Initial effects of kinesio® taping in patients with patellofemoral pain syndrome: A randomized, double-blind study

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Abstract. The purpose of this randomized, double-blind study was to determine the acute effects of kinesio® taping on pain, strength, joint position sense and balance in patients with patellofemoral pain syndrome (PFPS). Twenty-two subjects with PFPS participated in the study. Subjects were separated into two groups; kinesio® taping (KT) and placebo kinesiotaping (PKT). All subjects were assessed before and 45-min after the applications. Muscle strength, joint position sense, static and dynamic balance and pain intensity were used as the main outcome measures. Among all outcome parameters significant differences were found between strength of quadriceps muscle at 60 and 180°/s, and static and dynamic balance scores before and 45-min after application of KT. There was also a significant difference between strength of quadriceps muscle at 60°/s and static balance scores before and 45 minutes after application of the PKT. Therefore KT application does not seem to be an effective treatment method for both decreasing pain and improving joint position sense for patients with PFPS.

Keywords: Balance, isokinetics, joint position sense

1. Introduction

Patellofemoral pain syndrome (PFPS) is a common problem experienced by active adults and adolescents. Furthermore, studies have shown PFPS to be the single most common diagnosis among runner and in sports medicine [23]. However, its etiology has remained vague and controversial [1]. Management can be challenging, a well designed and non-operative treatment program usually allows patients to return to recreational and competitive activities [27]. Physical therapy is the first line of treatment for PFPS. The clinical efficiency of several different treatment regimens have been studied; however, a recent systematic review reveals a lack of high-quality clinical trials in this area [13,25].

Taping is widely used in the field of rehabilitation as both a means of treatment and prevention of sports-related injuries [5,8]. The essential function of most taping techniques is to provide support during movement. Some believe that the tape serves to enhance proprioception, motor function and, therefore, reduces the incidence of injuries [5,31]. The therapeutic effects of knee taping include minimizing pain, increasing muscle strength, improving gait pattern and enhancing functional outcome of patients with sports injuries, osteoarthritis and PFPS [5,7].

In recent years, the use of kinesio® tape (KT) has become increasingly popular [7,15]. KT was designed to mimic the qualities of human skin. It has roughly the same thickness as the epidermis and can be stretched...
between 30 and 140% of its resting length longitudinally [14,16,24,30]. Kase et al. and Thelen et al. have proposed several benefits, depending on the amount of stretch applied to the tape during application: 1) to provide a positional stimulus through the skin, 2) to align facial tissues, 3) to create more space by lifting fascia and soft tissue above the area of pain/inflammation, 4) to provide sensory stimulation to assist or limit motion, 5) to assist in the removal of oedema by directing exudates toward a lymph duct [14,24].

KT can be applied to virtually any muscle or joint in the body. However minimal evidence exists to support the use of tape in the treatment of musculoskeletal disorders such as PFPS [9]. The limited information on KT application shows decrease in pain intensity and improved function, stability and proprioception in acute patellar dislocation [21], stroke [12], ankle [19] and trunk dysfunction [30]. This information comes from case series and small pilot studies and thus represents lower level clinical evidence.

There appears to be at least some merit for the use of KT as a treatment adjunct, but to our knowledge no studies have investigated the initial effects on strength, joint position sense and balance of the KT with double blinded randomized, placebo trial. The purpose of the study was to determine the initial effects of kinesio® taping on pain, strength, joint position sense and balance in patients with PFPS as compared to placebo kinesio taping (PKT) application.

2. Methods

2.1. Subjects

Twenty two female subjects aged 24.1 ± 3.2 years diagnosed with PFPS participated in the study. Subjects were included if they had retro-patellar pain longer than 6 months brought on by two (or more) of the following without traumatic onset: prolonged sitting, stair climbing, descending; running; kneeling; hopping/jumping; pain on palpation of patellar facets; a step down. Subjects were also clinically diagnosed with PFPS by a physician. Exclusion criteria for this study were if subject; a) had a current or previous record of knee pain, trauma, surgery and other joint disease, b) was involved in competitive sports, c) had an allergy to adhesive tape. Subjects were instructed to avoid taking analgesics or anti-inflammatory medications during the study. All subjects provided written informed consent before the study began.

