

ORIGINAL ARTICLE

IJPHY

PATELLAR REALIGNMENT AND FUNCTIONAL PERFORMANCE IN PATIENTS WITH PATELLOFEMORAL PAIN SYNDROME

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ABSTRACT

Background: Patellar taping has long been used to relief pain in patients with patello-femoral pain syndrome (PFPS) patients with patello-femoral pain syndrome (PFPS). Yet, there is lack of knowledge regarding its effect on the functional performance. The purpose of the study was to examine the effects of therapeutic patellar taping on the Visual Analogue Scale (VAS) pain scores, number of bilateral squats, and stair climbing time in patients with PFPS.

Methods: 30 female patients with PFPS with mean age 20.3 ± 1.46 years, weight 66.1 ± 9.68 kg, height 165.83 ± 3.89 cm and BMI 23.91 ± 3.50 kg/m² participated in the study. The patients were tested randomly under three taping conditions; namely therapeutic, placebo and no-tape. The tested limb was determined to be the affected limb in patients with unilateral affection, the most symptomatic in patients with bilateral affection. Data were collected using the Visual Analogue Scale (VAS), Bilateral Squat Test and Timed Stair Ambulation Test.

Results: Repeated measures Multivariate Analysis of Variance (MANOVA) revealed that the number of bilateral squats increased significantly ($p < 0.05$) and the VAS scores and stair climbing time decreased significantly with the use of therapeutic tape compared with the other two tested tape conditions. Additionally, the VAS pain scores decreased significantly with placebo tape use compared with no tape, with no significant difference ($p > 0.05$) in between for the number of bilateral squats and stair climbing time.

Conclusion: The findings indicate that therapeutic patellar taping is effective in improving functional performance and reducing pain in patients with patellofemoral pain syndrome (PFPS).

Keywords: Patellofemoral pain syndrome, Patellar Taping, Pain, Functional Performance.

Received 18th December 2015, revised 10th January 2016, accepted 31st January 2016



www.ijphy.org

10.15621/ijphy/2016/v3i1/88915

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INTRODUCTION

Patellofemoral pain syndrome (PFPS) is one of the most common disorders encountered in the clinical setting [1,2]. It affects about 7% - 40% of adolescents and active young adults [3]. This high prevalence is associated with morbidity that is directly related to activity of patients [4,5]. Females are significantly more likely to develop PFPS than males⁶. They are 2.23 times more likely to develop PFPS compared to males [6]. Patellofemoral pain syndrome is caused by imbalances in the forces controlling patellar tracking during knee flexion and extension, particularly with overloading of the joint [7]. Patellofemoral pain syndrome is known as “runner’s knee” and “anterior knee pain [3].

Patients with PFPS suffer from pain, knee joint stiffness, patellar crepitus, locking, and decreased activity levels [8]. It manifests suddenly and may occur in both lower limbs. Pain is aggravated by activities such as prolonged sitting, stair descent, and squatting [9,10]. PFPS is always associated with functional impairments [11,12].

The ideal approach to deal with the condition is still questionable and treatment failure rates are high [13]. Specialists have demonstrated that patients may have higher than anticipated levels of disability [14] and psychological morbidity [15]. A large number of patients may experience symptoms many years after diagnosis [16] and there is evidence that the PFPS may lead to osteoarthritis [17]. This is because the PFPS has various causes such as quadriceps muscle weakness, increased quadriceps angle (Q angle), abnormal lower limb mechanics, overuse, and lateral retinaculum tightness [18, 19].

Few studies recommended that biomechanical abnormalities might be hastened by occupation, sports or footwear [20]. Once the diagnosis of PFPS has been set up, the modalities for interventions are various, and however no broad accord exists as to the most useful treatment approach. Current evidence based treatment methodologies incorporate taping, strengthening of the hip musculature and quadriceps, and fitting of foot orthoses [21,22]. One intervention frequently used for the management of patients with PFPS is patellar-taping [23].

Jenny McConnell, an Australian physiotherapist, initially created Patellar taping (PT) as a new component of managing PFPS [24]. Taping was assessed for its impact on pain, quadriceps torque and EMG activities in such patients [25, 26, 27,28,29]. Taping reduces pain by correcting patellar position and reducing the stresses imposed upon inflamed soft tissues [30].

