# Patellar Taping, Patellofemoral Pain Syndrome, Lower Extremity Kinematics, and Dynamic Postural Control

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**Context:** Patellar taping has been a part of intervention for treatment of patellofemoral pain syndrome (PFPS). However, research on the efficacy of patellar taping on lower extremity kinematics and dynamic postural control is limited.

**Objective:** To evaluate the effects of patellar taping on sagittal-plane hip and knee kinematics, reach distance, and perceived pain level during the Star Excursion Balance Test (SEBT) in individuals with and without PFPS.

**Design:** Repeated-measures design with 2 within-subjects factors and 1 between-subjects factor.

*Setting:* The University of Toledo Athletic Training Research Laboratory.

*Patients or Other Participants:* Twenty participants with PFPS and 20 healthy participants between the ages of 18 and 29 years.

*Intervention(s):* The participants performed 3 reaches of the SEBT in the anterior direction under tape and no-tape conditions on both legs.

Main Outcome Measure(s): The participants' hip and knee sagittal-plane kinematics were measured using the electromag-

netic tracking system. Reach distance was recorded by hand and was normalized by dividing the distance by the participants' leg length (%MAXD). After each taping condition on each leg, the participants rated the perceived pain level using the 10-cm visual analog scale.

**Results:** The participants with PFPS had a reduction in pain level with patellar tape application compared with the no-tape condition (P = .005). Additionally, participants with PFPS demonstrated increased %MAXD under the tape condition compared with the no-tape condition, whereas the healthy participants demonstrated decreased %MAXD with tape versus no tape (P = .028). No statistically significant differences were noted in hip flexion and knee flexion angles.

**Conclusions:** Although patellar taping seemed to reduce pain and improve SEBT performance of participants with PFPS, the exact mechanisms of these phenomena cannot be explained in this study. Further research is warranted to investigate the effect of patellar taping on neuromuscular control during dynamic postural control.

Key Words: anterior knee pain, McConnell taping

### **Key Points**

- Patellofemoral pain syndrome (PFPS) is a multifactorial condition that may be the result of more than one anomaly.
- Short-term patellar taping seemed to alleviate some pain in participants with PFPS during dynamic postural control tasks.
- Further research is warranted to investigate the long-term effect of patellar taping and associated kinematic changes.

**N** onoperative management for patellofemoral pain syndrome (PFPS) includes patellar taping, stretching, vastus medialis obliquus (VMO) strengthening, activity modification, biofeedback, neuromuscular electric stimulation, ultrasound, thermotherapy, bracing, and foot orthotics.<sup>1–8</sup> Although correcting proposed patellar or lower extremity misalignment and establishing proper patellar tracking within the patellofemoral groove through these interventions seems to help relieve patients' painful symptoms and increase their function (such as walking and stair ambulation<sup>2,3,5</sup>), previous studies regarding physical therapy interventions have yielded various results in patients with PFPS.

McConnell<sup>1</sup> introduced a rehabilitation program that incorporates patellar taping techniques to improve patellar tracking within the patellofemoral groove, as well as lateral knee structure stretching, VMO strengthening, and closed kinetic chain training. The McConnell patellar taping program is intended to correct patellar tracking by medializing the patella, allowing patients to engage in pain-free physical therapy exercises.<sup>1,9</sup> Several authors have demonstrated a reduction in perceived pain of patients with PFPS after the patellar tape application<sup>5,10–12</sup> as well as evidence of improvement in neuromuscular activity with patellar taping.<sup>10–15</sup> Additionally, a few groups<sup>9,16</sup> have demonstrated a short-term benefit of patellar taping in correcting patellar misalignment. In a recent systematic review of the literature, we concluded that patellar taping may be an effective intervention to reduce painful symptoms for the treatment of PFPS.<sup>17</sup>