Subjects were randomized into two groups: KT group (n = 12, age: Mean ± SD = 22.41 ± 1.62 years) and PKT group (n = 10, age: Mean ± SD = 26.20 ± 3.52 years). In PKT group, 2 participants dropped out of the study after applications. Outcome measurements were taken before and 45-min after the application. Only the physical therapist who made the taping knew the treatment condition, others who assessed the pre- and post-application measurements did not know the treatment conditions (KT or PKT).

Subjects were taped by a physical therapist certified to apply KT with a Y-Shaped kinesio® tape over the quadriceps territory according to the Kenzo Kase’s kinesio® taping manual [14]. Two Y strips were applied to the quadriceps. The first tape was initially applied to approximately mid-thigh over the vastus medialis muscle. The thigh was placed in about 45° knee flexed position. Light or paper-off tension (without stretch) was applied until the Y in the kinesio® strip has reached the superior pole of the patella. Then the tails of the Y shaped kinesio® tape with a 50–75% tension for correction were applied just below the tibial tuberosity with no initial tension. The tails of the Y shaped kinesio® tape without stretch were inserted into and around the medial and lateral borders of the patella including the vastus medialis and lateralis, respectively. Finally for two mechanical patellar correction techniques, two I shaped kinesio® tapes were applied around patella to 50–75% tension at 45° knee flexed position (Fig. 1a) [14].

In the PKT group subjects were taped with a sticking plaster without stretch. The main reasons for preferring the sticking plaster was similarity with KT, easy accessibility and no stretch property. Application places were similar to the KT group. A sticking plaster and KT allowed for the same dynamics in application (Fig. 1b). Although groups’ application materials and pressures were different, they were well concealed under clothing. Therefore, we did not believe that binding of the subjects was compromised.

2.2. Outcomes measures

2.2.1. Muscle strength

An isokinetic dynamometer (Cybex 770 Norm, Lumex Inc, Ronkonkoma, NY, USA) was used to evaluate quadriceps strength. At the beginning of each evaluation, the dynamometer was calibrated. Subjects were seated with hips and knees flexed at 90°. The axis of the dynamometer was positioned parallel to the lateral femoral condyle. Tests were done for the knees
with PFPS. Before tests, trial repetitions were applied for orientation. The isokinetic strength of the quadriceps was tested at constant angular velocities of 60 and 180°/s with 5 repetitions at each velocity. A 30-s rest period was allowed between sets. During tests, subjects were verbally and visually encouraged.

2.2.2. Joint position sense

The same dynamometer was used to evaluate the joint position sense. Subjects sat with hips and knees flexed 90°. The axis of dynamometer was positioned parallel to the lateral femoral condyle. Pneumatic boot and a blindfold were used to eliminate visual and cutaneous inputs. The continuous passive motion mode was used for testing at the constant velocity of 5°/second. Joint position sense evaluated between 0 degree knee extension to 90 degree knee flexion total 90 degree knee movement. Knee movement from flexion to extension was stopped by pressing the abort button when subjects felt they were in the mid-position of the range (45°). Initially, 4 repetitions were performed with subjects being alerted by the therapist to the point coinciding with the criterion position (45°). When subjects felt ready, the testing procedure started. At the test subjects were asked to press the abort button when they felt they were at mid point of the range (45°). The outcome measure consisted of the deviation from 45° based on 3 repetitions [22].