Patellar mal-alignment appears as patellar tilt, displacement or subluxation. This mal-alignment decreases and lateralizes the patellofemoral joint contact area and increases stresses imposed upon this area. [31] The increased stress might progress to OA of the patello-femoral compartment and decreasing functional performance [32, 33]. Various studies conducted for the effects of PT on pain

and muscle torque in patients with PFPS showed significant effects [34], in spite of the limitations in those trials (lack of control groups and small sample). However, these assessment tools have proved to be a poor predictor for the function in patients with PFPS [35]. Hence, there is limited knowledge about the effects of taping on functional performance in such patients. This study aimed at investigating the effects of taping on functional performance in addition to examining the perceived pain intensity in patients with PFPS. The Bilateral Squat test along with the Timed Stair Ambulation test were used to assess functional performance. These functional tests proved to have good intra-rater reliability and were related to changes in pain in patients with PFPS [36]. Additionally, about 86% of patients with PFPS have pain during stair climbing and 85% have pain with squatting [9]. It was previously reported that pain was a greater predictor of disability than radiographic changes [37] hence pain levels were recorded. The main goal of management for patients with PFPS is return to the highest and the most efficient functional level [38].

METHODS

Participants:

Thirty female patients with patellofemoral pain syndrome (PFPS) participated in this study. Their mean (SD) age, weight, height, and BMI were 20.3 ± 1.46 years, 66.1 ± 9.68 kg, 165.83 ± 3.89 cm, 23.91 ± 3.50 kg/m² respectively. The same orthopedic surgeon referred all patients. All our patients had diffuse, unilateral anterior knee pain for at least eight weeks exacerbated by stair climbing, squatting, sitting, walking, running, knee flexion, and isometric quadriceps contraction [39,40] in addition to radiographic evidence of lateral patellar glide [41,42,43,44,45]

The patients were excluded if they were previously diagnosed with osteoarthritis or patellar tendinitis, had a previous history of surgery, fracture, patellar dislocation/subluxation, or ligamentous or other soft tissue injury; or had any medical condition that precludes safe testing as any past allergic tape reaction [46]. None of the patients were involved in rehabilitation at the time of the study.

An informed written consent was taken from the subjects involved in the study. All the patients had knee radiographs (skyline views). The same radiologist examined the radiographs for patellar mal-alignment (tilt, rotation and gliding). In the current study, the tested limb was determined to be the affected limb in patients with unilateral affection, and the most symptomatic limb in patients with bilateral affection. The institutional review board for research at the Faculty of Physical Therapy, Cairo University approved the procedures used in this study.

Instrumentation

The level of functional performance was assessed using two functional tests; the bilateral squat test and the timed stair ambulation test. These Functional tests are specific to patellofemoral pain syndrome (PFPS) as they include weight-bearing stress with various knee-flexion angles,

which are common aggravating positions and require dynamic muscular control³⁶. The Visual Analogue Scale (VAS) was used for assessing pain intensity after both functional tests. The VAS is a valid and reliable tool for pain assessment [47].

Tape type and application:

A therapeutic tape (rigid non-stretchable zinc oxide) was used to realign the patella (figure:1). At first, an under-tape was applied over the patellar area to prevent any allergic (hypersensitive) response (figure:2). At that point, the therapeutic tape was applied by the same examiner to correct the mal-alignment found in the radiograph (through providing medial glide, medial tilt, and rotation forces to the patella) (figure:3,4). For the placebo taping condition, the under-tape was applied over the skin as therapeutic tape without any tension.



Figure 1: The Leukotape® (BSN medical GmbH, Hamburg, Germany) roll which used as a therapeutic tape to re-align the patella



Figure 2: The hypo-allergic under-tape (Fixomull® Stretch; BSN medical GmbH, Hamburg, Germany) which was applied first to cover the patellar area to prevent any allergic reaction



Figure 3: Application of patellar tape to correct patellar mal-alignment



Figure 4: The medial glide, medial tilt, and rotational forces applied to the patella using therapeutic patellar taping

PROCEDURE

Each patient was asked to randomly select one from three folded papers located in the examiner’s hand. These papers represented the three taping conditions; therapeutic, placebo and no tape. Each patient was tested according to this random selection. For bilateral squat test, patients were asked to stand with both knees in full extension, shoulder-width apart, and weight equally distributed on both limbs. Then patients were asked to lower their bodies to reach 90 degrees of knee flexion and then return to full knee extension. One repetition consisted of a complete cycle starting from straight standing to 90 degrees of knee flexion and return to straight standing. The number of bilateral squats completed in 30 seconds was recorded³⁶. After 5-minute resting period, the timed stair ambulation test was started. Each patient was asked to ascend and descend a set of nine steps at her usual speed. The total time taken was recorded, with longer time indicating poorer physical function. The level of perceived pain was assessed after both functional tests using the VAS.