Although previous investigators have examined the influence of patellar taping on PFPS during selected functional tasks, assessment of these factors during a measure of dynamic postural control has been limited. The Star Excursion Balance Test (SEBT) is a measure of dynamic postural control using a series of unilateral mini-squats performed on a test limb while attempting to reach as far as possible with the opposite limb in specified directions without compromising the unilateral base of support.<sup>18–23</sup> The further the distance the participant is able to reach, the more dynamic postural control he or she has been theorized to possess.<sup>21–23</sup> Earl and Hertel<sup>18</sup> demonstrated that the anterior-directed (anterior, anteromedial, and anterolateral) excursions used more vastus medialis activation than the other directions. Dynamic stabilizers of the patella also control tibial rotation and patellar gliding.<sup>24</sup> Thus, weakness or insufficiency of the VMO in participants with PFPS may contribute to abnormal lateral movement of the patella. This abnormal lateral movement may, as a compensatory mechanism, increase knee valgus and hip internal rotation and decrease knee flexion,<sup>25</sup> which could influence the performance in the anterior directions of the SEBT among those with PFPS.

Deficits in knee kinematics during functional activity have been associated with decreased VMO activity.<sup>26</sup> Although Earl et al<sup>27</sup> found that VMO weakness was related to decreased function in the anterior direction during the SEBT, the role of VMO weakness and associated alterations in hip and knee kinematics on dynamic postural control has not been studied extensively. McConnell taping is intended to increase function through patellar realignment and increased VMO activation, but its effect during dynamic postural control has not been investigated. One may make an assumption that if patellar taping does indeed change the position of the patella and subsequently influences the VMO activation pattern, then it will improve performance during the SEBT.

The McConnell patellar taping program has become a popular practice among athletic trainers and other health care professionals for treating PFPS. However, its true clinical efficacy is not well established. Previous authors have not investigated possible changes in lower extremity kinematics with patellar taping. Also, functional tests used in earlier research may not have been very effective in evaluating neuromuscular control in association with knee joint kinematic alterations after application of the patellar tape. Therefore, our purpose was to investigate the effects of patellar taping on knee and hip joint kinematics and normalized reach distance during the SEBT in participants with and without PFPS. We hypothesized that the PFPS participants would present with higher pain levels and shorter reach distances during the SEBT compared with the healthy control participants. We also hypothesized that the participants with PFPS would demonstrate decreased pain levels and increased reach distances with the application of patellar tape compared with the no-tape condition and that no changes would be observed in pain level or reach distance in healthy participants between taping conditions.

# METHODS

# Participants

Twenty individuals (12 females, 8 males) with PFPS (age =  $20.3 \pm 1.87$  years, height =  $170.1 \pm 10.17$  cm, mass =  $71.57 \pm 14.04$  kg) and 20 healthy participants (12 females, 8 males) (age =  $21.25 \pm 2.67$  years, height =  $172.08 \pm 8.76$  cm, mass =  $70.91 \pm 11.41$  kg) volunteered for this study. Based on the means and SDs from data by Earl et al<sup>27</sup> demonstrating a difference in performance on the anterior reaching direction of the SEBT between PFPS and matched control groups (control =  $0.648 \pm 0.066$ , PFPS =  $0.596 \pm 0.063$ ), an n of 20 in each of our groups would produce a statistical power level of .805.

All participants were recruited from a university student population by posted flyers and announcements. The partici-

pants were excluded if they (1) were previously diagnosed with osteoarthritis or patellar tendinitis or tendinopathy; (2) had a previous history of surgery (including arthroscopy), fracture, patellar dislocation/subluxation, or ligamentous or other soft tissue injury; or (3) had a concussion within the last year or suffered from any neurologic deficit. The healthy participants had no previous history of any anterior knee pain. The participants with PFPS (1) presented with diffuse, unilateral anterior knee pain for at least 8 weeks, exacerbated by stair climbing, sitting, walking, running, squatting, knee flexion, and isometric quadriceps contraction, 11, 12, 28-32 and (2) had never received patellar taping before this study. None of the patients with PFPS were participating in rehabilitation at the time of the study. Before the study began, each participant signed an informed consent form approved by the university's human subjects research and review committee, which also approved the study.

