Effect of Patellar Taping on Quadriceps Muscle of Knee Joint

This study aims to examine the effect of patellar taping common to patients with patellofemoral pain syndrome on the change of knee joint location. The total number of participants is 12 patients with no pain in their knee. There are three different experiments: no-taping, placebo taping, and patellar taping. After application, they squat on their hams. As a result, both the muscle activity of vastus medialis and that of vastus lateralis increased in placebo taping compared to no-taping, which wasn’t statistically significant. However, the muscle activity of vastus medialis and that of vastus lateralis decreased in patellar taping compared to no-taping, which was statistically significant. This suggests that patellar taping causing the lateral attraction of knee joint is more influential to the dynamics of knee joint than skin afferent input in placebo taping. Therefore, patellar taping is effective to change the location of knee joint, affect the muscle activity of quadriceps muscle of thigh, and thus correct the misalignments of the knee joint.

Key words: Patellofemoral Pain Syndrome; McConell Taping; Quadriceps

INTRODUCTION

The pain appeared on the front or rear of the knee is a major symptom of patellofemoral pain syndrome regardless of age, and a common knee disease corresponding to 20–40% of all knee pains(1), 10–19% of all athletes have this disease and especially women experience this about 25% in their entire life(2). Patellofemoral pain syndrome has a risk of developing into chronic diseases such as chondromalacia or arthritis and so proper care and treatment is needed(3). The factors causing patellofemoral pain syndrome include misalignment of lower limb, imbalance of muscles, stiffness of lateral part, increase in Q-angle of quadriceps muscle, and overuse and abnormal movement of hip joint(4, 5) and it is associated with the hypofunction of patellofemoral joint(6). Particularly if there is an imbalance of quadriceps muscle of thigh and a shortening of the lateral support attached to the lateral side of knee joint, patellar is an occurrence of tilting to the lateral side in the knee joint, which is a common symptom of patellofemoral pain syndrome(7).

Vastus medialis and vastus lateralis of quadriceps muscles are countervailing to adjust the location of knee joint and finally enhance the dynamic efficiency in knee function(8). The tilting of knee joint to the lateral side prevents the stability of vastus medialis during the knee functional activity and changes the normal mechanism of knee extending, which brings about pathological changes of patellofemoral joint(9). To recover the mechanism of patellofemoral joint extending, locating an exact location of knee joint is important to increase the activity of vastus medialis and recover the start time, and more important to treat the patient with patellofemoral pain syndrome(10). The common treatments of patellofemoral pain syndrome include conservative physical therapy and taping to adjust the misalignment of lower limbs, strength of lower limbs, neuromuscular control training of quadriceps muscle of thigh, particularly vastus medialis and vastus lateralis.

A direct patellar taping is known to be effective to
patients with patellofemoral pain syndrome. It relocates knee joint, reduces the pressure and pain of patellofemoral joint, and finally improves the functional activity of knee(1). The representative way of patellar taping is McConell’s(12) method which induces medial attraction in the lateral attraction induced knee joint resulting from pathological cause to normalize the position of patellofemoral joint. At this time, inelastic tape is used to increase fixation, which is called McConell Taping. If we look at the application of patellar taping into the patients with patello-femoral pain syndrome, Evangelos(13) applied patellar taping to normal experimentee and patient with patellofemoral pain syndrome and used isokinetic measuring instrument to see how active the muscle activity of vastus medialis and that of vastus lateralis is in terms of knee angle.

As a result, the activity of vastus medialis increased, but that of vastus lateralis decreased in patients with patellofemoral pain syndrome. On the other hand, the activity of vastus medialis decreased, but that of vastus lateralis increased in normal person. In addition patellar taping was applied in 20 adults with patellofemoral pain syndrome: the perceived pain reduced by 13%. The muscle activity was measured at knee flexion angle of 120°, 90°, 60° and 0° and the vastus medialis and vastus lateralis ratio increased. Many several studies showed that patellar taping is effective to reduce pain, increase the muscular strength of quadriceps muscle of thigh(14), improve the neuromuscular mobilization, and correct the muscular contracture start time of vastus medialis against vastus lateralis(10).

The effect of patellar taping on patellofemoral pain syndrome is well-known from many studies, and the causes of increasing the activity of vastus medialis include reduction in pain, change of location in patellofemoral joint, and increase in skin afferent stimulation(15, 16). However, there is still few biomechanical researches on the effect of patellar taping. So this study aims to apply the patellar taping to the normal person who shows no pain to see the impact of squatting down on the activity of vastus medialis. Ultimately, it is to see if patellar taping is actually inducing medial attraction of patellofemoral joint and to which patellar taping is influential, proprioception of skin or correction of misalignment of patellofemoral joint.

METHODS

Subjects

The number of participants in this study is 12 healthy adults(6 males, 6 females) working in Hospital P in Daegu-si in November, 2011. The average age is 32.23±4.31years, height 168.55±7.85cm, and weight 65.74±13.72kg. After explaining about the purpose and content of this study prior to experiment to each and every participant, they are given a consent form. The requirement for experimental subjects are as follows:

First, they should be healthy male and female adults with no pain around the knee joint and no tenderness on pressure when in palpation.

