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A comparison of the effect of knee muscle taping versus core muscle taping on balance, pain, and functional performance in patients with patellofemoral pain syndrome

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Abstract

Introduction. Patellofemoral pain syndrome is one of the most common musculoskeletal disorders which mostly affect young females. A widespread treatment for this condition is muscle taping. This study aimed to compare the effect of knee muscle taping versus core muscle taping on balance, pain, and functional activity in patients with patellofemoral pain syndrome.
Methods. Overall, 26 females with patellofemoral pain syndrome were randomly divided into 2 groups: knee muscle taping group ($n = 13$) and core muscle taping group ($n = 13$). Pain, functional activity, and balance were measured before and 48 hours after the intervention by using the visual analogue scale, Functional Index Questionnaire, and Y Balance Test and Functional Reach Test, respectively.
Results. The within-group comparison showed a significant pain decrease and functional improvement in both groups. However, balance improved significantly only in the core muscle taping group 48 hours after the intervention compared with baseline. The between-group comparison showed no significant difference in variables between the 2 groups at the assessed time points.
Conclusions. Both the knee and core muscle taping treatment caused improvement in pain and functional level of patients with patellofemoral pain syndrome. Also, no superiority of either treatment was demonstrated.
Key words: patellofemoral pain syndrome, Kinesio tape, core, knee

Introduction

Patellofemoral pain syndrome (PFPS) is a common condition of anterior knee pain [1] along with its numerous side effects, including irritating pain and balance and functional impairments [2–4]. PFPS predominantly affects young female patients aged 10–35 years [5]. Sex hormones, as well as psychosocial factors may be related to an increased perception of PFPS in women compared with men [6]. Although the main cause of PFPS is unclear, intrinsic factors such as anatomical, hormonal, and potentially psychological parameters may contribute to PFPS onset [7]. Patellar maltracking resulting from the imbalance of vastus medialis obliquus (VMO) and vastus lateralis (VL) is one of the likely mechanisms of PFPS [1]. Another assumed aetiology for PFPS is dysfunction of core muscles including lumbo-pelvic-hip muscles [1, 8]. Core muscles are responsible for human motion and offer sagittal, frontal, and transverse plane stabilization [8]. Core muscles contract prior to lower extremity prime movers, which results in spine stability [9]. Thus, impaired core stability significantly influences dynamic muscle stability of the knee joint [10]. Several studies found that patients with PFPS also reported dysfunction in muscles of the core region; this is supported by Motealleh et al. [11], Cowan et al. [4], Robinson and Nee [12], Piva et al. [13], and Ireland et al. [14]. However, in the clinical settings, physiotherapy interventions for treatment of patients with PFPS are primarily focused on knee joints rather than the proximal areas.

Kinesio tape (KT) is a common treatment for PFPS, applied to treat the imbalance of VMO and VL muscles [15]. Also, several studies have shown that KT application was associated with reduced pain, as well as improved functional activity and proprioception of knee joints in patients with PFPS [16–20].

Despite the positive relationship between core muscle impairment and PFPS, few studies have focused on the effects of core muscle KT in PFPS [16, 17, 19]. Besides, these studies evaluated the effect of muscle KT in the hip region, and the effect of muscle KT in the lumbar and pelvic regions has not been assessed yet. Therefore, this study was conducted to compare the impact of knee muscle taping versus core muscle taping including lumbo-pelvic-hip muscles on balance, pain, and functional performance in females with PFPS.

Subjects and methods

Study design

In this randomized controlled study, participants were randomly assigned to 2 groups (1:1 ratio): a knee muscle taping group ($n = 13$) and a core muscle taping group ($n = 13$). A block permutation method (block size of 2) was applied. Pain, functional activity, and balance were measured before and 48 hours after the intervention.

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Participants

Females diagnosed with PFPS were screened for eligibility by orthopaedic surgeons and referred to the physical therapy clinic of the School of Rehabilitation Sciences of Shiraz University of Medical Sciences.

The inclusion criteria were: age of 18–40 years [21, 22], unilateral pain in the anterior knee during at least 2 of the following activities: running, jumping, squatting, climbing the stairs, or sitting for a long period [21–23], persistence of pain for at least 2 months [23], reported pain during local pressure on VMO and VL muscles [21], gradual onset of symptoms without history of trauma or injury [21, 24], positive patellar grind test result [24], Functional Index Questionnaire score over 11.