2.3. Balance

Kinesthetic Ability Trainer (KAT) 3000 (KAT 3000, Berg, Vista, CA, USA) was used to assess static and dynamic balance. KAT is a computerized system designed for static and dynamic balance assessment and training. The system involves a centrally pivoted balance platform, and the stability of this platform is adjusted using a patented pressure bladder positioned beneath it. As pressure in the bladder is increased, the platform becomes more stable. As pressure is decreased, the platform becomes less stable. When the platform deviates from the reference position, this information is transmitted to the computer system via a tilt sensor connected to the front of the platform unit. On the computer screen, a circle represents the balance platform and the center of the circle represents the reference position. The circle is divided into four quadrants. The two upper quadrants (the top half) indicate the front of the platform and two lower quadrants (the bottom half) indicate the back of the platform. The horizontal and vertical lines that form the quadrants are considered the “x axis” and “y axis”, respectively. The four quadrants are referred to as “left front,” “left back,” “right front,” and “right back,” and an individual balance score is recorded for each of these sections. The position of the balance platform relative to the horizontal plane is represented by a cursor (red X) on the test screen. For each quadrant, the computer system measures the distance from the cursor to the reference position at every tenth of a second. The testing system generates seven different parametric data. The sum of the scores for each quadrant in a test period is recorded as the overall “balance index (BI) score.” This value reflects the person’s ability to keep the platform at or
Fig. 2. Assessment of static and dynamic balance with Kinesthetic Ability Trainer (KAT) 3000.

near the reference position. Balance index scores range from 0 to 6000 with lower values indicating better performance.

During static and dynamic balance testing, subjects were asked to maintain a bilateral stance to perform balance test with their eyes open while concentrating on the target at the eye level on a height-adjustable computer screen one meter in front of them. Three trials of testing, each lasting 30 seconds, with 10 seconds rest between trials, were performed. To ensure accuracy of the balance measurements, the KAT 3000 device was calibrated according to the manufacturer’s instructions (Fig. 2) [22].

2.3.1. Pain
A visual analog scale (VAS) was used to determine pain intensity. VAS is a 100 millimeter line with no marks along them, anchored with the words “no pain” on one hand, and “the most severe pain” on the other. Subjects were simply instructed to place a mark along the line at a level representing the intensity of their present pain when walking, ascending and descending stairs. Subjects were asked to walk a distance of 50-m in a straight hall then pain intensity when walking was evaluated with VAS. Subjects were also asked to ascend and descend standard 12 stairs while the pain intensity was rated with the VAS. The VAS has been reported as a valid measure for detection of clinical chance of pain in subjects with PFPS [4].

3. Statistical analysis
Normal distribution of the data was checked with Kolmogorov-Smirnov test. As the outcome measures were not normally distributed, non-parametric tests were used. Wilcoxon tests were used for the statistical analyses of comparing values before and 45-min after the application of KT and PKT; Mann-Whitney U tests were used for the statistical analyses of differences be-
tween groups at the end of applications. The level of significance was set at $p = 0.05$. The SPSS 15.0 was used for the statistical analyses.

4. Results

The descriptive characteristics of the subjects are shown in Table 1. Significant pre-post differences in strength at 60°/s ($p = 0.028$) and at 180°/s ($p = 0.012$), static ($p = 0.012$) and dynamic ($p = 0.046$) balance scores were indicated for the KT group (Table 2). There were also significant pre-post differences in strength at 60°/s ($p = 0.007$) and static balance scores ($p = 0.042$) for the PKT group (Table 2). No significant difference was found between groups regarding the intensity of pain during ascending and descending stairs and walking; quadriceps strength at 60 and 180°/s; static and dynamic balance scores and joint position senses (Table 3).

5. Discussion

The present findings indicate no significant difference between KT and PKT groups regarding proprioception, pain, balance and muscle strength in patients with PFPS. Even though case series and small pilot studies have previously reported improvements in function, pain, range of motion (ROM) and proprioception, some results indicate no benefit due to KT application, representing low level evidence [7,9,12,24,30]. Our results are partially consistent with previous reports showing that KT may have a positive effect on muscle strength and balance but this effect is significant in the KT application group before and 45-min after application. Results indicate no significant differences between the PKT and KT groups in proprioception, pain, balance and muscle strength. Specifically proprioception results do not concur with Murray and Hulsk [19] who have suggested that KT application enhanced proprioception. However, Halseth et al. [9] showed that KT application did not enhance proprioception in healthy subjects, which was similar to our results. Some researchers thought that adhesive taping increased proprioception by increasing feedback information from the muscle spindles, soft tissue and skin. We can only speculate that KT may not be enough to increase cutaneous sense to affect joint proprioception as KT covers less area and is less restrictive on the skin, resulting in lesser afferent stimulation compared to adhesive tape application. Furthermore, cutaneous mechanoreceptors may rapidly accommodate and thus would not provide useful feedback during repeated movements [9].