# Instrumentation

Testing and data collection were performed in the Athletic Training Research Laboratory. An electromagnetic tracking system (Ascension Technology Corp, Burlington, VT) was integrated with the MotionMonitor software (version 7.24; Innovative Sports Training, Inc, Chicago, IL) to quantify the kinematics of the hip and knee during the task. Tape measures were secured to a mat at 45° angles to each other, and the mat was placed on the ground for the SEBT reach distance measurements. Also, a 10-cm visual analog scale (VAS) for perceived pain was used to record each participant's perceived pain level at the end of each testing condition on each leg.

#### **Testing Procedures**

Each participant's height and mass were recorded. With the participant positioned supine on a plinth, we measured leg length for reach distance normalization from the anterior superior iliac spine to the middle of the medial malleolus. Data collection and tape application were performed on both legs, with the testing order for leg and taping condition (tape or no tape) randomized. "Affected" and "nonaffected" legs in the healthy participants group were matched with the same in the PFPS group.

The electromagnetic sensors were attached to the sacrum, lateral thigh, and lateral shank of the stance leg with hookand-loop straps. The participant stood barefoot and lined the toes up with the horizontal line of the SEBT mat. Foot placement was recorded so that the foot could be repositioned in the same place for both testing conditions. During performance of the SEBT, the sole of the stance-leg foot remained flat on the floor. The participant was instructed to reach as far as possible with the reaching leg and touch the designated tape line lightly with the most distal part of the reaching foot, while minimizing the transfer of any body weight from the stance leg and keeping hands on the hips.<sup>19,21,33</sup> Each participant performed 6 practice excursions in the anterior direction to limit any learning effects of the participants' performance.<sup>22</sup>

After 5 minutes of rest, the participant performed 3 excursions in the anterior direction, which were recorded for data collection. The assessor marked the reach distance for each trial on the tape by hand, and the number was rounded off to the nearest millimeter. All reach distance measures were recorded by the same investigator. If a participant stepped out



Figure 1. A, Patellar tape application procedure using the medial glide technique, with B, an obvious skin crease noted after tape application.

of the testing position or touched heavily during the reach, the trial was discarded and repeated. After 3 successful excursions were recorded under the first designated taping condition, the participant was given 5 minutes of rest. The procedure was then repeated under the other taping condition.

The patellar taping was applied by the investigator using the medial gliding technique established by McConnell.<sup>1</sup> The 15-cm Cover-roll tape (BSN-JOBST, Inc, Charlotte, NC) was applied first directly onto the skin. The 12-cm Leukotape P (BSN-JOBST, Inc) rigid tape was then applied, starting from

the lateral femoral condyle, anchoring over the patella, and ending at the posterior knee, with enough medial force applied to shift the patella medially. When the taping was complete, an obvious "pouch" of the skin (crease) was visible at the medial knee. To standardize the amount of medialization, the tape was pulled until a skin crease of greater than 2 cm wide was measured at the medial side of the knee (Figure 1). A 2-cm crease width indicates a medial pull applied to the patella. To our knowledge, no authors have quantified or standardized the force of the pull with the size of the crease during patellar tape application. Although previous researchers have suggested the need for a standardized width, we are unaware of any reference supporting a specific width. During pilot testing, we determined that a 2-cm-wide crease served as an appropriate standardized width for the application of the tape. After the 2 testing conditions were completed for the first stance leg, a 5-minute rest period was allowed, and then the procedures were repeated for the other leg.

To designate the knee and hip flexion at maximum reach distance, an event marker trigger synchronized with the A/D board of the motion analysis system was depressed by an investigator when the reaching leg touched down (Figure 2). Each participant's perceived pain was recorded on the VAS after the 3 reaches of each testing condition on each leg were completed. The participant placed a mark on the line representing the level of pain after each group of trials.

