Effects of patellar taping on knee joint proprioception in patients with patellofemoral pain syndrome

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Abstract

The aim of this study was to assess the effect of patellar taping of the proprioceptive status of patients with patellofemoral pain syndrome (PFPS). A total of 32 subjects (18 males, 14 females of age 31.9 $\pm$ 11.2, body mass index 25.8 $\pm$ 5.3) with PFPS were tested for Joint Position Sense (JPS) using a Biodex dynamometer. Outcomes of interest were the absolute error (AE), the variable error (VE) and the relative error (RE) of the JPS values for both active (AAR) and passive (PAR) angle reproduction at an angular velocity of 2 $\pm$ 1/s with a start angle at 90° and target angles of 60° and 20°. Taping was applied in random order across the patella of each subject with each of the subjects acting as their own internal control.

Results indicated initially that application of patellar tape did not enhance and in some cases worsened the JPS of the subjects ($P > 0.05$). However, when the subjects’ proprioceptive status was graded according to their closeness to the target angles into ‘good’ ($\leq 5°$, $N = 10$) and ‘poor’ ($> 5°$, $N = 22$) taping enhanced nearly all values of those with ‘poor’ proprioception, with AE at 20° to statistical significance ($P = 0.021$).

In conclusion, this study has shown that patellar taping did not improve the AAR and PAR JPS tests of a whole sample of 32 PFPS patients. It also has shown that a subgroup of PFPS patients with poor proprioception may exist and be helped by patellar taping.

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1. Introduction

Although patellar taping is an inexpensive technique readily used by physiotherapists in the treatment of patients with patellofemoral pain syndrome (PFPS), the mechanism for its success is still unresolved. McConnell\textsuperscript{(1986)} originally described patellar taping as part of a treatment programme for PFPS and theorized that this technique could alter patellar position, enhance contraction of the vastus medialis oblique (VMO) muscle, and hence decrease pain. Studies on patients with PFPS have thus far been inconclusive regarding taping realignment of patellar position (Crossley et al.,\textsuperscript{2000}) and patellar taping enhancement of VMO contractions (Cerny,\textsuperscript{1995}). However, a number of studies have shown that patellar taping helps decrease pain in patients with PFPS (e.g., Powers et al.,\textsuperscript{1997}) although the mechanism for this symptomatic improvement remains largely unknown (for review see Callaghan,\textsuperscript{1997}).

Proprioception, defined as the acquisition of stimuli from conscious and unconscious processes in the sensorimotor system (Lephart and Fu,\textsuperscript{2000}), is now thought to play a more significant role than pain in preventing injury in the aetiology of chronic injury and in degenerative joint disease (Lephart,\textsuperscript{1995}). As long as...
ago as 1986, Wilson and Lee proposed that various knee injuries may affect knee joint proprioception, due to damage of the position sense receptors (Wilson and Lee, 1986). Proprioception can be appreciated and measured consciously by a complex system involving quick adapting and slow adapting mechanoreceptors; these are thought to mediate the sensations of joint movement (often referred to as kinaesthesia) and joint position (referred to as joint position sense (JPS)) (Lephart et al., 1992). Proprioceptive deficits have been found in anterior cruciate deficient knees (Beynnon et al., 1999), in osteoarthritic knees (Sharma et al., 1997; Hewitt et al., 2002) and in knees with a chronic effusion (Guido et al., 1997). It was also thought that patients who suffered patellofemoral dislocation may suffer from a proprioceptive deficit due to disrupted neuromusculoskeletal structures in the medial retinaculum, capsule, bursae and vastus medialis (Jerosch and Prymka, 1996).

