The Effect of Patellar Taping on Knee Kinematics during Stair Ambulation in Individuals with Patellofemoral Pain

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Abstract: Background: Patellofemoral pain syndrome is a prevalent condition in young people. While it is widely believed that abnormal patellar tracking plays a role in the development of Patellofemoral pain syndrome. Recently, taping techniques with the primary purpose of altering muscle activity have become a part of clinical physiotherapy practice. A firmly applied tape across the fibers of the vastus lateralis (VL) muscles has been proposed to decrease the vastus lateralis muscle activity. **Methods and measure:** Ten subjects with a diagnosis of Patellofemoral pain were studied (five men and five women). The subjects' mean age, height and mass were 36.5 ± 11.1 years, 173.1 ± 10.3cm, and 70.9 ±13.3 kg, respectively. Lower extremity kinematics, Visual analog scale (VAS) and ground reaction force were obtained simultaneously while subjects ascend and descend stairs, under taped and untapped conditions. ANOVAs for repeated measures were used. **Results:** On the average, a 92% reduction in pain was observed following the application of tape. Increase in cadence and knee flexion angle were observed under the taped condition for both stair ascent and descent in comparison with the control group.

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1. Introduction

Patellofemoral pain is a musculoskeletal complaint that is common in active and general populations[5]. Recent prospective studies have identified that approximately10% of active individuals will develop Patellofemoral pain. Many cases of anterior knee pain are diagnosed as Patellofemoral pain syndrome, a largely idiopathic chronic pain disorder characterized by a gradual onset of poorly localized pain in the anterior aspect of the knee aggravated by activities such as squatting, stair climbing and descent, or prolonged sitting with the knee bent [11, 12] . In the general population, Patellofemoral pain syndrome is most prevalent among adolescent and young adult women; however, this gender difference is not observed in the highly physical active population such as the professional athletes [18].

Chronic Patellofemoral pain is a serious problem since it limits mobility and may lead to arthritis and permanent disability[17]. Despite the high prevalence of this disorder, its prognosis is not clearly understood. Although it is widely held that patellar mal-tracking plays a role in the development of Patellofemoral pain syndrome, this link has not been establish[14].

Patellofemoral pain syndrome has been attributed to abnormal Patellofemoral joint mechanics caused by mal-alignment and tracking disorders, damage to the articular cartilage, and chronic overloading although it has been suggested that the syndrome is often not associated with definable abnormality[18, 20]..

Lower limb biomechanical deficits that been proposed to cause abnormal spin, tilt, and lateral translation of the patella can be identified in many cases of Patellofemoral pain syndrome, but it is not clear that these are symptoms-generating factors because similar types of mal-alignment have been observed in many people with no knee pain and disorders[15]. The most widely accepted theory regarding the etiology of the Patellofemoral pain suggests that the symptoms are a result of excessive Patellofemoral joint stress (force per unit area) owing to abnormal patellar tracking[1].

Elevated Patellofemoral stress, a result of excessive Patellofemoral joint reaction forces or reduced Patellofemoral contact area, or both, is believed to cause irritation and degradation of retro patellar tissue[16]. As the Patellofemoral joint reaction force increases with quadriceps muscle contraction and knee flexion angle, patient with Patellofemoral pain may adopt compensatory gait strategies to reduce pain and minimize Patellofemoral joint reaction force. For example, person with Patellofemoral pain have been shown to demonstrate decreased stance phase knee flexion, decreased walking velocity, and diminished vasti muscles activity during level walking compared to individuals without Patellofemoral pain syndrome[19].

In addition some authors reported that subjects with Patellofemoral pain had reduced peak knee extensor moments compared to controls during level walking. The previous mentioned kinematics and kinetic compensations noted in individual with Patellofemoral pain are suggested of a quadriceps avoidance gait pattern, which also reported for those patients with anterior cruciat ligament deficient kne[9].

Great controversy surrounds the proper

rehabilitation of the Patellofemoral joint pain, whether it is coincident with surgical intervention or not. It has historically been assumed that strong quadriceps lead to abated knee symptoms because of the quadriceps role in deceleration and concomitant reduction in the joint impact, as well as their influence on the anatomic position of the patella with respect to the femur[16]. The most practical way to maximally strengthen the quadriceps appears to be with a leg extension maneuver since these exercises allow for quadriceps isolation[3,10].

One of the most common treatment interventions for patient with Patellofemoral pain is the patellar taping technique, a technique to correct patellar mal-alignment with specific tape application[8,13]. It has been reported that patellar taping result in decreased pain, increased patellar alignment, increase quadriceps muscle activity, and increase quadriceps muscle torque production. The primary purpose of taping technique is to alter the muscle activity of the vastus lateralis muscle by firmly applied the tape across the fibers of the vastus lateralis muscle aiming to decrease the activity of that muscle [7,14]. Powers et al have reported improve the gait function following the application of the patellar taping. Also these authors observed improved knee flexion during the loading response phase of level gait.