#### **Data Analysis**

The reach distances of the SEBT were normalized by dividing the distance by the leg length, denoted as %MAXD.<sup>20</sup> The means and SEs of hip flexion and knee flexion at the point of maximum reach distance and the normalized reach distance from the 3 trials were used for data analysis. For each dependent variable (%MAXD, hip flexion, knee flexion, and VAS score), we calculated a separate 2 within-subjects (condition, side), 1 between-subjects (group) repeated-measures analysis of variance. Significance level was set at P < .05, and SPSS (version 12.0; SPSS Inc, Chicago, IL) was used for data analysis. Tukey post hoc testing was performed in the event of statistically significant interactions.

#### RESULTS

Data from the PFPS group under the taped condition were presented as PFPST and under the nontaped condition, as PFPSNT. Similarly, data from the control group under the taped condition were presented as ControlT and under the nontaped condition, as ControlNT.

# Pain Level

A significant tape-by-group interaction was noted for VAS scores ( $F_{1,38} = 8.691$ , P = .005). Tukey post hoc testing revealed that the PFPS group had significantly greater pain in both the taped (PFPST = 1.073 ± 0.176, ControlT = 0.175 ± 0.176) and nontaped (PFPSNT = 1.453 ± 0.201, ControlNT = 0.109 ± 0.201) conditions compared with the control group ( $F_{1,38} = 19.06$ , P < .001; Figure 3). Additionally, the PFPS group had reduced pain with tape (PFPST = 1.073 ± 0.176) compared with no tape (PFPSNT = 1.453 ± 0.201). The effect size for the tape-by-group interaction was 0.186.



Figure 2. Anterior-direction Star Excursion Balance Test with taped condition applied to stance leg.

#### Normalized Reach Distances (%MAXD)

For normalized reaching distance, a significant tape-bygroup interaction was shown ( $F_{1,38} = 5.189$ , P = .028). Tukey post hoc testing revealed that the PFPS group demonstrated less reaching distance in the taped (PFPST =  $63.5\% \pm 1.3\%$ , ControlT =  $64.8\% \pm 1.3\%$ ) and nontaped (PFPSNT = 62.8% $\pm 1.2\%$ , ControlNT =  $65.6\% \pm 1.2\%$ ) conditions versus the control group. In addition, the PFPS group significantly increased its reaching distance with tape application (PFPST =  $63.5\% \pm 1.3\%$ ) compared with no tape (PFPSNT = 62.8% $\pm 1.2\%$ ). However, the control participants demonstrated significantly decreased reaching distance in the taped (ControlT =  $64.8\% \pm 1.3\%$ ) versus the nontaped (ControlNT = 65.6% $\pm 1.2\%$ ) condition (Figure 4).

#### **Kinematic Variables**

**Hip Flexion.** No statistically significant tape-by-side-by group interaction was demonstrated for hip flexion angle at %MAXD ( $F_{1,36} = 1.400$ , P = .244). In addition, no main effects of tape ( $F_{1,36} = .126$ , P = .725), injured side ( $F_{1,36} = .092$ , P = .763), or group ( $F_{1,36} = .664$ , P = .421) on hip flexion were evident. Means and SEs for hip flexion are presented in the Table.

**Knee Flexion.** No statistically significant tape-by-side-by group interaction was noted on knee flexion angle at %MAXD ( $F_{1,37} = .367, P = .548$ ). Additionally, no main effect of tape ( $F_{1,37} = .119, P = .732$ ), injured side ( $F_{1,37} = .014, P =$ 



Figure 3. Tape-by-group interaction for visual analogue pain scores ( $F_{1,38} = 8.691$ , P = .005). <sup>a</sup>Indicates significance differences between groups (P = .005), <sup>b</sup>significant differences within the patellofemoral pain syndrome (PFPS) group (P = .005).

.906), or group ( $F_{1,37} = 1.075$ , P = .307) on knee flexion was found. Means and SEs for knee flexion are presented in the Table.

# DISCUSSION

Our results suggest that patellar taping reduced pain and improved dynamic postural control in the PFPS group without influencing hip and knee sagittal-plane kinematics during anterior reach performance on the SEBT. The patellar taping improved dynamic postural control by reducing pain and not by influencing positioning of the hip and knee in the sagittal plane.