The patient was allowed to rest for another five minutes then the same whole procedure was repeated again for the second tape testing condition followed by another 5-minute rest period that was terminated with repeating the same procedures with the third tape testing condition. These rest periods were given to minimize the carry-over effect of taping on the cutaneous sensation as indicated by Bell-Krotoski et al., 1995 [23].

Statistical Analysis: -

All statistical measures were performed through the Statistical Package for Social Studies (SPSS) version 20 for windows. Initially, data were screened through conducting Kolmogorov-Smirnov and Shapiro-Wilks normality tests for normality assumption as a prerequisite for parametric analysis. This was done also through assessing for the presence of significant skewness and kurtosis in addition to the presence of extreme scores. Mauchly’s test of sphericity was also used to assess the significant dependency among the three taping conditions. Once data were found not to violate the normality and sphericity assumptions, parametric analysis was used. Repeated measures Multivariate Analysis of Variance (MANOVA) was used to differentiate among the three taping conditions for the VAS pain scores,

number of bilateral squats and stair climbing time. The level of significance was set at an alpha level of 0.05.

RESULTS

Repeated measures Multivariate Analysis of Variance (MANOVA) showed that the number of bilateral squats was significantly increased with therapeutic tape use compared with placebo and no tape use ($p < 0.05$). Regarding the VAS pain scores and the stair climbing time, the repeated measure MANOVA revealed significant reduction in their scores with therapeutic tape use compared with the other two tested tape conditions ($P < 0.05$).

Moreover with placebo tape use, the Repeated measures MANOVA revealed that the VAS scores decreased significantly compared with no tape use, while no significant differences were found ($p > 0.05$) in the number of bilateral squats and stair climbing time between placebo and no tape conditions. Tables 1 & 2 show the above findings

Table 1. Descriptive Statistics of the VAS Pain Scores, Stair Climbing Time and Number of Bilateral Squats using the Three Taping Conditions in Patients with Patellofemoral Pain Syndrome.

	VAS Pain Scores Mean(SD)	Stair Climbing Time Mean(SD)	Number of Bilateral Squats Mean(SD)
Therapeutic tape	3.92(2.05)	15.5(7.42)	15.96(3.14)
Placebo tape	5.66(2.1)	19.2(8.7)	13.37(1.7)
No tape	6.37(2.2)	20.88(9.3)	11.62(1.5)

Table 2. Post-Hoc Analysis for the Multiple Comparisons among the Three Tested Taping Conditions in Patients with Patellofemoral Pain Syndrome.

	VAS Pain Scores	Stair Climbing Time	Number of Bilateral Squats
No tape versus placebo	$P = 0.003^*$	$P = 0.14$	$P = 0.41$
No tape versus therapeutic	$P = 0.000^*$	$P = 0.000^*$	$P = 0.000^*$
Placebo versus therapeutic	$P = 0.000^*$	$P = 0.000^*$	$P = 0.000^*$

Note: (*) the mean difference is significant at $p < 0.05$.

DISCUSSION

The findings of the present study showed a significant reduction in the VAS pain scores with therapeutic PT compared with placebo and no tape conditions. Despite the fact that it is not well known how taping diminishes pain [48], it is suggested that pain alleviation is brought about by patellar position correction [49,50]. Since pain appears in the patellofemoral joint results from the high contact pressure stresses imposed on the lateral aspect of the patellofemoral joint [51] as a result of patellar mal-alignment that causes patellofemoral osteoarthritis [52], So correction of this mal-alignment may reduce these additional stresses and

consequently decrease the level of perceived pain [52].

Additionally, Bockrath et al.(1993) declared that the use of tape to re-align the patella stimulates the mechanoreceptors [53]. The authors suggested that taping produce a strong inhibitory stimulus, through the large afferent fibers at the dorsal horn of the spinal cord, to block the small diameter (nociceptor) input through a pain gate mechanism [54]. On the other hand, taping may stimulate the prieductal gray area of the medulla, creating descending noradrenergic system inhibition at the dorsal horn and generating hypoalgesia [55].

Gifford [54] suggested that placebo taping have positive effects (especially when dealing with chronic pain).It can affect neural activity at the dorsal horn through the descending pain suppression system. Therefore, the treatment is still beneficial. Although a placebo effect was evident in our patients, it should be noted that pain alleviation with the use of therapeutic tape could not be solely attributed to the cutaneous stimulation provided by the placebo effect. The superiority of therapeutic tape over placebo tape shown in our findings suggests that the therapeutic tape has a direct effect on knee pain that cannot be attributed to placebo or cutaneous stimulation alone.