It has been further speculated (Sanchis-Alfonso et al., 1999) that PFPS patients with more subtle forms of chronic patella malalignment may exhibit dysfunction of the peripatellar plexus, detectable with proprioceptive testing. These researchers found histological evidence of neuromata and nerve damage to the peripatellar soft tissues particularly the lateral retinaculum that suggested altered proprioception, subsequent patellar instability with resultant patellar pain. They recommended that proprioception training with tape should form part of a rehabilitation programme in patients with these symptoms. There have been few clinical studies to investigate proprioception status in PFPS. One found no differences between 24 PFPS patients and matched controls for JPS testing in weight and non-weight bearing (Kramer et al., 1997). Another, in abstract form (Prymka et al., 1998), conversely found significant differences between 43 PFPS patients and 30 controls in isolated JPS testing of the knee. The poor proprioception performance associated with PFPS was improved after applying a simple elastic bandage. The most recent study to test the theory of poor proprioception associated with PFPS was performed on a group of 20 patients (Baker et al., 2002). Compared to 20 healthy control subjects, Baker et al. (2002) found significant differences in the proprioceptive ability of the PFPS group as measured by absolute, relative and variable error (VE) during weight bearing and non-weight bearing active JPS tests.

Regarding the effects of interventions for PFPS, Callaghan et al. (2002) in a multicentre study showed that the application of patellar tape significantly improved the proprioceptive status using active and passive JPS tests of a sub-sample ($n = 26$) of 52 healthy subjects whose proprioceptive status was graded as ‘poor’. The tape did not improve those healthy subjects ($n = 26$) whose status was graded as ‘good’. This gave some insight into the enhanced proprioceptive effect of taping. To date, the efficacy of tape on the proprioception of a symptomatic group of PFPS patients has not been studied. We were interested if a similar subclassification could be applied to the group of patients with PFPS.

Just as the restoration to good proprioception status is widely accepted as a key component in the rehabilitation of other knee pathologies, so it may be that improving proprioception in patients with PFPS may help towards normal knee function and accelerate the rehabilitation process.

Therefore, the purpose of this study was to determine the effect of application of patellar taping on the JPS proprioceptive ability of the knee in a group of patients with PFPS. In addition, we wanted to investigate the possibility of sub-classification of PFPS proprioception values and whether or not this influenced the effect of patellar taping on JPS results. The null hypothesis was that there would be no difference in JPS proprioceptive ability between the taped and untaped conditions.

2. Methods

2.1. Subjects

Thirty-two patients with patellofemoral pain were referred from the Physiotherapy departments of Manchester Royal Infirmary and St. Luke’s Hospital, Bradford. None of the subjects had commenced physiotherapy treatment, but were examined by two authors (MJC, AmCh) to confirm the diagnosis clinically and exclude other causes of their symptoms. Each patient served as their own control with the no-taping condition being the internal control. All patients gave verbal and written informed consent. Ethical approval was obtained by the appropriate LRECs.

2.2. Inclusion criteria

Patients had retropatellar pain greater than 6 months brought on by two (or more) of the following without traumatic onset: prolonged sitting (theatre goer’s sign); stair climbing, descending; running; kneeling; hopping/jumping; pain on palpation of patellar facets; a step down (25 cm step) or double legged squat (Crossley et al., 2002). Patients were also included if they had a normal radiograph, normal MR scan or normal arthroscopy, if performed.

2.3. Exclusion criteria

Patients were excluded from the study if they had previous knee surgery (not including arthroscopy),
previous knee trauma that was still symptomatic or had an allergy to adhesive tape. Further clinical examination determined the presence of other lower extremity dysfunction that may account for the knee symptoms. These include referred pain from the lumbar spine and hip joint, severe leg length discrepancy, knee ligament, quadriceps tendon and meniscal pathologies; patella tendinitis (‘Jumper’s knee’); tibial tubercle apophysitis (Osgood Schlatters disease); bursitis; infrapatella fat pad lesion (Hoffa’s syndrome); medial plica syndrome; femoral anteversion and tibial torsion, bipartite patella (James, 1979) and also osteochondritis dessicans patella (Bentley, 1989).

2.4. Materials

JPS testing was performed on the Biodex system 2 Dynamometer (Biodex Corp. Shirley NY, USA) using this system’s electrogoniometer, sensitive to 1° increments. This was calibrated before the sessions in accordance with the manufacturer’s instructions. Data were processed using the Biodex Advantage software (v4.5).

In all tests, visual cues were eliminated by a blindfold. The tape was a 10 cm wide strip of Hypafix adhesive tape (Smith & Nephew, Hull, UK). A sphygmomanometer cuff provided equal sensory input to the lower limb of each patient from the dynamometer’s tibial pad (SP Services, Telford, UK).