Second, they should have no clicking in the knee when doing some sports activities or in everyday lives.

Third, they should have no difficulty in squatting down.

Fourth, they should be no history of knee, hip joint, ankle, and foot joint dysfunction.

Measurement

Experimental procedure

12 participants squat in the following three conditions: no-taping, placebo taping with no tilting of knee joint, and patellar taping with medial tilting of knee joint. In no-taping, they squat with no taping attached. In placebo taping, they are taped at the same place as patellar taping without inducing the medial attraction of knee joint. In patellar taping, McConell taping(12) is applied, the knee joint is pushed toward the inside to induce medial attraction, and then they are taped before they squat.

The advanced fixing tape(Endura–FIX, China) is attached to prevent the skin slipping and then non-elastic tape(Endura–FIX, China) is attached on it. A skilled physical therapist with more than 10 years of experiences helped to tape it.

When squatting down, their two foot angle is 120° on the basis of their shoulder(17), their two arms folded in the front, and trunk stood up to avoid lumbar flexion. For the knee angle, a semi-squatting posture is adopted as it is widely common to patients with patellofemoral pain syndrome: 50° angle(8). Before exercise, 50° is measured and then a bar is installed so that each participants can participate in the experiment at the same angle. For the order of exercise, the order is distributed randomly by drawing cuts. When doing each movement, they should
keep for 5 sec and rest for 30 sec, which is repeated three times. After exercise, tape is replaced by another one. And then they squat in another condition (Fig. 1).

![Fig. 1. EMG electrode attachment](image)

**EMG and data processing**

For data collection, EMG Myosystem 1200 (Noraxon Inc., USA) System (Fig. 2) is used to measure the muscle activity of vastus medialis and vastus lateralis according to the taping. The attachment location of vastus medialis is 55° in a vertical line from the upper and inner point of the knee joint: 4 cm upper and 3 cm inner from the knee joint. That of vastus lateralis is 15° from the upper line of knee: 10 cm upper and 6–8 cm outer. The distance between electrodes is constant at 2 cm intervals. The single reference electrode is attached to knee joint. Before electrode attachment, skin is cleaned with an alcohol swab and shaved to reduce the skin resistance to less than 5 kΩ (10). To obtain the maximum torque of each muscle, MVIC (maximal voluntary isometric contraction) of vastus medialis and vastus lateralis is obtained at 60° knee joint in the squatting posture (18). In the analysis of muscle activity, MVIC is measured with the RMS (root mean square) measured when contracting for 5 sec from the knee muscle strength test (19). After measuring each muscle activity in three different taping conditions, it is regarded as RMS and then each muscle activity for 3 sec in the middle is converted into a percentage (%MVICRMS) as in the below. And the ratio between vastus medialis and vastus lateralis is calculated with normalized muscle activity value in each and different taping condition.

![Fig. 2. EMG Myosystem 1200 (Noraxon Inc., USA)](image)

**Data Analysis**

All measures from this experiment are statistically treated by SPSS ver 18.0. One-way repeated measured ANOVA is used to see if there is a difference between the measured muscle activity of vastus medialis and vastus lateralis and the ratio between the measured vastus medialis and vastus lateralis in three different conditions: no taping, patellar taping, and placebo taping. In post-test for the significant difference, pair-comparison is conducted with Bonferroni’s correction. The significant level for statistical significance testing is at α=0.05.

**RESULTS**

The average muscle activity of vastus medialis is 23.51±12.73% in no taping, 21.20±12.32% in patellar taping, and 23.72±14.91% in placebo taping. The average muscle activity of vastus lateralis is 20.47±10.34% in no taping, 18.86±10.47% in patellar taping, and 20.71±11.91% in placebo taping. The activity ratio between vastus medialis and vastus lateralis is 1.16±0.48% in no taping, 1.06±0.39% in McConell taping, and 1.30±0.50% in placebo taping.

In the comparison of the muscle activity between vastus medialis and vastus lateralis, the activity is significantly reduced in patellar taping (p<0.05). Also, in the comparison of the activity ratio between vastus medialis and vastus lateralis, the activity is significantly reduced in patellar taping (p<0.05). On the other hand, placebo taping is not statistically significant.
in the muscle activity between vastus medialis and vastus lateralis and the activity ratio between vastus medialis and vastus lateralis(p<0.05)(Table 1)(Fig, 3).