Knowledge of the effect of taping on the kinematics of the knee during stair ambulation in subjects with patellofemoral pain would provide additional information about the usefulness of the patellar taping as a treatment intervention for improving gait function[13].

From a clinical standpoint, the high demand task of ascending and descending stars often exaggerates compensation pattern in individuals' with patellofemoral pain, and as a result, step negotiation has become one of the primary diagnostic procedures used to establish the signs and symptoms of this condition[4,6,9].

The purpose of this study was to determine the effects of patellar taping on knee joint kinematics during stair ambulation of person with patellofemoral pain. We hypothesized that the application of patellar tape would result in decrease pain and increase knee flexion angle during stair ascent and descent in individual with patellofemoral pain.

2. Methods

Subjects

Twenty subjects (ten men, ten women) with a confirmed diagnosis of patellofemoral pain syndrome participated in this study showed in the following table (Table 1)

Table1:

Men (n = 10)				Women (n = 10)		
Range	Mean	SD	Range	Mean	SD	Range
Age (years)	38.0	7.8	(27.0-46.0)	35.0	14.0	(22.0-55.0)
Mass (Kg)	77.6	15.2	(59.0-46.0)	64.2	7.5	(57.2-76.7)
Height(cm)	178.9	10.7	(162.6 189.0)	167.3	6.2	(156.2-170.2)

Patellofemoral pain was determined by the presence of retro patellar pain elicited by one of the following symptoms provocation test: resisted terminal knee extension, stair descent, or unilateral partial squat. Exclusion criteria were a history of knee ligament or cartilage injury, prior knee surgery, current pain originated from associated structure (bursa, patellar ligament), or neurological involvement that would influence coordination or balance during testing. Before participation, all subjects signed consent from.

Procedure

Before data collection, subjects were screened to determine if inclusion and exclusion criteria were met. All subject completed the Visual Analog Scale (VAS) to determine the level of pain in response to one of the symptom provocation tests. The pain scale consists of a 100-mm horizontal line drawn on a piece of paper, such that the left edge of the line represents no pain and the right edge of the line represented sever pain. Subjects were instructed to mark the line at the point corresponding to their pain levels. It was not the purpose of this study to determine the effect of the taping on pain, but the pain assessment was necessary to determine whether taping procedures were performed with the effectiveness.

Reflective markers were placed directly on the skin of the subject's involved (painful) lower extremity according to Vicon protocol. Markers locations consists of the right ASIS, left ASIS, Sacrum, lateral thigh, lateral femoral epicondyle, lateral shank, lateral malleolus, second metatarsal head, and calcaneus. The thigh and shank markers were attached to 2-inche wands that allowed inherent thigh and shank transverse plane rotation to be captured. Subjects performed the first set of stair

ascent and descent trials without tape to capture their natural compensation without the influence of any intervention. It was thought that if the taped trials were performed first, the untapped trials would not represent subject's true gait patterns owing to a carryover effect.

All subjects completed several practice trials to accommodate the stair apparatus and minimize the likelihood of an order effect. Participants were instructed to walk step over step at a self-selected pace. One trial was defined as one episode of ascent or descent.

Two trials of stair ascent and descent were collected for all subjects with kinematics data obtained simultaneously. the applied corrective tape procedure was medial glide technique. Tape application was determined to be successful if a 50% reduction in pain (quantified using the VAS) was achieved during the same symptom provocation test used to establish the pre-tape pain level. If 50% reduction in pain did not occur, the taping procedure was repeated until the desired decrease in pain was achieved. Subjects completed several practice trials after the application of tape, and two trials of stair ascent and descent were obtained using the methods previously described.

Data analysis

Analysis of variance (ANOVA) tests were performed using the following dependent variables: average knee flexion angle, and cadence. Each ANOVA was a repeated measures designed consisting of two factors (tape condition and stair condition) with two level in each factor (taped/untapped and ascent/descent). All analysis were performed using SPSS software (version 10.0) with significance levels set at $p<0.05$.

3. Results

Pain

On Average, the pre-tape pain level was 5.4± and post tape level was 0.4 ± 0.5 on a 10-point Scale, resulting in a 92.6% reduction in pain.

Cadence

A significant tape effect for cadence was found with no associated interaction. On the average, subjects walk with a faster cadence during the taped trials compared to the untapped trials (Stair ascent: 85.4 steps/min taped, 73.6 steps/min untapped; stair descent; 92.4 steps/min taped, 74.0 steps/ min untapped) and that described in the next figure.