2.5. Procedure

Wearing shorts, barefoot and blindfolded for each test, patients were seated with hip flexion at 90° and a starting position for knee flexion of 90°. In the event of bilateral PFPS, the most symptomatic leg was tested. The tibial pad was secured to the Shank of the leg 3 cm superior to the lateral malleolus. The sphygmomanometer cuff was wrapped around the tibia under the tibial pad and inflated to 40 mmHg, with constant checking to ensure equal pressure throughout the study. To avoid any learning effect the order of conditions (tape or no tape) was randomly allocated for each subject using a random number generator (www.mathgoodies.com/calculators/random_number.html). After each test condition the patient left the seat and walked around the room for approximately 5 min in order to reduce any possibility of proprioceptive carry over to the next test.

2.6. Measurement of proprioception

In order to detect JPS aspects of proprioception, we used a family of methods adopted from our previous study and widely used in other studies on knee proprioception, namely, passive angle reproduction (PAR) (Perlau et al., 1995), active angle reproduction (AAR) (Friden et al., 1996).

The knee was moved from a 90° start position to each of the target angles of 20° and 60° in random order. These target angles were chosen for several reasons. Firstly, at 20° of knee flexion the distal patella contacts the proximal femoral trochlea (Fulkerson, 2004) so that any proprioceptive deficit at this angle may be related to patella mal-tracking, which is widely accepted to be a major causative factor in PFPS symptomology (Powers, 1998). Secondly, 60° of knee flexion has been highlighted as a pertinent angle in PFPS pathology. When the critical test for the patellofemoral joint was first described (McConnell, 1986) it included the angle of 60°; the significance of this angle has since underlined by functional motion analysis (Selfe et al., 2001). Thirdly, choosing non-weight bearing angles at 20° and 60° facilitates comparison with another proprioception study on PFPS patients (Baker et al., 2002).

2.7. Passive angle reproduction

For PAR, starting at 90° of knee flexion the lever arm extended the test limb, without resistance to the movement, to the target angles. Passive movement occurred at an angular velocity of 2°/s to limit reflexive muscle contractions. Subjects were instructed not to voluntarily contract their muscles. The limb was maintained at the target angle for 10 s to enable the subject to remember the position. After passively returning to 90°, and after a pause of 5 s, the same cycle was repeated. This time the subject activated a hand-held stop button when they felt the target angle had been reached. Once the angle had been reached, patients were not permitted to correct the angle. The angle was noted from the on-screen goniometer. A total of six readings were taken, and the difference between the perceived angle and each of the target angles calculated for each reading and saved for subsequent analysis.

2.8. Active angle reproduction

In the same seated conditions, the subject’s limb was passively moved to the target angles. The leg was held there for 10 s for the subject to memorize the position and then returned to 90° knee flexion. After a pause of 5 s, the subject moved the lower limb by active contraction at an angular velocity approximating 2°/s and stopped when he/she perceived the target angle had been reached. Once the angle was achieved, patients were not permitted to correct the angle. A total of six readings were taken and the difference between the perceived angle and each of the target angles noted for each trial.
2.9. Patellar taping

Patellar taping was applied by the two lead researchers (MJC and JS) following the methods of our previous study (Callaghan et al., 2002). With the patient in supine with a relaxed extended knee, one strip of tape was applied without tension across the centre of the patella. The centre of the tape was as near as possible to the centre of the patella, with its medial and lateral edges aligned with the medial and lateral knee joint lines. The length of tape was calculated at 50% of the total circumference of the subject’s knee. This was in order to account for anthropometric differences between patients, which may have meant some smaller patients getting proportionally greater amounts of tape than others. In order to standardize the taping technique and because of difficulties in assessing patella malalignment (Watson et al., 1999), no attempt was made to correct patellar position. The theory was that affrent cutaneous sensation changes from the tape may alter proprioception without the need to correct patellar malalignment.

Pain was not formally assessed during testing as it has already been established that there are no significant correlations between JPS errors and levels of patellar pain (Baker et al., 2002). Therefore, it could be assumed that patients were not using pain as a strategy to position their knee (Kramer et al., 1997).

2.10. Sample size calculation

A sample size calculation based on means and standard deviations from our previous study (Callaghan et al., 2002) determined that the number of subjects in each group (taped and untaped) needed to detect similar differences would be 30 for PAR and 23 for AAR with a power of 80% (P<0.05).

