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The effect of patella taping on quadriceps strength and functional performance in normal subjects

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Abstract

Objective. To investigate the effect of patella taping on normal subjects. This was undertaken through the examination of isokinetic quadriceps strength and functional performance (hop distance), in an attempt to clarify the mechanism behind patella tapings reported success in the patellofemoral pain syndrome (PFPS) patient population. The aim of the study is to examine the effect of patella taping on normal quadriceps function.

Method. Forty asymptomatic females (mean age 20.4 ± 1.9 years) had their single hop for distance and concentric quadriceps peak torque (on an isokinetic dynamometer at 180°/s) assessed under two conditions (with or without patella taping) using a same subject randomised repeated measures design.

Results. Patella taping brought about a significant decrease in hop distance ($p = 0.004$) and a non-significant decrease in quadriceps concentric peak torque ($p = 0.47$).

Conclusion. Taping brought about a decrease in performance of normal subjects, this may be because of a subtle alteration in the extensor mechanism alignment causing it to function in less than optimal manner. This research supports the hypothesis that the mechanism by which patella taping has brought about reported improvements in PFPS patients is not solely related to a reduction in pain inhibition, but may involve an alteration in patella position and so efficient functioning of the extensor mechanism.

Keywords: Patella taping; Patellofemoral pain syndrome; Isokinetic test

1. Introduction

Corrective taping of the patella is a commonly used treatment for patellofemoral pain syndrome (PFPS).This technique has been reported as being highly successful (Cushnaghan et al., 1994; Gerrard, 1989) producing excellent results even after long-term review of patients (Hilyard, 1990). In a review of the literature Herrington (2000) reported that taping appeared to successfully relieve pain, improve quadriceps function and bring about a repositioning of the patella within the trochlear groove in PFPS patients. These results are in spite of the difficulty of specifically delineating PFPS patient populations to a particular pathology based diagnosis. Taping appears to be equally effective with osteoarthritic patients as those with non-specific anterior knee pain (Cushnaghan et al., 1994; Gerrard, 1989).

On PFPS patients patella taping has been found by Conway et al. (1992), Handfield and Kramer (2000) and Kowall et al. (1996) during concentric isokinetic quadriceps contractions and Herrington (2001) during eccentric and concentric contractions to significantly increase quadriceps peak torque. Powers et al. (1997) found patella taping allowed a significant increase in knee loading response permitting increased shock absorption and quadriceps activity. In their study Ernst et al. (1999) showed patella taping to increase knee extensor moment and power during vertical jump and lateral step up, compared with no-tape and placebo tape conditions. There are two main explanations for the increase in quadriceps force, generation force and improved functional performance. The most commonly reported one is due to reduction in pain inhibition of the quadriceps (Herrington, 2001). Pain can inhibit both quadriceps activation and force production. If patients had lower levels of pain, potentially greater quadriceps activation would be possible through a reduction of arthrogenic inhibition. An alternative explanation for the increased activation is that taping brings about a change in the quadriceps lever arm through changing patella position, because any factor altering patella position has the potential

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to alter lever arm length and thus knee extensor moment (Ernst et al., 1999).

If the previously reported improved performance following patella taping in PFPS patients was due to pain inhibition then patella taping should have little or no effect on the performance of normal subjects (Parsons and Gilleard, 1999). But, if it is the case that taping brings about a change in quadriceps lever arm (i.e. patella position), the performance of normal subject's should change as a result of patella taping. This change could be either positive or negative in nature dependent on whether the taping optimises or disadvantages the patella position. The objective of this study is to investigate the effect of patella taping on normal subjects isokinetic quadriceps strength and functional performance (hop distance), in an attempt to clarify the mechanism behind patella tapings reported success in the PFPS population.

The research hypothesis of this study was that patella taping would have no effect on quadriceps strength or functional performance in normal asymptomatic individuals. This finding would then support the argument that improved performance in PFPS patients following taping was due to reduction of pain inhibition alone, not a change in patella position.

2. Method

2.1. Subjects

Forty physically active female University stud
ents mean age 20.4 years (± 1.9) with no history of lower limb, spinal or neurological injury participated in the study. They all gave informed consent to participate and the study

