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The Effect of a Patellar Bandage on the Postural Control of Individuals with Patellofemoral Pain Syndrome

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Abstract. [Purpose] A patellar bandage is often used by individuals with patellofemoral pain syndrome (PPS) to reduce pain and the additional sensorial input improves proprioception of the knee joint. The aim of this work was to assess the effect of a patellar bandage on the postural control of individuals with and without PPS. [Subjects and Methods] An analysis was performed of variables of center of pressure (CoP) as recorded by a force plate. Information about the forces and moments in three directions was used to obtain the CoP. Thirty women participated in this study: 15 with PPS and 15 without PPS. All subjects performed 3 trials in a unipodal stance with and without a patellar bandage. The force plate data were used to calculate the following variables: CoP sway area, CoP displacement frequency, and CoP mean velocity for the anteroposterior (AP) and mediolateral (ML) directions. A the linear mixed effects model was used for statistical analysis. [Results] Postural sway was significantly reduced in individuals with PPS when a patellar bandage was applied. [Conclusion] Additional sensory input from a patellar bandage increase proprioceptive feedback and this could be related to the improvement in postural control of PPS subjects.
Key words: Patellofemoral pain syndrome, Postural control, Patellar bandage

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INTRODUCTION

A patellar bandage is one of the commonly used treatments for relieving patellofemoral pain syndrome (PPS)[1–4)]. It is known to reduce pain in individuals with PPS; however the cause of the pain in such patients and the mechanisms through which it is reduced by a patellar bandage, as well as the effect of a patellar bandage's additional sensory input on postural control remain unclear[3, 5–7)].

Several factors are believed to contribute to PPS etiology, including biomechanical alterations in the proximal, and distal lower limb joints as well as alterations in the patellofemoral joint[4)]. Considering the local risk factors as patellofemoral joint factors leading to PPS, several structures around the joint, such as stabilizers patellofemoral muscles, static stabilizers may be involved[8)], and most of these structures have proprioceptive receptors that may be affected by this disorder.

Individuals with PPS have proprioceptive deficits that could alter the neuromuscular control of patellar kinematics[9)]. Neuromuscular control deficits may also affect the central nervous system's (CNS) control of anticipatory postural adjustments[10)], and thus change postural control, which involves interaction between the visual, vestibular, and proprioceptive systems[11, 12)]. A change in the sensory input that originates around the patellofemoral joint may lead to an alteration in the relationship between sensory information and motor action, thus changing an individual's motor control[13)]. Pain may also affect dynamic activities and alter the movement of the center of pressure (CoP) in individuals with PPS[14)].

The proprioceptive deficit of these individuals may have a relationship with the acting mechanism of a patellar bandage. Some studies have reported that the use of patellar taping or bandages has beneficial effects on the proprioception of PPS individuals[3, 15)]. The addition of a sensory afferent adds tactile information to the visual, vestibular and somatosensory systems and this may improve the organization of the strategy of motor control[13, 16)]. Thus, this additional sensory information may also improve postural control leading to a decrease in body sway[13)].

Previous studies have established that a patellar bandage can improve the function of the quadriceps and reduce or eliminate pain in individuals with PPS[4, 5)]. However, no study has yet analyzed the postural control of PPS subjects using additional sensory information. Hence, the purpose of this study was to analyze the effect of a patellar bandage on the static postural control of individuals with and without PPS. Our hypothesis was that a patellar bandage would

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Table 1. Mean and standard deviation of the anthropometric data of the PPS and Control Groups

Characteristics	PPS Group (n=15) Mean (SD)	Control Group (n=15) Mean (SD)
Age (years)	23.1 (2.5)	23.2 (2.3)
Height (cm)	160.5 (2.8)	160.2 (3.3)
Weight (kg)	58.7 (3.9)	54.4 (2.1)
Visual Analog Pain Scale (last month)	4.6 (1.1)	0

change the static postural sway patterns of individuals with PPS, since the proprioceptive deficit of these individuals may be influenced by the additional sensory information provided by the additional sensory input delivered by a patellar bandage.

SUBJECTS AND METHODS

The postural control of a convenience sample of 30 individuals was assessed under two different conditions, with and without a patellar bandage, in a non-randomized trial and case-control study.