2.11. Data analysis

Statistical analysis was performed using SPSS (Statistical Package for Social Sciences) for Windows (v11.5). Prior to analysis, the data were tested for normal distribution using the Kolmogorov–Smirnov test with a significance level set at P<0.05. Additionally, histograms were produced to visualize any non-normally distributed data. Results from these methods revealed that the assumption for normality was violated (K–S test P>0.05). Therefore, the data were transformed using natural logarithmic transformation (Atkinson and Nevill, 1998). The appropriateness of the logarithmic transformation was checked visually by histograms of the standardized residuals. Unfortunately, although this transformation permits a more robust statistical analysis, it converts the raw data into percentage figures and makes the data difficult to interpret in a clinically relevant manner. Therefore, data are presented as Medians (IQR) in order to aid comparison with other studies and illustrate clinical relevance. The mean of the six trials was taken for each subject at each angle and for each condition, and used to calculate the difference between the actual angles achieved and the target angles (Beynon et al., 1999). Three dependent variables were analysed for AAR and PAR tests (Baker et al., 2002). (1) Absolute error (AE)—the difference between the actual angle relative to the target angle; this has no directional bias. (2) Relative (or real) error (RE)—the difference between the actual angle relative to the target angle; this had a directional bias. (3) VE—the standard deviation of the mean of the subject’s score of six trials; this reflects the consistency of the actual angle achieved. Patients who had JPS scores further away from the target angles would have high AE and RE values and could be said to be less accurate. Those with high VE scores could be said to be less consistent.

Analysis consisted of a 3-way ANOVA (two movements (PAR and AAR), two conditions (Tape and No-Tape) and two angles (20º and 60º)) to assess the presence of any interactions. The level of probability was set at P<0.05. A Wilcoxon signed ranks test was used to analyse differences within groups for the non-parametric data.

3. Results

A total of 32 patients with PFPS were recruited; their characteristics can be seen in Table 1. During testing, no patients complained of increased patellar pain. There were no adverse events attributed to the procedure or the application of tape.

Data for all 32 subjects are presented in Table 2. These results showed that, for the whole group of 32 patients in all tests, the application of patellar tape made no difference to the error scores. Most scores remained the same or were less accurate and less consistent with the tape.

A 3-way ANOVA showed no significant interactions for AE, RE and VE regardless of movement type, target

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Subjects’ characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristics</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Age</td>
<td>31.9 (11.2)</td>
</tr>
<tr>
<td>BMI</td>
<td>25.8 (5.3)</td>
</tr>
<tr>
<td>Duration of PFPS symptoms (months)</td>
<td>14.6 (18.2)</td>
</tr>
<tr>
<td>Gender</td>
<td>18 m; 14 f</td>
</tr>
<tr>
<td>Pain at rest (VAS)</td>
<td>1.0 (1.6)</td>
</tr>
</tbody>
</table>

BMI = body mass index; PFPS = patellofemoral pain syndrome; VAS = visual analogue scale.
AAR and PAR 'good' proprioception (This revealed two subgroups of patients: those with target angle (Callaghan et al., 2002; Perlau et al., 1995). and 'poor' based on the accuracy of the scores from the effect on any condition for the whole sample group. no evidence that the application of tape had a significant Table 3
Poor proprioception status (N = 22) (> 5°), medians (IQR)