The exclusion criteria involved: knee joint pathologies such as meniscus or ligament rupture, knee joint osteoarthritis, cartilage lesion [25], tendon injury, patellar subluxation or dislocation, bursitis, inflammation around patella, plica syndrome, Sinding-Larsen and Osgood-Schlatter disease [21, 24], pain during patellar tendon or pes-anserine tendons palpation [22], referred pain from the lumbar region, hip, or sacroiliac joint [22], lower limb surgery [24], neuromuscular and rheumatic diseases, using anti-inflammatory drugs [24], malignancy and other symptomatic chronic diseases, e.g. diabetes mellitus, chronic liver disease, chronic obstructive pulmonary disease [26], having received an intra-knee injection for any reason within the previous year [27].

Blinding and concealment

Group allocation was concealed by using consecutively numbered opaque sealed envelopes, which were opened after completion of the baseline assessment in the presence of the participant. Owing to the manifested nature of the interventions, blinding of the participants was not possible.

Intervention

For participants in the knee muscle taping group, KT was applied on VMO and VL muscles; for the core muscle taping group, KT was applied on erector spinae (ES), internal oblique (IO), and gluteus medius (GM) muscle. In both groups, the same type of a 5-cm-wide KT (3NS TEX, Gyeonggi-do, Korea) was used for 48 hours on a shaved and oil-free skin. The subjects were instructed to remove the tape in any case of skin irritation.

The Kinesio taping method

Internal oblique taping

In a side-lying position, an ‘I’ strip tape was used from the anterior iliac crest to the linea alba with 50% muscle tension to facilitate the IO muscle [28]. Since IO muscles are continuously active during the stance phase in walking, the affected leg was taped (Figure 1) [29].

Erector spinae taping

An ‘I’ strip tape was used from the inside edge of the sacrum to the lower edge of rib 6 and 7 with 50% muscle tension to facilitate the ES muscle [28]. ES muscles are constantly active during the stance and swing phases of walking, with a longer activity in the swing phase. Thus, KT was applied on the opposite side of the affected leg (Figure 2) [30, 31].

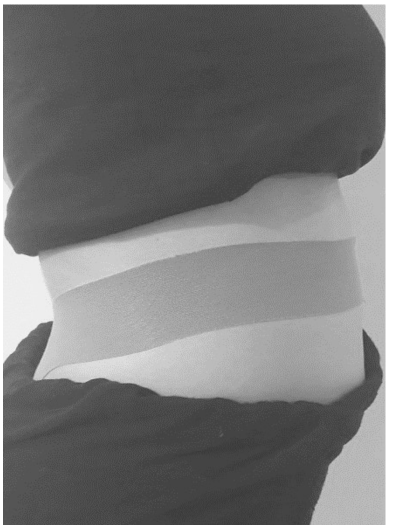


Figure 1. The internal oblique Kinesio tape

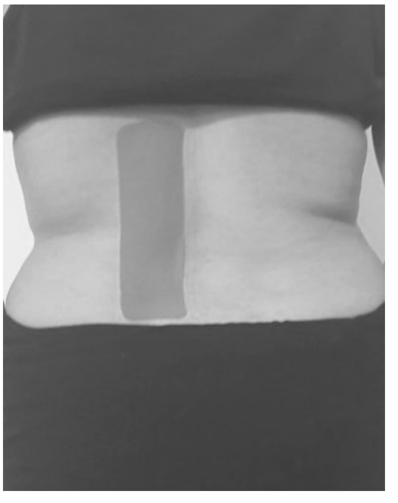


Figure 2. The erector spinae Kinesio tape

Gluteus medius taping

Two ‘I’ strip tapes were used in the side-lying position. The first ‘I’ strip was applied from the posterior superior iliac spine to the greater trochanter with 50% muscle tension. The second ‘I’ strip was applied from the anterior superior iliac spine to the greater trochanter with 50% muscle tension [32]. Since GM muscles are continuously active during the stance phase in walking, the affected leg was taped (Figure 3) [31].