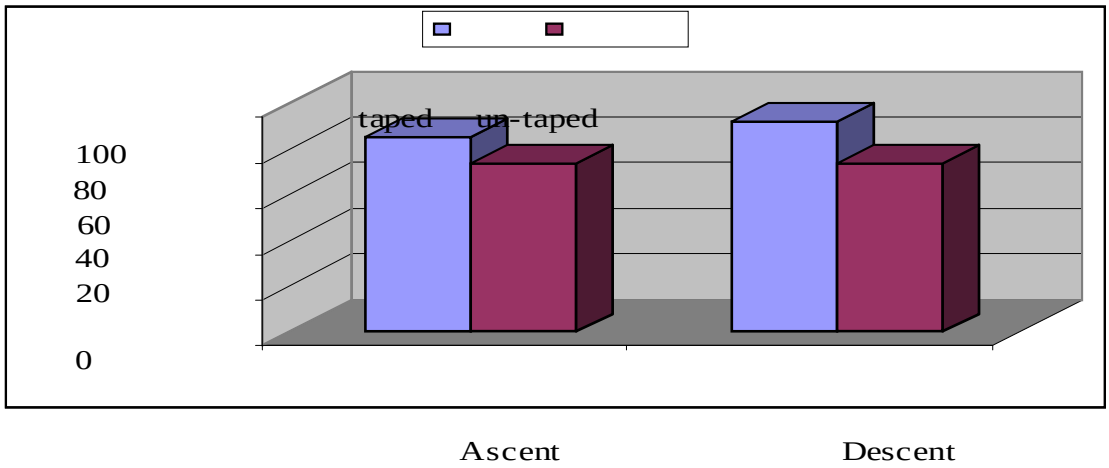

Figure 1. Cadence during stair ascent and descent for subjects with PFP (20) under both taping condition

- Taping result in increase cadence during Ascent and Descent.

Knee Angles

When the average knee flexion angle was analyzed, there was a significant tape effect with no interaction. Subjects demonstrated greater knee flexion during the taped condition compared to the untapped condition during ascent (39.2º taped; 34.3º untapped) and descent (46.6º taped; 38.5º untapped).($p < 0.001$) table 2.

Table2. average knee angles during stair ascent and descent for subject with PFP (n = 20)

P^b	Tape			No Tape			
	Range	SD	Mean	Range	SD	Mean	
<0.001	27.5-47.9	5.8	39.2	27.3-40.6	4.5	34.3	**Ascent** Average knee flexion angle (deg)
<0.001	36.3-52.1	5.6	46.6	28.4-45.1	5.6	38.5	**Descent** Average knee flexion angle (deg)

4.Discussion

Patellar taping result in an immediate reduction in pain (92.6%), similar to the finding reported by other investigators. Power et al reported a 78% reduction in pain in individual with Patellofemoral pain after taping, while Bockrath and Kowall (2002), indicated that pain was reduced by approximately 54 and 44 % respectively.

The large reduction in pain achieved by the subjects in the current study corresponded with change in the gait characteristics including increase cadence and increased knee flexion.

The improved gait characteristics noted in this study similar to the findings of powers et al, who reported increase in knee flexion angle and walking velocity during level walking in response to taping.

One possible explanation of increase in the gait characteristics was increased in cadence. Because stride length is relatively fixed stair ambulation, cadence is an indicator of walking speed, which has been shown to influence moments during gait (either through increase segment acceleration or ground reaction forces).

Another factor that may have contributed to the improvement in the gait characteristics obtained in our study was trunk posture. Although upper body kinematics was not assessed, observational analysis suggests that before taping, the subject adapted a more forward trunk position during stair ambulation. This posture would move the trunk's center of mass anteriorly, creating a smaller external knee flexion moment and corresponding internal knee extensor moment (i.e. quadriceps avoidance gait).

Taping appear to result in subjects assuming a more upright posture, a position that would move the trunk's center of mass posteriorly, creating a greater external knee flexion moment and a corresponding increase in the internal knee extensor moment[2, 15]. Ernst *et al.*,(2005), offered a similar explanation (altered trunk position) for their finding of increased knee moment after the application of tape

Clinical implications

Patellar taping appears to be a useful treatment intervention for improving gait function in person with Patellofemoral pain syndrome. While patients appear to walk more normally with tape, the quadriceps muscle may not have a response to this intervention. So, the taping technique may help the patient to improve his gait but at the same time regular evaluation of the quadriceps with strengthening exercise may help those patients to maintain this improvement in the pattern of gait.

It would appear that care must be taken to thoroughly evaluate the quadriceps performance for each patient with Patellofemoral pain syndrome (e.g. Isokinetic or functional performance test), as improved gait pattern with taping technique may not necessarily indicate improved muscular response. So program of rehabilitation for those patients should continue to emphasize muscle retraining as an important component of Patellofemoral rehabilitation.

Limitations

While the present study appears to have clinical implications, some limitations need to be addressed. The sample size was notably small (n = 20), and although it was sufficient to differences in several gait variables, the sample increment must be considered in further studies and try to compare between the athletes and regular people. Involvement of the EMG analysis while the patient ascent and descent stair may help to provide more information about the synchronization between the vastus lateralis and the vastus medialis and the changes in the knee extensors moment.

Conclusion

During stair ambulation, patellar taping resulted in decreased pain, increased cadence, and increased knee flexion angle in the subjects with Patellofemoral pain syndrome. Care must taken to thoroughly evaluate the quadriceps muscle performance capability of individual with Patellofemoral pain.

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