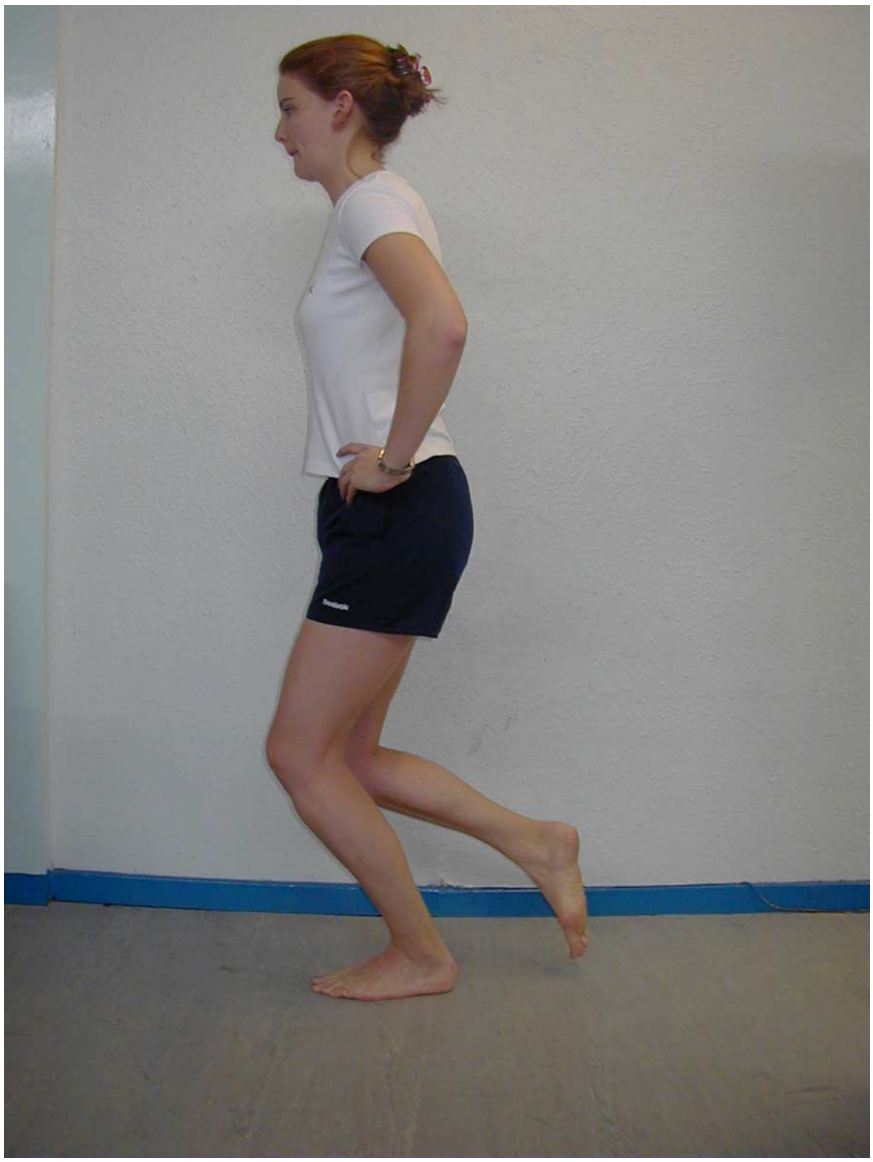

Fig. 1. Start position for the single hop for distance.

was approved by the Manchester Metropolitan University Ethics Committee.

2.2. Measurement

Quadriceps strength of the dominant leg of all subjects (peak torque) was measured on a Cybex Norm isokinetic dynamometer (Lumex Inc., Ronkonkoma, New York) at 180°/s. The use of this testing velocity avoids the potential high loads per unit of time of the slower testing velocities (Dvir et al., 1991). These have been shown to cause quadriceps inhibition in normal and PFPS patients (Anderson and Herrington, 2003). Also this velocity equates to the velocities reached during the hop test. All subjects were familiarised with the equipment prior to the commencement of data collection. They were seated in the chair of the dynamometer unit with chair and subject position mimicing those described by Dvir et al. (1991). They carried out 10 repetitions, completing a full cycle of concentric quadriceps contraction followed by sub-maximal hamstrings contraction to return to the start point. They were instructed to work sub-maximally for the first seven repetitions (to allow for familiarisation), then were verbally encouraged in a standardised manner to carry out three maximal concentric quadriceps contractions and the average peak torque was taken from these.

Subjects also had a single hop for distance measured using a standard metric tape measure, from a single starting point. The single hop was initiated in a position of 60° knee flexion and no downward counter movement was allowed (Fig. 1). The subject squatted to a position of 60° knee flexion with the angle being confirmed using a universal 360° goniometer, on achieving 60°, the subject held the position for 1–2 s then carried out the concentric hop. This eliminated any eccentric muscle action during the test, as eccentric quadriceps contractions have been shown to have specific inhibitory effects on performance (Anderson and Herrington, 2003). The hop was repeated three times with 1 min rest intervals between each attempt and the average distance hopped over the three repetitions was recorded.