# Pain Level

An immediate reduction in pain level, as quantified by the VAS, with the application of patellar taping is consistent with previous findings.<sup>5,10–13,28,34–36</sup> The reduction in pain may have contributed to the increased reach distances, but no previous researchers have measured the effectiveness of patellar taping on dynamic postural control. Nevertheless, the successful pain reduction and improved performance during functional tasks, such as stair ambulation and walking, with the application of taping as reported in previous studies,<sup>11,14,34</sup> may suggest that reducing pain via the application of patellar tape helps improve performance in symptomatic individuals. No significant kinematic alterations were noted after patellar tape application, so changes in pain did not appear to influence hip and knee kinematics during this dynamic postural control task. The changes in afferent input via tape application may be an underlying cause for this phenomenon.<sup>10,12,15,37</sup> Bockrath et al<sup>36</sup> also argued that patellar tape may elicit neural inhibition by facilitating large afferent fiber input. Changes in neural input through afferent receptors, such as cutaneous mechanoreceptors and Messner corpuscles, from the patellar tape application may have been enough to block nociceptive input and cause neural inhibition via the large afferent fibers. Another possibility is that reduced pain was the result of the placebo effect of the patellar tape, regardless of the direction in which the tape was applied. We cannot draw a conclusion because we did not have a placebo tape group in our study. However, previous authors have indicated that therapeutic taping had a greater effect on pain reduction and functional improvement than placebo taping or control conditions.<sup>3,11,35,38</sup> Alternately, several investigators<sup>12,13,39</sup> have reported no significant differ-



Figure 4. Tape-by-group interaction for normalized reach distance (%MAXD) on the Star Excursion Balance Test ( $F_{1,38} = 5.189$ , P = .028). PFPS indicates patellofemoral pain syndrome group. and indicates significant differences between groups (P = .028), bignificant differences within the control group (P = .028).

ences between therapeutic and placebo taping techniques on perceived pain and neuromuscular activity. Further research is warranted to assess the influence of the forces and directions applied on the patellar tape on pain level and function, as well as the potential placebo effects from these techniques.

Only the medial gliding technique of the McConnell taping regimen was applied in this study. Although this technique relieved pain in the symptomatic group, some individuals may not have received the full benefits of patellar taping, depending on the extent of their patellar misalignment or rotation. Furthermore, if the participants did not present with a lateral shift of the patella, pulling the patella medially via tape may not have reduced pain and may have even elicited more pain. These possible variabilities may have contributed to the small effect size.

Finally, for convenience, we recruited participants from the university community, using posted flyers and announcements, rather than from clinical sites. Therefore, we can partially attribute the low VAS scores in our study to the fact that our participants were not actively seeking treatment for pain at the time of recruitment. Future authors should examine these relationships among groups of PFPS sufferers who are under the care of clinicians.

# Normalized Reach Distance (%MAXD)

Improved %MAXD after the patellar tape application in the PFPS group and decreased %MAXD with patellar taping in the healthy group suggest that the patellar tape may have al-

tered the afferent or efferent pathways (or both), affecting the participants' ability to maintain dynamic postural control. Perhaps the reduction in pain enhanced the magnitude of VMO activation to help stabilize the knee joint during the SEBT, allowing participants to maintain their balance more effectively while attempting to reach further. Our results indicated that the PFPS participants demonstrated significantly less %MAXD, regardless of taping condition, than the healthy participants during the anterior excursion.

