therapist from Thai National Sports University, Thailand. The required sample size was calculated using G*Power software based on a two-way ANOVA (group $\times$ time interaction), with an alpha level of 0.05, a statistical power (1- β) of 0.95, and an assumed medium effect size ($f = 0.25$). The calculation indicated that 32 participants were required.

The inclusion criteria were: (1) pain intensity between 3 and 8 on a 10-point pain scale; (2) anterior knee pain during at least two functional activities, including descending stairs, ascending stairs, squatting, running, jumping, or prolonged sitting with the knee flexed at 90°; and

(3) a history of anterior knee pain for at least six months ⁽¹⁻³⁾.

Participants were excluded if they had a history of knee trauma, previous knee surgery (except arthroscopy), meniscopathy, ligament injury, knee joint effusion, knee osteoarthritis, or patellar subluxation or dislocation.

This study was approved by the Human Ethics Committee of Huachiew Chalermprakiet University (Approval No. A.898/2562). All participants were informed about the study procedures and provided written informed consent prior to participation.

A total of 32 participants were randomly assigned to two groups (1:1) using a computer-generated random number sequence (Figure 1). Due to the nature of the intervention, blinding of participants and therapists was not feasible. However, outcome assessment was performed by a blinded assessor who was not involved in group allocation at baseline and immediately after the intervention. The placebo taping was applied in a similar manner to the intervention but without tension or therapeutic effect.

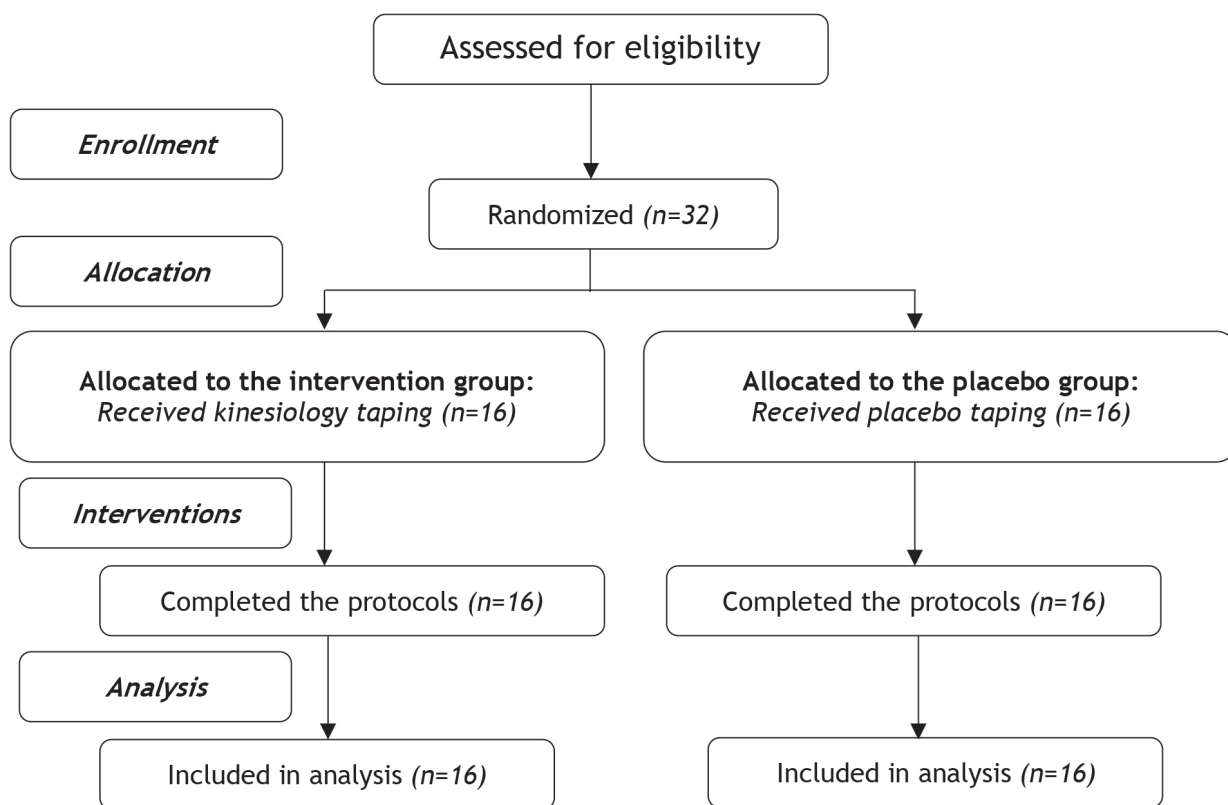


Figure 1 CONSORT flow diagram of participant recruitment, allocation, intervention, and analysis