Several mechanisms may help explain the pain-relieving effect of therapeutic tape. Adhesive tape can improve patellar alignment in healthy controls and those with PFPS [18,28]. Therapeutic tape may ease pain by improving patellar alignment. Hinman et al. [10] and Cushnaghan et al. [3] demonstrated instant and daily pain reduction by taping application. Pain modulation via the gait control theory is another plausible explanation for such a change; as it could stimulate neuromuscular pathways via increased afferent feedback [17]. Worth mentioning, pain and functional measures were not different between groups in either our study or at Thelen et al.’s [24], in variance with other studies which have applied KT [6,29]. This lack of agreement could be due to a number of factors. Although some previous studies were only case serious and no control group, it was difficult to ascertain causation. Also some of our subjects reported lower initial function and VAS scores. These findings show that KT

### Table 1

Descriptive characteristics of the study subjects

<table>
<thead>
<tr>
<th>Characteristics of subjects</th>
<th>KT group ($n = 12$)</th>
<th>PKT group ($n = 10$)</th>
<th>Total</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Mean ± SD, year)</td>
<td>22.41 ± 1.62</td>
<td>26.20 ± 3.52</td>
<td>24.13 ± 3.22</td>
<td>0.014$^*$</td>
</tr>
<tr>
<td>BMI (Mean ± SD, kg/m²)</td>
<td>20.63 ± 2.26</td>
<td>21.86 ± 2.19</td>
<td>21.19 ± 2.26</td>
<td>0.069</td>
</tr>
<tr>
<td>Duration of Pain (Mean ± SD, month)</td>
<td>16.16 ± 9.68</td>
<td>13.70 ± 8.00</td>
<td>15.04 ± 8.83</td>
<td>0.812</td>
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<tr>
<td>PFPS Side, (n)</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Right</td>
<td>6</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>6</td>
<td>6</td>
<td></td>
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<tr>
<td>Total (n, %)</td>
<td>12 (% 54.5)</td>
<td>10 (% 45.5)</td>
<td>22 (% 100)</td>
<td></td>
</tr>
</tbody>
</table>

BMI: Body Mass Index.
PFPS: Patellofemoral Pain Syndrome.
KT: Kinesio® tape.
PKT: Placebo Kinesio tape.
$^*$ $p < 0.05$. 