Earl and Hertel<sup>18</sup> reported that in healthy participants, VMO activity was highest during the anterior reach of the SEBT. More recently, Earl et al<sup>40</sup> demonstrated that delayed VMO activation onset, combined with lower extremity misalignment, weak musculature, and decreased kinematics, can predict development of PFPS, suggesting that VMO insufficiency may be associated with decreased performance during a functional task. Previous authors have reported improvement in the onset of the VMO during functional activity after the patellar tape application.<sup>10–15</sup> These results may support the hypothesis that the increase in VMO activity from patellar tape application may improve performance during dynamic postural control. Because we did not collect electromyography data, we cannot conclude that patellar taping altered neuromuscular control related to VMO function. However, evidence for such a relationship may be in improved reach distance with tape application in symptomatic participants. Future investigators should record lower extremity muscle activity and determine how these measures change after patellar tape application.

Table. Hip and Knee Flexion Values at Maximum Reach Distance, Anterior Direction, Star Excursion Balance Test (Mean ± SE)°a

Group	Condition	Side	Hip Flexion	Knee Flexion
Control	Tape	Injured	10.212 ± 3.065	48.444 ± 3.911
		Uninjured	11.406 ± 2.990	49.123 ± 3.810
	No tape	Injured	11.051 ± 3.180	$48.848 \pm 3.981$
		Uninjured	10.705 ± 2.949	$50.237 \pm 3.629$
Patellofemoral pain syndrome	Tape	Injured	7.164 ± 3.231	45.151 ± 3.812
		Uninjured	7.349 ± 3.152	42.892 ± 3.714
	No tape	Injured	$7.356 \pm 3.353$	$43.803 \pm 3.880$
		Uninjured	$7.565 \pm 3.108$	$43.402\pm3.537$

<sup>a</sup>No values were statistically significant.

# **Kinematic Variables**

Although a strong relationship seemed to exist between pain level and %MAXD in our study, suggesting that reducing pain may be a factor in improving the reaching distance in the symptomatic group, the observed improvement in pain level and %MAXD occurred without significant changes in hip and knee sagittal-plane kinematics. Additional kinematic variables that were not investigated in this study may have also contributed to the increased %MAXD. The PFPS participants may have undergone biomechanical alterations at other joints or planes of movement resulting from compensatory strategies in an attempt to increase reaching distance.

Differences in knee flexion moment created by the degree of trunk flexion or extension may affect %MAXD.<sup>18</sup> Increased trunk extension may create an external knee flexor moment, which must be overcome by the internal knee extension moment produced by the quadriceps.<sup>18</sup> If pain was reduced and more VMO activity was produced with the patellar tape, knee extension moment may have increased. Therefore, the resultant kinematic change may have been present at the trunk but was not quantified by the methods of our study. We cannot support or reject this notion because we did not collect appropriate information in this study; thus, the effect of trunk movement on joint moments and muscle activity during the SEBT should be investigated in the future.

Hip abduction-adduction also may have affected the performance of the task. Ireland et al<sup>41</sup> found that participants with PFPS demonstrated significantly lower isometric hip abduction and external rotation strengths than healthy participants. Brindle et al<sup>42</sup> also reported that PFPS participants exhibited delayed-duration and shorter-duration activation of the gluteus medius muscle during stair ascent and descent compared with healthy controls. The authors suggested that compensatory strategies may be adopted by the PFPS participants at the hip during these activities. Additionally, while the available amount of closed chain dorsiflexion at the ankle was not a significant predictor of SEBT performance among healthy participants,<sup>20</sup> ankle and foot positioning could be influencing the hip and knee positions in PFPS participants during the task and should be examined.

Our results failed to demonstrate improvement in the lower extremity sagittal-plane kinematics related to McConnell taping observed in other studies, such as the increase in knee flexion angles during walking and ascending and descending stairs.<sup>14,34</sup> However, these previous authors used different functional tasks. The SEBT has been appraised to have relatively high intratester reliability<sup>22,23</sup> and has been a useful tool to differentiate injured participants' abilities to maintain dynamic balance and functional stability.<sup>18,19,27,33</sup> The possible mechanisms of neuromuscular adaptations and alteration in dynamic postural control strategies due to the presence of PFPS should be further investigated using the SEBT protocol.