Taping methods

Intervention group: Participants received KT consisting of VMO facilitation and patellar correction techniques. With the knee flexion to approximately 90°, a Y-shaped KT was applied to

the quadriceps muscle. The anchor of the tape was placed at the mid-thigh with no tension. Each tail of the Y-strip was applied along the quadriceps muscle, bracketing the patella and terminating below it. The middle portion of the

tape was applied with moderate tension, whereas the tails were applied without tension. In addition, a patellar correction I-strip was applied with the knee flexed at approximately 90° , using moderate tension along the medial aspect of the patella⁽¹⁰⁾ as shown in Figure 2a and 2b.

Control group: Participants received placebo KT to avoid any mechanical influence

on patellar alignment. Two I-strips were applied horizontally with the knee in a neutral position. One strip was placed approximately 7 cm above the superior border of the patella, and the second strip was placed approximately 7 cm below the inferior border of the patella. Both strips were applied without tension⁽¹⁰⁾ as shown in Figure 2c.

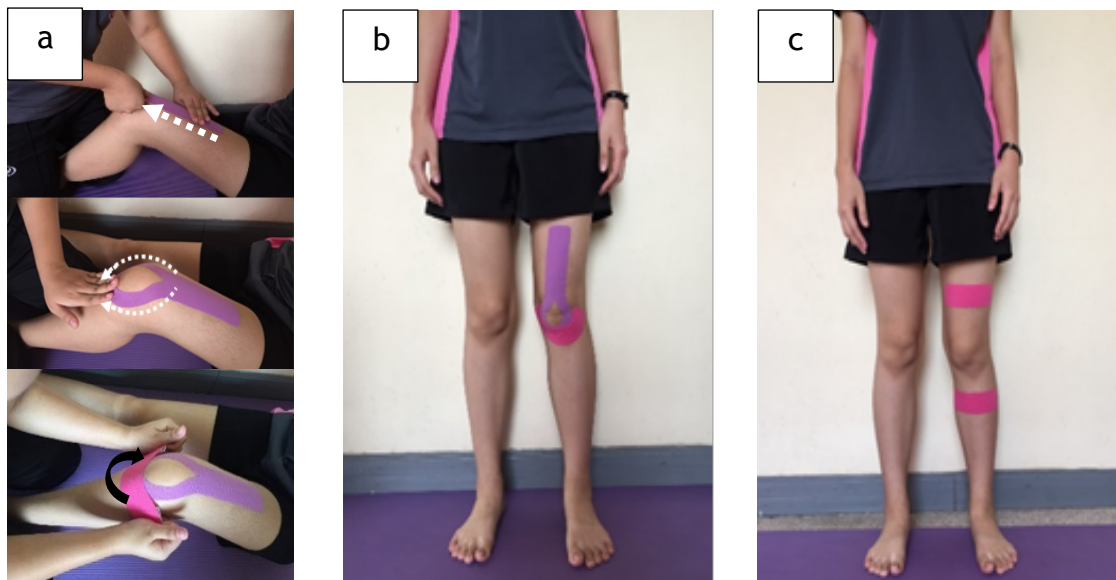


Figure 2 Kinesiology tape (KT) application for the participants
(a and b) Y-I shape KT application for the intervention group
(c) Placebo KT application (I-strips without tension) for the control group

The KT tape procedures of each group were delivered by a trained physical therapist. All participants received the allocated intervention as intended, with no protocol deviations. Participant adherence was complete, as all participants underwent the taping procedure and completed all outcome assessments (Figure 1). No concomitant care or additional interventions were provided to participants in either group during the study period. Participants were monitored during and immediately after the interventions and were asked to report any discomfort, pain, or skin irritation related to the KT used.

Outcome measures

The primary outcome of this study was pain intensity, assessed using the visual analog scale (VAS). Participants were instructed to indicate their level of pain on a 10-cm horizontal line, where 0 represented “no pain” and 10 represented “worst imaginable pain,” during a squatting task⁽⁹⁾.

Secondary outcomes included squat ROM and quadriceps muscle strength. Details of the tests are as follows.

- Knee flexion ROM during squatting was measured using a universal goniometer. Participants were instructed to stand and perform a squat

to the point of pain, at which the knee flexion angle was measured ^(9,10).