The design of the project was that of randomised repeated measures on the same subjects. The tests were carried out under two conditions either un-taped or with the application of corrective patella taping as described by McConnell (1996), applied by a single experienced physiotherapist. For each subject the order of taping vs. non-taping was randomised as was the testing sequence of hop or isokinetic test. Each subject carried out a standard 5-minute warm up on a cycle ergometer and were given 2 min rest between each exercise trial.

2.3. Analysis

The statistical analysis was carried out using an SPSS package (version 10). The significance of any differences between the two conditions (taped and un-taped) was analysed by paired *t*-test, with the level of significance set at $p = 0.05$.

Table 1
The effect of patella taping on subject performance

	Without patella taping	With patella taping
Mean quadriceps peak torque (Nm)	52.6 (± 15.1)	52.5 (± 15.7)
Mean hop distance (m)	1.18 (± 0.16)	1.15 (± 0.17)

3. Results

Mean quadriceps concentric isokinetic peak torque was 52.6 Nm (± 15.1) and mean single hop distance was 1.18 m (± 0.16) for the un-taped conditions. Mean quadriceps concentric isokinetic peak torque was 52.5 Nm (± 15.7) and mean single hop distance was 1.15 m (± 0.17) for the taped condition. These results are displayed in Table 1.

The effect of taping on isokinetic quadriceps strength was not a significant one ($p = 0.47$), but the effect of taping on hop distance was a significant one ($p = 0.004$) causing a statistically significant reduction in distance hopped.

4. Discussion

These findings do not support the research hypothesis that the primary mode of patella tapings action is decreasing of quadriceps inhibition through the reduction of pain inhibition. This is because the asymptomatic individuals quadriceps were not inhibited due to pain, yet taping still brought about changes in performance. Parsons and Gilleard (1999) hypothesised that this alteration in muscle activation brought about by taping might be an attempt by the motor control system to counter the mechanical effects of the patella position or due to cutaneous stimulation from the tape affecting the threshold or recruitment of motor units.

The reason for the success of patellar taping in improving quadriceps function in symptomatic subjects (Conway et al., 1992; Gilleard et al., 1998; Handfield and Kramer, 2000; Herrington, 2001; Kowall et al., 1996; Powers et al., 1997) has been usually attributed to one of two potentially interrelated mechanisms. The first is the reduction of pain, if a patient has lower level of pain on activity; greater quadriceps activity would be possible (Ernst et al., 1999) as arthrogenic inhibition is reduced. Patella taping has been reported on numerous occasions to reduce PFPS patients' pain on activity (Herrington, 2000) supporting this mechanism for the increases in performance demonstrated. The second potential mechanism is a change in the quadriceps lever arm. Any factor that alters the patella position or its movement can influence the length of the quadriceps lever arm and thus knee extensor moment and quadriceps activity.

The medial glide of the patella brought about by taping (Larsen et al., 1995) will change the length tension relationship of the Vastus Medialis Obliques muscle (VMO), facilitating VMO contraction and so an improved patella position (McConnell, 1996) and therefore a more efficient and strong quadriceps contraction (Ernst et al., 1999).

Furthermore, previous work has established that quadriceps inhibition 'a break phenomena' is related to patella maltracking and chondral lesions in symptomatic individuals (Herrington et al., 2003). Decreasing the load placed upon these specific areas could therefore bring about improved performance in symptomatic individuals with taping, with taping changing the point of load application.

The potential causes of improvement in symptomatic individuals may also conversely provide an explanation for the decreases in performance experienced as a result of taping in this study. Pain and its occurrence and inhibitory effects cannot be an explanation as the subjects in this study were asymptomatic and experienced no pain whilst carrying out the testing procedures. This leaves a change in the lever arm of quadriceps as a possible explanation for the decrease in performance following taping. The greater medial orientation of the patella following tape application may have had the effect of altering the length tension relationship of VMO in a negative fashion, without its controlling influence on patella position; patella position is no longer optimal decreasing the efficiency of the extensor mechanism. The change in patella position brought about by taping may also have altered the loading stresses on the PFJ, and these asymptomatic subjects may have suffered from inhibition of the quadriceps to prevent deleterious loading.

5. Conclusion

Asymptomatic female subjects following taping of the patella were found to have decreased knee extensor strength and functional performance. These findings could possibly aid in the understanding of the mechanism by which patella taping brings about improved quadriceps performance in PFPS patients. As in normal subjects without pain to inhibit performance, taping is most likely to have brought about a positional change at the patellofemoral joint in order to generate a change in performance. In these asymptomatic individuals patella taping could have disrupted the optimal performance of the patellofemoral joint. This research supports the argument that in symptomatic individuals the improvements in performance may be brought about not only by a reduction of pain inhibition, but also by an improvement in the efficiency of the functioning of the extensor mechanism. Confirmation of this mechanism of action requires further investigation in a symptomatic population.

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