<table>
<thead>
<tr>
<th>Target angle</th>
<th>Test</th>
<th>Error type</th>
<th>No tape (deg.)</th>
<th>Tape (deg.)</th>
<th>Outcome</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>60°</td>
<td>AAR</td>
<td>Absolute</td>
<td>10.83 (7.7–14.3)</td>
<td>9.00 (4.9–13.2)</td>
<td>Better</td>
<td>.142</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relative</td>
<td>10.83 (7.2–14.3)</td>
<td>4.83 (–3.3–13.2)</td>
<td>Better</td>
<td>.068</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variable</td>
<td>0.60 (0.40–86)</td>
<td>0.53 (42–98)</td>
<td>Better</td>
<td>.664</td>
</tr>
<tr>
<td></td>
<td>PAR</td>
<td>Absolute</td>
<td>8.08 (5.7–14.2)</td>
<td>5.83 (4.8–13.4)</td>
<td>Better</td>
<td>.158</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relative</td>
<td>5.66 (–6.6–10.6)</td>
<td>0.66 (–3.7–10.7)</td>
<td>Better</td>
<td>.969</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variable</td>
<td>3.81 (2.4–5.3)</td>
<td>3.73 (2.2–5.4)</td>
<td>Better</td>
<td>.814</td>
</tr>
<tr>
<td>20°</td>
<td>AAR</td>
<td>Absolute</td>
<td>9.83 (7.7–15.4)</td>
<td>9.00 (5.5–12.5)</td>
<td>Better</td>
<td>.021*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relative</td>
<td>–8.00 (–11.7–5.6)</td>
<td>–7.41 (–12.5–2.5)</td>
<td>Better</td>
<td>.968</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variable</td>
<td>3.04 (1.3–3.8)</td>
<td>2.81 (1.9–4.6)</td>
<td>Better</td>
<td>.526</td>
</tr>
<tr>
<td></td>
<td>PAR</td>
<td>Absolute</td>
<td>10.25 (6.9–16.3)</td>
<td>9.25 (3.2–18.2)</td>
<td>Better</td>
<td>.646</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relative</td>
<td>–3.83 (–16.3–9.5)</td>
<td>–5.25 (–15.1 to –2.1)</td>
<td>Worse</td>
<td>.445</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Variable</td>
<td>4.1 (2.5–5.9)</td>
<td>3.0(2.0–4.1)</td>
<td>Better</td>
<td>.445</td>
</tr>
</tbody>
</table>

Analyses by Wilcoxon signed ranks test; *statistically significant.
AAR = active angle reproduction; PAR = passive angle reproduction.

As stated earlier, further analysis was performed by sub-classifying the proprioceptive test results into 'good' and 'poor' based on the accuracy of the scores from the target angle (Callaghan et al., 2002; Perlau et al., 1995). This revealed two subgroups of patients: those with 'good' proprioception (≤ 5° from the target angles, N = 10) and those whose proprioception could be classed as 'poor' (i.e. > 5° from the target angles, N = 22). The descriptive statistics now revealed that whereas proprioceptive values were hardly affected by the application of tape in those patients with 'good' proprioception, it improved all but one of the test values for those with 'poor' status, one to statistical significance when analysed by a non-parametric test. Table 3 shows the results of those patients whose median values were > 5° from the target angles and were classified as having 'poor' proprioception.

4. Discussion

Initial results using logarithmically transformed data revealed that there were no significant interactions for using patellar tape on target angle and active or passive testing. However, careful analysis of the non-transformed data suggested that not all patients with PFPS had the same proprioception as detected by the JPS tests of AAR and PAR. Indeed, there appeared to be subgroups of patients whose status was regarded as ‘poor’ (N = 22) or ‘good’ (N = 10) (i.e. ≤ 5° or > 5° from the target angles of 20° and 60°). After applying a single strip of tape across the patella with no directional pull or attempted realignment of the patella, PFPS patients with ‘poor’ proprioception were more accurate and more consistent with their AAR and PAR JPS tests at both angles of 20° and 60°. Only one of these improvements reached statistical significance. The subgroup with ‘good’ proprioception, on the other hand, did not find any benefit from the addition of taping, and
in several tests were actually found to be worse. Two other studies (Perlau et al., 1995; Kaminski and Perrin, 1996) also noticed this phenomenon when testing JPS pre- and post-application of knee bracing in healthy subjects. Perlau et al. (1995) explained that far from finding extra cutaneous stimuli helpful, those with inherently ‘good’ proprioception derive no benefit and may even find a brace or taping confusing when asked to perform a positioning task. A further explanation can be the concept of treatment effect. Put simply, patients with ‘good’ proprioception do not need any extraneous help, whereas those who are ‘poor’ have more chance of benefiting from taping treatment. This concurs with our previous finding when using patellar tape on healthy subjects using a target angle of 45°. Those whose proprioception was categorized as ‘good’ by the same definition found no statistically significant benefit from patellar taping on AAR AE, and were actually made significantly worse on PAR AE (Callaghan et al., 2002).