- Quadriceps muscle strength was assessed using a hand-held dynamometer with a curved transducer to measure isometric knee extensor strength (Figure 3). Participants were positioned in a supine position with the affected knee in flexion approximately 90° on a quadricep board. The dynamometer

was placed approximately 5 cm proximal to the lateral malleolus. Participants were instructed to perform maximal voluntary isometric contraction, and verbal encouragement was provided. Three trials were performed, with a 3-minute rest between trials to minimize fatigue, and the average value was used for analysis ⁽¹⁵⁾.



Figure 3 Quadriceps muscle strength was measured through a hand-held dynamometer.

Statistical analysis

As the data were normally distributed according to the Shapiro-Wilk test, all data were presented using the mean $\pm$ standard deviation (SD). A two-way mixed analysis of variance (two-way ANOVA) was performed to examine differences between the groups (intervention vs. control) and conditions (pre and post-intervention). Given that the outcomes were assessed immediately, the analysis focused primarily on group differences and condition-related changes rather than long-term time effects. Statistical significance was set at p -value < 0.05 .

Results

Participant characteristics

Thirty-two young male participants with average age of approximately 20 years old completed the study. The participant characteristics, including age and body mass index, and baseline symptom severity, which was classified as mild to moderate, were comparable between the two groups (Table 1, p -value > 0.05).

Table 1 Participant characteristics (16 participants/group).

Variable	Control		Intervention	
	Mean	SD	Mean	SD
Age (year)	20.00	1.37	20.19	1.42
Weight (kg)	68.20	12.97	62.8	11.63
Height (cm)	173.80	6.30	169.70	7.80
BMI (kg/m ²)	22.36	3.39	21.72	3.14

The baseline data indicated no significant differences for all outcomes of the study (Table 2). After the treatments, participants in both groups showed significant reduction in pain scores, with increased quadriceps muscle strength (p -value < 0.05). However, the significant improvement in

squat ROM was found only in the KT group (p -value = 0.001, Table 2). The data comparisons after treatments, however, suggested no significant differences between the groups (p -value > 0.05). Participants in both groups additionally reported no adverse events of using the KT.

Table 2 Comparison of pain intensity and quadriceps muscle strength between the kinesiology taping and placebo groups before and after intervention using two-way ANOVA

Variable	Control (mean $\pm$ SD)	Intervention (mean $\pm$ SD)	Mean difference	p -value ^a
Visual analog scale (cm)				
Before	3.53 $\pm$ 1.56	4.16 $\pm$ 1.37	-1.59 to 0.31	0.181
After	2.64 $\pm$ 1.44	2.02 $\pm$ 1.73	-5.22 to 1.77	0.275
p -value ^b	0.002*	0.001*		
Squat range of motion (degree)				
Before	67.69 $\pm$ 19.68	64.88 $\pm$ 19.32	-11.27 to 16.90	0.686
After	72.69 $\pm$ 15.30	79.00 $\pm$ 14.85	-17.20 to 4.58	0.246
p -value ^b	0.131	0.001*		
Quadriceps muscle strength (kg)				
Before	22.44 $\pm$ 3.56	22.39 $\pm$ 3.42	-2.47 to 2.57	0.967
After	24.01 $\pm$ 2.56	24.18 $\pm$ 2.20	-1.89 to 1.56	0.844
p -value ^b	0.012*	0.005*		

Note: ^a p -value from two-way mixed analysis of variance (two-way ANOVA), ^b p -value from dependent samples t-test. *indicate significant differences.

Discussion

The present study investigated the immediate effects of KT on pain intensity, squat ROM, and quadriceps muscle strength in young adults with PFPS. The findings demonstrated significant improvements in pain and muscle strength in both groups, while squat ROM improved only in the intervention group. However, data comparisons showed no significant differences between the groups in all variables (p -value > 0.05, Table 2).

The reduction in pain observed in this study may be explained by the neurophysiological mechanisms associated with KT. The elastic

properties of the tape are believed to stimulate cutaneous mechanoreceptors⁽⁷⁾, which may modulate nociceptive input through the pain gate mechanism⁽⁵⁾. This sensory stimulation may alter afferent feedback and subsequently reduce perceived pain during functional activities such as squatting^(8,9). Additionally, the mechanical lifting effect of the tape on the skin may improve local circulation and reduce pressure on pain-sensitive structures around the patellofemoral joint^(8,12). The pain improvement observed in control group, may be due to the effects of tactile stimulation provided by the tape itself, a placebo response, natural pain fluctuation, or regression to the

mean. The physical presence of any tape on the skin may generate sufficient cutaneous afferent input to partially modulate nociception, even in the absence of therapeutic tension^(5,7). However, the lack of significant differences between groups in the present study is consistent with previous studies reporting that KT does not demonstrate superior effects compared with placebo or other conservative interventions in individuals with PFPS^(8,9,12).