Moreover, changing patellar position may alter the magnitude or distribution of patellofemoral joint pressures or stresses on joint structures ($\text{pressure} = \text{force}/\text{area}$) [30]. Additionally, unloading the fat pad may reduce strain on this usually inflamed soft tissue [56]. These changes might have been responsible for the superiority of therapeutic tape over placebo tape.

The effect of PT on pain intensity has been previously studied with controversial findings. The results of the current study are similar to those reported by Herrington and Payton, Hinman et al., and Hinman et al.[25, 46, 48]. These authors found significant reductions in the intensity of perceived pain with the use of therapeutic taping. On the other hand, our findings are contradicted with those reported by Keet et al. and Kowall et al. [27, 28]. These researchers did not find any significant effect of therapeutic PT on the levels of perceived pain. These contradictions might be attributed to the different application techniques of PT, and/or small sample sizes which might have resulted in low statistical power.

Regarding the effect of taping on functional performance, the findings of the current study revealed a significant improvement in the mean values of the numbers of the bilateral squats and a significant reduction in the stair ambulation time with therapeutic tape use in comparison with placebo and no tape use. As many previous study proved that much of the disability experienced with knee pain is attributed to quadriceps muscle weakness and pain [57,43], the effect of taping on functional performance may occur through its significant effect on pain and quadriceps muscle peak torque.

Many previous studies found a significant improvement in the peak torque of the quadriceps muscle with therapeutic

tic PT [58, 59, 60, 26, 61]. The improvement found with therapeutic taping are suggested to have resulted from realignment of the patella and the consequent change in the leverage offered to the quadriceps muscle by the patella, maximizing its mechanical advantage. The larger the mechanical advantage, the less the force required by the quadriceps muscle to produce the same torque ($\text{torque} = \text{force} \times \text{moment arm}$) and therefore the less patellofemoral joint compression forces [62].

A second possible explanation is that taping reduces the inhibitory effect of pain of the quadriceps muscle, causing an increase in the muscle peak torque [63,59]. Alternatively, PT unloads the mechanically irritated and swollen peri-articular soft tissues such as the synovium, instantaneously relieving pain [17]. The effect of PT on functional performance may also be attributed to the sense of “support” reported by the tested patients with therapeutic tape use [64].

Hinman et al., and Powers et al [48, 65] assessed the effect of PT on functional performance previously. The researchers found that therapeutic PT is more efficient than placebo tape for management of disability in patients with knee OA. It should be noted that they assessed the disability levels in patients with knee OA using functional scales (the WOMAC, Knee Pain scale and SF-36) under different taping conditions; therapeutic tape, placebo tape and no tape. Similarly, Vagal [61] reported a significant improvement in functional performance in patients with patellofemoral pain syndrome (PFPS) who received medial PT compared with the control group. Moreover, Powers et al [65]. Assessed the influence of PT on gait characteristics and joint motion in patients with PFPS. The patellar tape resulted in a small but significant increase in loading response knee flexion during the taped condition while walking at two speeds, up and down ramps and up and down stairs.

On the other hand, Hinman et al [46] reported that taping did not produce significant effect on the speed of walking or the scores of the time up and go test. However, a significant difference was evident in the step test with use of therapeutic tape because the patients were able to take more steps as their balance was suggested to have been improved. The difference between their findings and ours might be attributed to their small tested sample size which might have resulted in low statistical power.

The current study is limited by the inability of generalizing the findings on the male population as the study being conducted on females. Females were examined as they constitute higher incidence than males [6] and the fact that the measured variables are affected by sex [66, 67, 68]. On the other hand, this study has the privilege of being stringently designed. The randomization of taping conditions rendered it more controlled than much of the previously conducted research in this area [60,26]. Furthermore, examining one group of patients in a repeated-measures design enabled minimizing the extraneous effects that might affect the relationship between taping and the measured variables. Hence, the internal validity of the study was im-

proved.

CONCLUSION

Patellar taping is effective for improving functional performance and reducing pain intensity in patients with patello-femoral pain syndrome.

Acknowledgment

The author would like to thank all the patients who kindly participated in the study.

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Citation

Abeer Farag Hanafy. (2016). PATELLAR REALIGNMENT AND FUNCTIONAL PERFORMANCE IN PATIENTS WITH PATELLOFEMORAL PAIN SYNDROME. *International Journal of Physiotherapy*, 3(1), 71-77.