Compared to other knee conditions, there have been fewer studies to assess proprioception in patients complaining of PFPS. Baker et al. employed a kinematic system to compare healthy and PFPS active knee JPS testing in weight bearing and non-weight bearing (Baker et al., 2002). Although the difference in testing equipment and protocol makes comparison of all test values difficult, they noticed significant between-group differences in AE, RE and VE at 20° and 60° in NWB AAR trials. They found, as we did, that the greatest error value was in AE. Their maximum mean value for AE was 2.9° at 60° compared to our equivalent AAR median value of 7.7°. In general, our median AE, RE and VE values for all 32 subjects were higher than their mean values for NWB AAR.

Using an electrogoniometer, Kramer et al. (1997) found no differences between 24 PFPS and healthy controls using WB and NWB AAR. At a 60° target angle, the mean AE of the PFPS group was only 1.8° from the target angle; our median AAR equivalent score for all 32 subjects was 7.7°. Apart from employment of different equipment, a further explanatory factor of these differences is that their data were taken from the average values from 2 separate test days.

Prymka et al. (1998) described in abstract form that patients with ‘chondropathia patellae’ averaged 13.2° from the target angle for AAR tests. Their error scores are higher than any other work in this area and may simply reflect the different knee pathology of their patients.

4.1. Rationale for efficacy of patellar tape

A possible explanation as to why patellar tape has the capacity to improve JPS testing in PFPS may be either in chemical sensitizing of small and large diameter nerve fibres as a response to pain (Capra and Ro, 2000) or microscopic small nerve damage in the lateral retinaculum (Sanchis-Alfonso et al., 2001; Fulkerson, 2004). The application of some form of knee support is thought to augment afferent input via the enhancement of cutaneous stimulation (Lephart et al., 1992). It has also been proven that cutaneous afferents in the hand provide proprioceptive feedback information when stretched with tape resulting in the perception and detection of finger movement (Collins et al., 2000). Therefore, it is possible that the loss of afferent information in the subgroup of PFPS patients was improved by tape-enhancing feedback information from the muscle spindles, soft tissue and skin. The fact that both AAR and PAR were affected suggests that both active and passive systems of patellar control were affected and concurs with the detailed discussions of Baker et al. (2002, p. 213).

It was deemed impractical for the present study to correlate patellar malalignment with the proprioception values of our PFPS patients, as a clinically reliable method of assessing patellar malalignment has yet to be developed. These results raise the issue of sub-classification of PFPS patients in the domain of proprioception. There appear to be some PFPS patients with poorer JPS proprioceptive status than others, and treatment of these patients may be more appropriately applied if they could be easily identified and appropriately categorized. There is the intriguing possibility that the subgroup helped by tape is comprised of patients with neural damage within the lateral retinaculum or nerve sensitization due to pain. A three-way comparison of malalignment, proprioception and histological findings would be an intricate but useful area of further research.

4.2. Clinical significance

The small values involved in JPS testing (both in this study and others previously) raise the issue of clinical significance. There are two schools of thought. Firstly, that patellar taping can bring about improvements in JPS, which although statistically significant are so small as to be of doubtful clinical significance (in the present study—0.83° for AE AAR 20°). Secondly, that proprioception as detected by JPS is such an inherently precise task requiring high levels of precision that even very small changes achieved with a treatment technique such as taping are clinically important.

4.3. Study limitations

A post hoc power calculation showed that for AE at 60° the study was underpowered (29% power; $P > 0.05$;
mean = 2.01, pooled SD = 6.11, N = 22) and would need a sample size of N = 74 (P<0.05; 80% power) to see significant differences between the tape and no-tape conditions. Despite our best efforts to recruit an appropriate sample size following an a priori power calculation, this study probably suffered from a type 2 statistical error.

5. Conclusion

This study has shown that patellar taping did not improve the AAR and PAR JPS tests of a whole sample of 32 PFPS patients. However, it did improve the AAR and PAR JPS tests of 22 PFPS patients who were > 5° from the target angles of 20° and 60°. Only one of these reached statistical significance.

Those patients with ≤ 5° accuracy were not improved by the tape. This raises the issue of proprioception ability being a sub-classification of PFPS and may help appropriate treatment.

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References