Figure 3. The gluteus medius Kinesio tape

Vastus medialis obliquus taping

In a supine position, a 'Y' strip tape was applied from the intertrochanteric line with 50% muscle tension to facilitate the VMO muscle. The medial part of the 'Y' strip tape was anchored to the pes-anserinus muscles and the lateral part of the 'Y' strip tape was anchored to the patella [33]. Owing to the weakness of the VMO muscles in patients with PFPS and the continuous activity of these muscles during the stance phase, the tape was applied on the affected leg (Figure 4) [18, 31].

Figure 4. The vastus medialis obliquus Kinesio tape

Vastus lateralis taping

An 'I' strip tape was applied from the lateral edge of the patella to the greater trochanter, without tension to inhibit the VL muscle [33]. Because of the tightness of the VL muscles in patients with PFPS and the continuous activity of these muscles during the stance phase, the tape was applied on the affected leg (Figure 5) [18, 31].

Figure 5. The vastus lateralis Kinesio tape

Outcome measures

Pain

Pain was measured by using a visual analogue scale (VAS) [25, 27]. VAS is a continuous scale, usually 10 cm (100 mm) in length, and the score ranged from 0 to 100 (0 – no signs of pain, 100 – the maximum pain level) [34].

Functional performance

Functional status was assessed with the lower extremity Functional Index Questionnaire. The questionnaire is comprised of 8 items regarding daily activity, with a 3-point scale from 0 to 2 (0 – unable to do the task, 1 – doing the task with difficulty, and 2 – doing the task properly) [35].

Balance

Balance was evaluated by using the Y Balance Test (dynamic balance test), which is a modified version of the Star Excursion Balance Test, and with the Functional Reach Test (static balance test).

In the Y Balance Test, the patients stood on one leg barefoot while reaching out in 3 different directions (anterior, posteromedial, and posterolateral). They performed 4 practice sets for familiarization prior to the main test. For the main test, the participants completed 3 consecutive trials for each reach direction, and the mean of the 3 trials was recorded for each direction. The test results were normalized in accordance with the leg length [36]. To measure the lower limb length, the individuals were asked to lie in a supine position. Then, the assessor passively stretched the leg out and measured the distance from the anterior superior iliac spine to the distal end of the medial malleolus using a tape measure [36].

In the Functional Reach Test, the patient was instructed to stand close to the wall and position the arm at 90° of shoulder flexion. The assessor recorded the starting position at the 3rd metacarpal head on the yardstick. Then, the participant was asked to reach as far as possible forward without taking a step. The location of the 3rd metacarpal was recorded. The difference between the start and end positions was recorded as the reach distance. The test was repeated for 3 trials: 2 practice ones, followed by one major test trial. The distances of the last trial were used as the patient's score [37].

Sample size calculation and statistical analysis

On the basis of data from a previous study [17] and assuming 80% power and the value of $\alpha = 0.05$, we estimated the sample size as 22 (11 participants per group) with power analysis software (v. 13, NCSS, LLC Co., Kaysville, UT, USA). In anticipation of an overall attrition rate of 15%, we increased the final sample size to 26 (13 in each group).

The Shapiro-Wilk test showed a non-normal distribution of all data. Thus, nonparametric tests were used to compare the variables. The Mann-Whitney test was applied to compare demographic characteristics and baseline pain level between the 2 groups. In addition, the Wilcoxon signed-rank test and the Mann-Whitney test served for within- and between-group comparisons, respectively. The statistical significance level was set at $p < 0.05$. All analyses were performed with the SPSS software (v. 20, IBM, Armonk, NY, USA).

The statistician was blinded to treatment group allocations until the analysis was complete.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Ethics Committee of Shiraz University of Medical Sciences (ethics code: IR.SUMS.REC.1395.5) and registered in the Iranian Registry of Clinical Trials (code: 2016041927469N1).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

Participants

Two participants dropped out, so data for a total of 24 patients were analysed in this study. The reason for withdrawal was unrelated to treatment in one case. The CONSORT flow diagram for the trial is shown in Figure 6. A comparison of demographic characteristics revealed no significant differences between the groups prior to the intervention (Table 1).