The study participants were allocated to two different groups (Table 1), a PPS and control group. The PPS group (n = 15) included those with pain in the anterior knee region over the previous month (reporting a visual analogue scale score of at least 3 cm), those who reported experiencing pain during at least two functional activities (such as stepping up and down, squatting, kneeling or sitting for a long period), and those who showed at least three symptoms of PPS in a functional evaluation[17]. All participants had symptoms in both knees. The control group included 15 individuals with no pain in the knee joint, and no knee or lower limb injury, pathology, or surgical history[17] were excluded from the study individuals who had history of traumatic injury or previous surgery of the hip and/or ankle; musculoskeletal system, neurological, cardiovascular, and/or rheumatologic diseases; and a history or symptoms of vestibular system disorders.

All participants were informed about the procedures of this study and signed an informed consent form in accordance with the Research Ethics Committee of Clinics Hospital of Ribeirão Preto- University of São Paulo − USP − Brazil (HCRP process number 5318/2008).

Postural control was evaluated using a force plate (AMTI-OR6-7-1000). Data were collected at 100 Hz frequency, which was then used to calculate conventional CoP-based measures. Data were analyzed using the BioDynamicsBr Analysis software (DataHominis Tecnologia Ltda, Uberlândia MG, Brazil). The processed data included the values of the forces on the force plate, according to their direction, Fx (anteroposterior force), Fy (mediolateral force), and Fz (vertical force) as well as the moments of the reference directions. On the basis of these data, the coordinates of CoP were calculated in the anteroposterior and mediolateral directions.

The CoP coordinates were used to calculate the following variables: sway area, displacement frequency, and CoP mean velocity in the anteroposterior (AP) and mediolateral (ML) directions. Increases in conventional CoP-based measures are typically interpreted as an overall deterioration in postural control[18]. The most reliable conventional CoP measure is the CoP mean velocity[18–20], which is calculated from the total displacement of the CoP in both directions divided by the time of the trial. The mean velocity is a measure of how fast the displacements of the CoP are. Participants were instructed to perform right single leg stance and left single leg stance, under taped and untapped conditions. The tape was applied while the subjects were lying down, with the knees relaxed and extended. A non-glide patellar alignment was maintained during the tape application. The tape used was a regular adhesive tape.

Participants performed each trial with their eyes closed for better evaluation of the influence of the proprioceptive system on postural control. The standardized body position was: neutral hips, opposite knee at 90° flexion, tested knee fully extended, and arms parallel to the body. Each trial lasted 30 seconds[21], and 3 trials were performed for each condition and task, resulting in a total of 12 trials. The tested limb was randomly selected, the single-leg standing trials lasted for 30 seconds. The interval between taped and untaped trial was 15 minutes to avoid any tape residual information.

Comparisons were made between legs and the taped and untapped conditions for all tasks. The mean and standard deviation were calculated for each condition of each activity, and linear mixed effects models (random and fixed) were used for data analysis[22]. Linear mixed effects models are used in the analysis of data in which responses of the same individual are grouped and there is an inadequate supposition of independence between observations in the same group. The participants were considered random effects, and the groups and different conditions (with and without patellar bandage) were considered fixed effects. The model was adjusted using the PROC MIXED procedure of the statistical software SAS 9.0 (Cary, NC, USA).

The mixed-effects model assumes that the residue obtained from the difference between the values predicted by the model and the observed values has a normal distribution with a null mean and constant variance.

RESULTS

Our data showed no significant differences between the 2 groups or between legs. The within group comparison of the taping conditions showed that in the control group after the application of patellar tape, there was a statistically significant reduction in the mean velocity of mediolateral

Table 2. Means and standard deviations of center of pressure variable and intragroup differences with their respective confidence intervals