Improvements in quadriceps muscle strength were observed in both groups, while squat ROM improved significantly only in the intervention group. These findings may be associated with reduced pain inhibition and improved neuromuscular activation during functional tasks^(8,13). The improvement in quadriceps muscle strength following KT may be related to enhanced neuromuscular activation of the quadriceps muscle, particularly the VMO⁽¹³⁻¹⁵⁾. Previous studies have suggested that KT may facilitate muscle activation by improving proprioceptive feedback and optimizing muscle recruitment patterns⁽¹⁶⁾. Increased sensory input from the tape may enhance motor unit recruitment and improve muscle performance during isometric contraction^(13,15). However, the effects are often small and not significantly different from control conditions. This supports the findings of the present study, indicating that the benefits of KT may be related to psychological or proprioceptive mechanisms rather than direct mechanical effects⁽¹⁴⁾. Importantly, no adverse events or unintended effects were reported in either group, indicating that KT is a safe intervention for individuals with PFPS when applied appropriately. This is consistent with previous literature reporting minimal risk associated with taping interventions^(5,8,14).

The present findings extend existing literature by specifically examining the immediate effects of KT on pain, squat ROM, and quadriceps muscle strength simultaneously in young male athletes with PFPS - a population that has

received limited attention in previous studies. While earlier research has primarily focused on functional outcomes or kinematics over longer durations, the present study addresses the gap in evidence regarding acute neuromuscular responses to KT. The results are consistent with previous research reporting beneficial effects of KT in individuals with PFPS. Several studies have demonstrated that KT can reduce pain and improve knee function by assisting patellar alignment and enhancing neuromuscular control^(14,16). These results support the clinical application of KT as an adjunct intervention for managing symptoms associated with PFPS⁽¹⁶⁾.

However, some previous studies have reported inconsistent findings regarding the effectiveness of KT. Differences in taping techniques, participant characteristics, and outcome measurements may contribute to these variations. In the present study, a combined approach of VMO facilitation and patellar correction was applied. This may have contributed to the observed improvements in pain and quadriceps muscle strength through enhanced neuromuscular activation of VMO and improved patellar tracking, thereby optimizing patellofemoral joint mechanics^(13,15). These findings suggest that the immediate effects of KT may be influenced by the specific application technique used, which could explain differences compared with previous literature.

From a clinical perspective, therefore, KT may provide an immediate therapeutic effect for individuals with PFPS. This intervention may be particularly useful during rehabilitation programs to reduce pain and facilitate quadriceps muscle activation during exercise or functional training.

Study limitations

Several limitations should be noted. This study included only male participations from a single institution, which limits the generalizability of the findings to other populations. The study was also limited to young athletes, so results may not be applied to older or less active individuals with PFPS. The short study duration assessed only

immediate effects, and no long-term follow-up was conducted to evaluate sustained outcomes of KT in individuals with PFPS. Additionally, the use of a hand-held dynamometer rather than an isokinetic dynamometer may limit the precision of muscle strength measurements. Future studies should examine the effects of KT using electromyography and biomechanical analysis to further elucidate the neuromuscular mechanisms underlying the immediate responses to taping. Research including female participants, older adults, and diverse clinical settings is also warranted to improve generalizability of findings.

Conclusions

KT demonstrated significant immediate effects in reducing pain intensity and improving quadriceps muscle strength in individuals with PFPS. The present findings suggest that KT may enhance neuromuscular activation of the quadriceps muscles and provide short-term pain relief during functional activities. Therefore, KT may be considered as an effective adjunct intervention in the rehabilitation of individuals with PFPS.

Take home messages

KT may help to reduce pain, improve quadriceps muscle function, and improve squat ROM in young male individuals with PFPS, making it a beneficial adjunct to support rehabilitation and functional activities. However, the immediate benefits of KT were not significantly superior to placebo taping, suggesting that psychological and proprioceptive mechanisms may contribute to its effects.

Conflicts of interest

The authors declare no conflict of interest.

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Author contributions

Nipaporn Rigo: Conceptualization, Methodology, Formal analysis, Resources, Funding acquisition, Writing - Original draft.

Atcharaphan Changkeaw: Conceptualization, Methodology, Formal analysis, Writing - Review & Editing.

Data availability

The datasets analyzed during the current study are not publicly available due to ethical and privacy restrictions to protect participant confidentiality but are available from the corresponding author on reasonable request.

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