Table 1. Patients' demographic characteristics and baseline pain level

Variable	Knee muscle taping group (mean ± *SD*)	Core muscle taping group (mean ± *SD*)	*p*
Age (years)	23.84 ± 3.31	24 ± 2.76	0.70
Body mass index (kg/m^2)	21.67 ± 2.41	21.42 ± 2.07	1.00
Baseline pain level (visual analogue scale)	35.76 ± 21.77	30.76 ± 18.00	0.55

Pain, balance, and functional activity

The within-group comparison showed a significant pain decrease and functional improvement in both groups. However, balance improved significantly only in the core muscle taping group 48 hours after the intervention compared with baseline (Table 2, Figures 7–10). The between-group comparison revealed no significant difference in the variables between the 2 groups at the assessed time points (Table 3).

Table 2. The within-group comparison of variables before and 48 hours after Kinesio taping in both groups

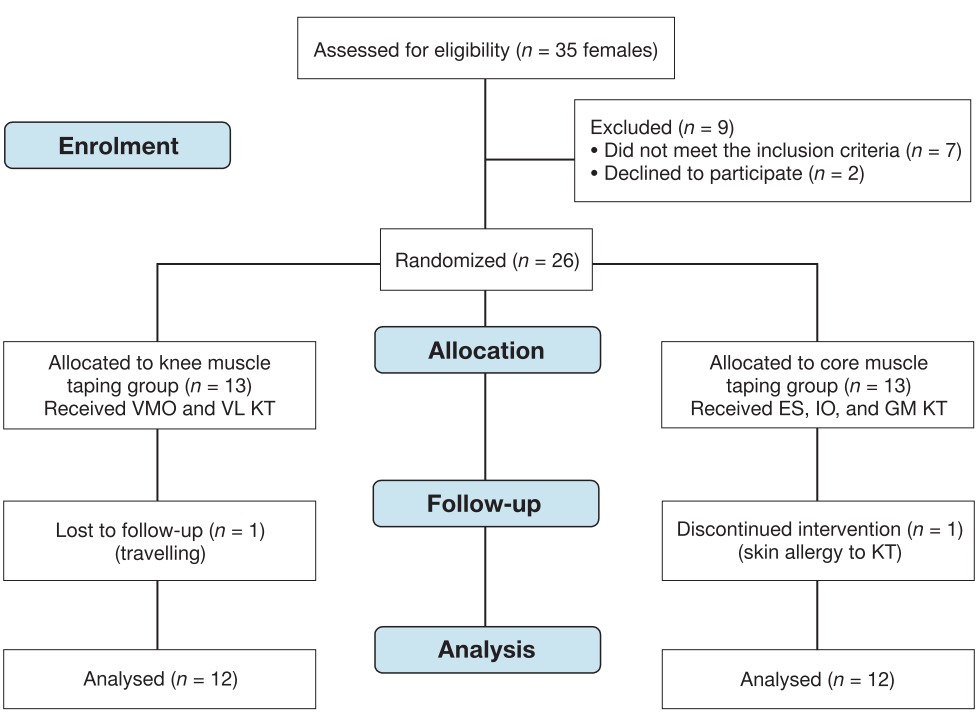
Variable		*p*	
		Knee muscle taping group	Core muscle taping group
Pain		0.007*	0.001*
YBT	Anterior	0.041*	0.012*
	Posterolateral	0.006*	0.005*
	Posteromedial	0.08	0.02*
	Total	0.054	0.007*
FRT		0.26	0.045*
FIQ		0.002*	0.001*

YBT – Y Balance Test, FRT – Functional Reach Test, FIQ – Functional Index Questionnaire
* significant values

Table 3. The between-group comparison of variables before and 48 hours after Kinesio taping

Variable		*p*
Pain		0.89
YBT	Anterior	0.18
	Posterolateral	0.35
	Posteromedial	0.44
	Total	0.22
FRT		0.94
FIQ		0.58

YBT – Y Balance Test, FRT – Functional Reach Test, FIQ – Functional Index Questionnaire



VMO – vastus medialis obliquus
VL – vastus lateralis
KT – Kinesio tape
ES – erector spinae
IO – internal oblique
GM – gluteus medius