We did not measure changes in patellar position or the angle of pull on the quadriceps as a result of patellar tape application. However, the proposed changes in these factors via patellar taping, as suggested by McConnell,<sup>1</sup> may have altered the function of the motor neurons during the dynamic postural control task. A number of groups have demonstrated improvement in the timing and quality of VMO activation with patellar taping.<sup>11–13,15</sup> Although these authors suggested that changes in the VMO activation pattern may have been caused by the changes in patellar position via patellar taping, they did not measure VMO activation. Moreover, most researchers investigating the effects of patellar taping on patellar position did not report any change in patellar position via patellar taping.<sup>4,9,36</sup> However, Worrell et al<sup>16</sup> noted that at 10° of knee flexion, bracing and taping conditions created a more medial patellofemoral congruence angle than a control condition. It should be noted that Pfeiffer et al<sup>9</sup> tested healthy participants only and used static measurements of patellar position. Further research is warranted to determine the effects of patellar taping on patellar position during a functional activity and to design a measurement device or technique to quantify the changes in patellar position before and after the application of patellar taping.

The finding that healthy participants demonstrated decreased reach distance and increased pain may indicate that patellar taping produces different effects on an uninjured population. Healthy individuals with no symptoms of PFPS may not have patellar misalignment. (We did not screen for misalignments in any of our participants.) Therefore, shifting the patella medially with the patellar tape may have increased contact between the undersurface of the patella and the lateral portion of the medial femoral condyle, potentially causing pain and a subsequent decrease in the reaching distance. The medial shift of the patella with tape elicited more pain and a decline in performance in healthy participants but decreased pain and increased function in the participants with PFPS. Thus, patellar tape may change patellar position, altering the perception of pain, which may have elicited changes in the performance of the SEBT between the healthy and PFPS participants.

# Limitations

The imposed demand of the SEBT protocol of this study may not have been great enough to exacerbate pain and functional and kinematic deficits in the PFPS participants. The participants' pain levels were relatively low, regardless of time. Our low effect size (0.186) suggests that, although pain levels with and without taping were significantly different, the meaningfulness of this finding may be very limited due to the low pain level exhibited by the participants. The severity of PFPS symptoms or level of pain tolerance may vary among participants. An index that would determine the pain level and extent of functional deficits presented by symptomatic individuals during activities of daily living and other functions may be helpful.

The source of pain in some participants with PFPS may be elsewhere (eg, excessive foot pronation), which may suggest that taping did not help alleviate the painful symptoms and, therefore, did not change performance in some individuals. Patellar taping is intended for correcting misalignment of the patella within the femoral groove. If participants do not have this problem, the application of patellar tape may bring no benefits to these individuals. A multifactorial condition, PFPS is caused by a combination of structural and neuromuscular deficits. Thus, thorough assessment is essential in determining the underlying cause of PFPS and which therapeutic intervention is best suited to treat the symptoms.

To standardize the SEBT task, we followed previously published procedures in which the hands remain on the hips and the heel of the stance leg remains in contact with the ground.<sup>18,20,22,27,33</sup> However, the imposed restrictions that required maintaining heel contact with the ground may have influenced the kinematics of the stance leg. Yet we felt that it was important to standardize the task as much as possible between the groups. Future authors may want to consider kinematic assessment of the stance leg and foot when this restriction is not imposed.

Finally, a single application of the patellar tape during a short time period may not have been enough to elicit neuromuscular adaptation and kinematic alterations, although it may have brought changes in cutaneous sensation. The effects of longer-term tape application on kinematics, pain level, and dynamic postural control should be investigated.

#### CONCLUSIONS

We are the first to investigate the effects of patellar taping during a dynamic postural control task such as the SEBT. Although patellar taping seems to alleviate pain and improve performance on the SEBT in participants with PFPS, the underlying mechanisms are still unclear, as we did not find significant kinematic alterations. Further research is warranted to investigate the role of patellar taping on neuromuscular control during dynamic postural control. However, patellar taping seems to be a safe and effective way to reduce the painful symptoms of PFPS and may be beneficial in allowing patients to engage in functional rehabilitation exercises.

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