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Table 2

Results before and 45 minutes after application of KT and PKT

<table>
<thead>
<tr>
<th></th>
<th>Pre: Minimum-Maximum</th>
<th>Pre-KT Mean ± SD</th>
<th>Post: Minimum-Maximum</th>
<th>Post-KT Mean ± SD</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KT</td>
<td>PKT</td>
<td>KT</td>
<td>PKT</td>
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<tr>
<td>Pain (VAS, mm)</td>
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<tr>
<td>Descending Stairs</td>
<td>10.00–80.00</td>
<td>10.00–80.00</td>
<td>50.41 ± 24.35</td>
<td>35.00 ± 21.21</td>
<td>0.096</td>
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<td></td>
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<td></td>
<td>0.00–70.00</td>
<td>10.00–80.00</td>
<td>0.157</td>
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<td></td>
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<td></td>
<td>46.25 ± 26.38</td>
<td>33.00 ± 21.62</td>
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<tr>
<td>Ascending Stairs</td>
<td>10.00–80.00</td>
<td>20.00–80.00</td>
<td>52.91 ± 20.27</td>
<td>50.00 ± 17.63</td>
<td>0.317</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>0.00–80.00</td>
<td>20.00–80.00</td>
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<td></td>
<td></td>
<td></td>
<td>51.25 ± 23.75</td>
<td>48.00 ± 16.86</td>
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<tr>
<td>Walking</td>
<td>00.00–70.00</td>
<td>10.00–70.00</td>
<td>42.50 ± 24.54</td>
<td>45.00 ± 23.21</td>
<td>0.655</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>0.00–70.00</td>
<td>10.00–70.00</td>
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<td></td>
<td></td>
<td>42.08 ± 23.88</td>
<td>41.00 ± 23.78</td>
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<tr>
<td>Strength (Peak Torque, Nm)</td>
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<tr>
<td>Q 60°/s</td>
<td>55.58–141.00</td>
<td>29.82–113.88</td>
<td>100.43 ± 26.20</td>
<td>74.97 ± 24.67</td>
<td>0.028</td>
</tr>
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<td></td>
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<td></td>
<td>61.01–150.49</td>
<td>35.25–113.88</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>106.64 ± 24.39</td>
<td>79.85 ± 25.55</td>
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<tr>
<td>Q 180°/s</td>
<td>16.26–113.88</td>
<td>25.76–73.21</td>
<td>70.04 ± 31.21</td>
<td>45.69 ± 15.83</td>
<td>0.012</td>
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<td></td>
<td></td>
<td></td>
<td>77.95 ± 28.78</td>
<td>50.30 ± 22.41</td>
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<tr>
<td>Static Balance Score</td>
<td>92.00–332.00</td>
<td>59.00–219.00</td>
<td>167.58 ± 80.05</td>
<td>148.40 ± 62.92</td>
<td>0.012</td>
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<td></td>
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<td></td>
<td>55.00–225.00</td>
<td>59.00–219.00</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>128.08 ± 52.44</td>
<td>139.40 ± 63.62</td>
<td></td>
</tr>
<tr>
<td>Dynamic Balance Score</td>
<td>1325.00–4459.00</td>
<td>1356.00–3047.00</td>
<td>2702.16 ± 1101.59</td>
<td>1912.30 ± 701.85</td>
<td>0.046</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>1325.00–4182.00</td>
<td>1356.00–3047.00</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>2428.41 ± 959.76</td>
<td>1834.90 ± 674.40</td>
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<tr>
<td>Joint Position Sense</td>
<td>−3.66–3.67</td>
<td>−3.66–5</td>
<td>0.17 ± 2.23</td>
<td>−0.260 ± 2.67</td>
<td>0.678</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>−3.66–2.67</td>
<td>−3–5</td>
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<td></td>
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<td>−0.05 ± 1.61</td>
<td>0.46 ± 2.34</td>
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</tbody>
</table>

VAS: Visual Analog Scale.
KT: Kinesio® tape.
PJT: Placebo Kinesio tape.
*P < 0.05.
Q = Quadriceps Muscle.
application may stimulate cutaneous receptors but not sufficient to decrease the pain unlike taping. As we mentioned above, KT application is not widely spread around the knee like taping.

Afferent stimulation by cutaneous mechanoreceptors could decrease pain and increase balance and facilitate motor activity [21]. There have been only a few publications in peer-reviewed literature on the effects of KT on motor activity recruitment. Murray [20] found that the elastic tape applied to the anterior thigh enhanced active ROM and increased surface electromyographic (EMG) activity of the quadriceps in two individuals with recent anterior cruciate ligament reconstructions in peer-reviewed literature on the effects of KT for decreasing pain or increasing joint position sense. Consequently, application of KT for decreasing pain or increasing joint position sense for PFPS does not constitute an effective treatment method when compared with PKT.

6. Conclusions

Other than a significant effect on quadriceps strength, this study failed to indicate improvements in pain, balance and joint position sense. Consequently, application of KT for decreasing pain or increasing joint position sense for PFPS does not constitute an effective treatment method when compared with PKT.

References

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