Figure 6. The CONSORT flowchart of the study

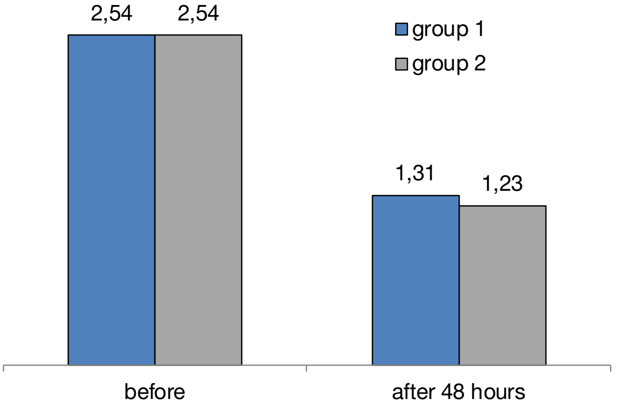


Figure 7. The within-group comparison of pain level before and 48 hours after Kinesio taping in both groups

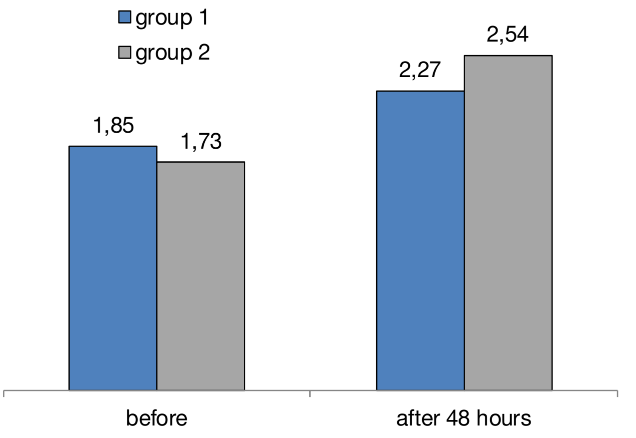


Figure 9. The within-group comparison of static balance before and 48 hours after Kinesio taping in both groups

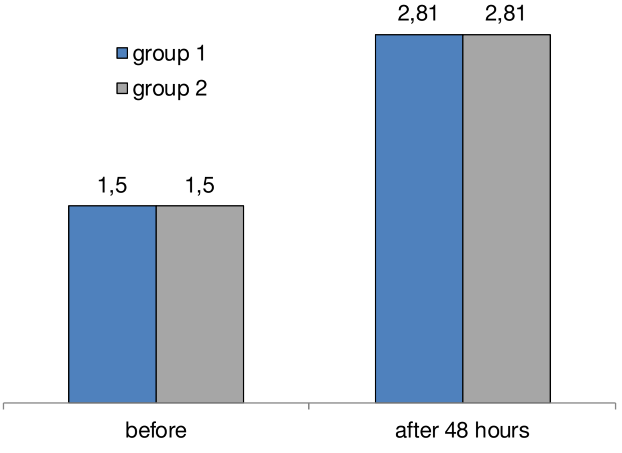


Figure 8. The within-group comparison of functional level before and 48 hours after Kinesio taping in both groups

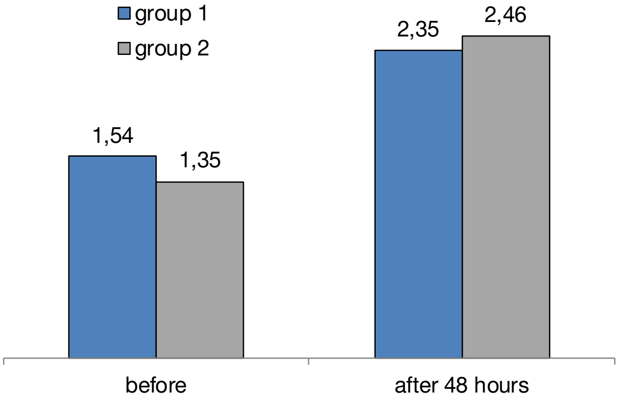


Figure 10. The within-group comparison of dynamic balance before and 48 hours after Kinesio taping in both groups

Discussion

Pain

The within-group comparison showed a significant pain decrease in both groups 48 hours after the intervention compared with baseline. However, the between-group comparison demonstrated no significant difference in the variables between the 2 groups at the assessed time points (Table 3).