Table 1. The normalized EMG value for the vastus medialis & lateralis muscle(3\% MVC)

<table>
<thead>
<tr>
<th>Variables</th>
<th>No taping</th>
<th>Patellar taping</th>
<th>Placebo taping</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMed</td>
<td>23.51±12.73</td>
<td>21.20±12.32</td>
<td>23.72±14.91</td>
</tr>
<tr>
<td>VLat</td>
<td>20.47±10.34</td>
<td>18.86±10.47</td>
<td>20.71±11.91</td>
</tr>
<tr>
<td>VMed/VLat ratio</td>
<td>1.16:1</td>
<td>1.06:1</td>
<td>1.30:1</td>
</tr>
</tbody>
</table>

Value : Mean(SD)
VMed : vastus medialis activity
VLat : vastus lateralis activity
VMed/VLat : activity ratio between vastus medialis and vastus lateralis

Fig. 3. The Normalized EMG data for vastus medialis(VMed), vastus taping conditions, lateralis(VLat) while performing three

* p<0.05

DISCUSSION

The tilting of patellofemoral joint is caused by the imbalance of quadriceps muscle of thigh, especially vastus medialis and vastus lateralis. The shortening of the lateral support causes the increase or decrease relatively at vastus medialis and so does not contribute to the dynamic medial stabilization(a major action of vastus medialis), thus resulting in abnormal movement of knee joint(20). In patellar taping, the use of inelastic tape is known to be effective to induce the medial attraction of lateral tilting knee joint, reduce pain with fixation, affect the functional activity, and change the start time of vastus medialis associated with vastus lateralis and reeducate the nerve root(21). Scientific hypotheses on the effect of patellar taping include suppression of pain(22), change of muscle mobilization order of quadriceps muscle of thigh associated with the start time of vastus medialis and vastus lateralis(23), increase in knee joint attraction caused by relocation of knee joint(12, 24), and increase in skin stimulation of tape(16).

In this study, normal people with no pain participate in the experiment. Their pain is excluded and taping is attached to the patellofemoral joint with normal alignment to see what is happening and support the hypothesis that taping probably induces the increase of knee joint attraction. After patellar taping to normal people, they squat. The findings are that vastus medialis has the highest activity in placebo taping, followed by no-taping, patellar taping and that the higher activity between vastus medialis and vastus lateralis indicates that patellar taping may reduce the muscle activity: the values are significant. To see the similar previous studies to this founding, Herrington(15) reported that mean quadriceps concentric isokinetic peak torque was 52.6Nm and mean single hop distance was 1.18m for the un-taped conditions. Mean quadriceps concentric isokinetic peak torque was 52.5Nm and mean single hop distance was 1.15m for the taped condition. Asymptomatic female subjects following taping of the patella were found to have decreased knee extensor strength and functional performance. After patellar taping to normal people, the muscle activity of vastus medialis and vastus lateralis when stepping on stairs showed that no taping group showed the highest muscle activity in both vastus medialis and vastus lateralis(25). There is a difference in each study, but patellar taping is proved to be negatively affected in the functional aspect and muscle activity aspect if applied to the knee joint of normal people. The opposite effect of patellar taping in patients with or without symptoms suggests that taping is dynamically changing the causes of symptoms in the functional activity of lower limbs. The important point of dynamical factor is the change of location of knee joint, which causes the change in muscle length–tension relationship and quadriceps muscle of thigh lever arm. Also, the change of location of knee joint changes the compression of patellofemoral joint surface and reduces the stress in articular surface as well(25).

In this study, it is not statistically significant, but the muscle activity of vastus medialis and the activity ratio between vastus medialis and vastus lateralis
increases numerically in placebo taping group compared to no-taping group. In previous study, the application of patellar taping to patients with patellofemoral pain syndrome (not to normal people) increased the muscle activity of vastus medialis, which was explained by skin afferent input (16). The result seems to be that taping promotes the tendon origin of vastus medialis and then afferent input is stimulated, and thus the increase of stimulation of α-motor neuron source increases the muscle activity. In conflicting study, the muscle activity in healthy women rather decreased in placebo taping, and seen from the fact that the pressure of knee joint is the highest in placebo taping, strong compression prevented the movement of knee joint, which indicates that it is different from this study (13).

This study is conducted in 12 healthy adults in the late 20s and early 30s, has problems of not considering age variable and limitations in generalizing the finding due to the limited number of subjects. Also, participants couldn’t take the same posture due to physical differences between individuals. More sophisticated equipment and optimal laboratory and apparatus are required and above problems should be supplemented.

CONCLUSION

In this study, patella taping which is commonly used to patient with patellofemoral pain syndrome is applied to normal people to compare the muscle activity between vastus medialis and vastus lateralis and activity ratio between them after squatting. This result showed that the muscle activity of vastus medialis and vastus lateralis and the muscle activity ratio between them increased in placebo taping than no taping, which was not statistically significant. On the contrary, the muscle activity of vastus medialis and vastus lateralis and the muscle activity ratio between them decreased at a statistically significant level in patellar taping than no-taping. This suggests that patellar taping shows afferent input effect touched with skin, but rather change of the location of knee joint changes the dynamics of knee joint when extending or flexing knee, which again is influential to the improved muscle balance between vastus medialis and vastus lateralis. Therefore, patellar taping is an effective treatment to change the knee joint location and considered to be effective for patients with knee joint misalignment.

REFERENCES