Group	Variable	Untaped Mean (SD)	CI Untaped	Taped Mean (SD)	CI Taped	Difference	CI (95%)
PPS	Displacement X (cm)	5.00 (0.74)	(4.846–5.156)	4.73 (0.65)	(4.590–4.864)	−0.27*	(−0.45–−0.09)
	Displacement Y (cm)	7.18 (2.09)	(6.740–7.616)	6.99 (2.35)	(6.494–7.482)	−0.19	(−0.74–0.36)
	Area of CoP (cm²)	16.12 (4.66)	(15.144–17.10)	14.90 (4.80)	(13.892–15.908)	−1.22*	(−2.34–−0.1)
	Frequency X (Hz)	0.33 (0.31)	(0.2698–0.3998)	0.27 (0.28)	(0.2076–0.3231)	−0.07	(−0.14–−0.002)
	Frequency Y(Hz)	0.24 (0.21)	(0.2004–0.2865)	0.21 (0.20)	(0.1728–0.2557)	−0.03	(−0.08–0.02)
	Mean speed of displacement X (cm/s)	6.68 (1.30)	(6.406–6.951)	6.19 (1.37)	(5.902–6.476)	−0.49*	(−0.75–−0.23)
	Mean speed of displacement Y (cm/s)	6.22 (1.49)	(5.904–6.528)	5.77 (1.45)	(5.464–6.073)	−0.45*	(−0.72–−0.17)
Control	Displacement X (cm)	4.90 (0.89)	(4.714–5.089)	4.76 (0.71)	(4.616–4.914)	−0.14	(−0.31–0.04)
	Displacement Y (cm)	7.39 (2.40)	(6.888–7.897)	6.96 (1.82)	(6.576–7.34)	−0.43	(−0.98–0.11)
	Area of CoP (cm²)	16.52 (4.43)	(15.592–17.452)	16.27 (4.36)	(15.351–17.182)	−0.25	(−1.37–0.86)
	Frequency X (Hz)	0.34 (0.24)	(0.2924–0.3952)	0.36 (0.25)	(0.3052–0.4118)	0.01	(−0.05–0.08)
	Frequency Y(Hz)	0.29 (0.21)	(0.242–0.3281)	0.28 (0.18)	(0.2397–0.3158)	−0.007	(−0.05–0.04)
	Mean speed of displacement X (cm/s)	5.90 (1.65)	(5.557– 6.249)	5.80 (1.85)	(5.412–6.187)	−0.1	(−0.36–0.16)
	Mean speed of dislplacement Y (cm/s)	5.74 (1.90)	(5.339–6.137)	5.42 (1.99)	(5.002–5.835)	−0.32*	(−0.6–−0.04)

*intragroup comparison in the conditions with and without patellar bandage ($p<0.05$). CI: Confidence interval and SD: Standard deviation

displacement (Y). In the PPS group the application of patellar tape, a statistically significant reduction was anteroposterior displacement (X), in the CoP sway area, and in the mean velocity of anteroposterior (X) and mediolateral (Y) displacements (Table 2).

DISCUSSION

Our results do not support the hypothesis that the control group has better postural control than the PPS group. Our results are in agreement with Collins et al.[23] who did not observe improvements in center of pressure (CoP) measures of postural sway between control and knee disorder groups; however it should be noted that Collins et al.[23] evaluated individuals with knee osteoarthritis. Saad et al.[14] showed that individuals with PPS presented a greater displacement area of the CoP during dynamic postural control than the control group. Thus, the activity evaluated in our study may not have been challenging enough for the PPS group.

Nevertheless, our results demonstrate that additional sensory input at the anterior knee of individuals with PPS leads to a decrease in the value of the most important parameter for evaluating postural control, CoP velocity. The reductions in CoP displacement area and displacement velocity can be seen as an improvement of postural control and according to Salavati et al.[21] and Meshkati et al.[24], these parameters are reliable for evaluating motor control.

Reduced body sway, including the CoP displacement velocity of our PPS subjects, may have been the result of increased proprioceptive feedback and changes in postural adjustment reactions arising from the additional sensory input given by the patellar bandage. The application of a patellar bandage may stimulate phasic tactile receptors, improving sensory information quality and proprioceptive response. This would lead to increased activity in the motor cortex, suggesting the possible influence of additional sensory information on motor control and coordination[25].

In the control group, a patellar bandage did not elicit significant changes in body sway, probably because these individuals did not have any proprioceptive deficit due to knee joint disorders. Thus, control individuals did not benefit from the additional sensory information provided by the taping. These findings agree with those of Callaghan et al.[15], who studied the effects of taping on a group of healthy subjects. They measured proprioception in their subjects by active and passive angle reproduction, and threshold to detect passive movement on an isokinetic dynamometer. Their results were classified as “good” and showed no improvement after patellar taping was applied.

Additional sensory input as a patellar bandage can be used by individuals with PPS not only to relieve their pain[5]. Our present study did not evaluate pain; however there is a general consensus that a patellar bandage decreases anterior knee pain[1–4]. An important feature of this study is that it investigated the improvement in postural control elicited by patellar bandages, especially in PPS cases with impairments in proprioceptive acuity. Nevertheless, further studies are needed to establish the mechanisms of action of the additional sensory input, especially over static postural control, and the possible relationship between this improvement in postural control and the performance of functional activities by PPS subjects.

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