Pain decrease in the knee muscle taping group

In patients with PFPS, the imbalance between the VMO and VL muscles causes patella maltracking. Patellar maltracking exerts an extra pressure on the knee joint and results in damaged patella retinaculum, impaired motor control patterns, and pain [38]. Also, sensitization to painful stimuli is achieved by development of sensitizing central nociceptive circuits that amplify pain sensation [39], which, in turn, decreases periarticular muscle tone and increases mechanical load on the knee joint [40]. According to the current study, it seems that KT of VMO and VL may balance the activity of these muscles and subsequently reduce pain in patients with PFPS. In addition, KT may decrease the pain by skin lifting, improving blood circulation and lymphatic drainage owing to increased space between skin and muscle, and decreasing swelling and muscle cramp. Moreover, KT may improve proprioception and subsequently enhance motor control, leading to pain reduction. Pain decrease after KT application was reported in studies by Chen et al. [41], Salsich et al. [42], Hinman et al. [43], and Cushnaghan et al. [44], which are consistent with the result of the current research.

Pain reduction in the core muscle taping group

Impairments in core muscle function may cause dynamic imbalance and pain in patients with PFPS [45]. Weakness in GM as a core muscle is reported in patients with PFPS [14, 23]. GM weakness decreases the strength of hip abduction and external rotation, which leads to adduction and internal rotation of the hip in weight-bearing activities and lateral tracking of the patella [14, 23]. Lateral tracking of the patella may cause pain in patients with PFPS [14, 23]. Evidence shows that proximal muscle stability and strengthening of abductor and external rotator muscles such as GM can reduce adduction, internal rotation, valgus deformity, and pain [23, 45]. We found that GM taping significantly reduced local pain in patients with PFPS, which is congruent with observations by Miller et al. [32] and Chevidikunnan et al. [45]. The mentioned results can be associated with normalizing GM activity and restoring the normal function of core muscles by KT.

There has been no previous study investigating the effect of KT of IO or ES on knee pain. It seems that KT of these core muscles may improve core stability and reduce pain in patients with PFPS [45, 46].

Balance

Our study showed that balance improved significantly only in the core muscle taping group 48 hours after the intervention compared with baseline.

Balance in the knee muscle taping group

Postural control is associated with information received by the brain from the visual, vestibular, and somatosensory systems [47]. Factors such as pain, proprioception, muscle strength, or proximal stability influence balance [47]. Knee joint pain and patellar maltracking in patients with PFPS may cause abnormal afferent input to the nervous system, which leads to impaired neuromuscular control both in static and dynamic conditions [48]. According to the present study, static and dynamic balance were not improved after knee KT, which may be due to the local effect of KT.

Balance in the core muscle taping group

Our study showed that core muscle KT significantly improved static and dynamic balance in patients with PFPS. Core muscles play a major role in dynamic stability. Core muscle impairment is one of the leading causes of PFPS [49]. There is evidence demonstrating that an improvement in core muscle activity leads to enhanced balance [45]. Therefore, the improvement in balance in the core muscle KT group may be related to the facilitation and restoration of the function of these muscles.

Functional activity

The within-group comparison showed a significant functional improvement in both groups 48 hours after the intervention compared with baseline. The between-group comparison exhibited no significant difference in functional activity between the 2 groups at the assessed time points. Functional level is influenced by neuromuscular control [50]. Also, evidence demonstrates that pain causes limitation in physical activity [51]. Furthermore, according to the fear avoidance model, fear of pain is associated with functional disability and muscle weakness [52, 53]. Thus, pain reduction and balance improvement by KT may have led to enhanced functional activity in both groups. Earl and Hoch [46] and et al. Boling [23] proposed that strengthening of core muscles caused improvement in functional activity in patients with PFPS, which is consistent with the current study.

Strengths and limitations

The strengths of our study include a comprehensive assessment of clinical and functional variables after KT application in patients with PFPS. The lack of follow-up and blinding of the outcome assessors were the main limitations. We note that because of the specific characteristics of our participants, i.e. female patients, caution should be advised in generalizing these results to male populations.

There is a need for a much larger-scale study with a longer-term follow-up and for assessing the effect of KT in other core muscles with regard to pain, function, and balance among patients with PFPS. Besides, it is strongly recommended to investigate the combined effect of core muscle taping and knee muscle taping in PFPS.

Conclusions

Both the knee and core muscle taping treatment caused improvement in pain and functional level of patients with PFPS. Also, no superiority of either treatment was demonstrated.

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Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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