The Influence of Iliotibial Tract on Patellar Tracking
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Chun-Hsiung Shih, MD†

Abstract

Thirty patients with 49 snapping hips and patellar malalignment underwent surgical release of the iliotibial tract contracture over the trochanteric area. Minimal follow-up was 2 years (average 4.6 years, range: 2-9 years). Eight patients underwent computed tomography (CT) preoperatively and 1 month postoperatively to investigate the patellar location in the patellofemoral articulation with knee bending at 0°, 20°, 45°, 60°, and 90°. Significant improvements in the congruence angle and lateral patellofemoral angle were noted on Merchant radiograph for all knees (P<.01). On CT, at 20° and 45° knee bending, all congruence, lateral patellofemoral, and patellar tilt angles significantly improved postoperatively in 8 knees (P<.01). Iliotibial tract affects patellar tracking and dominates lateral patellar supporting structures.

Anterior knee pain is common in orthopedics and patellar malalignment is a common disorder that causes this pain.1-10 The cause of patellar malalignment has been investigated and predisposing factors include an abnormal patellofemoral articulation, abnormal lower extremity alignment, and abnormal patellar supporting structures.11-13 Patellar tracking is most commonly affected by abnormal patellar supporting structures.11-13 Patellar malalignment usually occurs as lateral tilting or lateral patellar subluxation, which is due to weakened medial soft tissues or tight lateral soft tissues around the patella.7,14,15 Iliotibial tract also affects patellar tracking.1,16-19 However, its role and importance regarding lateral patellar supporting structures have not yet been defined.

Snapping hip, an uncommon disorder, is caused by iliotibial tract contracture (external type).20-23 Snapping hip usually is diagnosed because of discomfort or snapping in the upper thigh. The senior author (C.-C.W.) created a hypothesis that iliotibial tract contracture may cause external snapping hip and patellar malalignment. Therefore, treatment of such a contracture could concomitantly correct both disorders. If so, the importance of the iliotibial tract related to patellar tracking could be assessed.

To test this hypothesis, a prospective study was performed. A pilot clinical study investigated the validity of the concept and computed tomography (CT) was supplemented to test the hypothesis.

MATERIALS AND METHODS

Pilot Study

From February 1993 to July 2000, all consecutive patients (aged <40 years) who presented to the senior author’s (C.-C.W.) orthopedic outpatient department due to patellofemoral pain syndrome were routinely examined regardless of the presence or absence of snapping hip.22,24-25 The clinical features of patellofemoral pain syndrome included aggravated anterior knee pain during stair climbing, knee soreness after prolonged sitting, and positive grinding tenderness in the patellofemoral joint.7,19,26-28 When external snapping hip was combined in the ipsilateral knee, anteroposterior (AP) pelvic, AP and lateral knee, and Merchant tangential view radiographs were obtained.23

Patients who had both clinical disorders, malaligned patella on the Merchant view, and normal patellofemoral articulation and lower extremity alignment on plain radiograph were candidates for surgical release of the iliotibial tract contracture. Patients who had patellofemoral pain syndrome and snapping hip but no malaligned patellae on the Merchant radiograph were excluded due to the inability to objectively evaluate the improvement quantitatively.

The 7-year pilot study included 37 patients and 60 hips. Average patient age was 28 years (range: 21-35 years) with a 1:2 male to female ratio. Twenty-three patients had bilateral disorders and 14
unilateral. Duration of anterior knee pain was intermittent for several months to several years. Conservative treatment did not improve pain. Trochanteric area soreness was noted in 22 hips, with several months’ to several years’ intermittent duration.

No abnormal patellofemoral articulations or lower extremity malalignments were noted in these patients. Twenty-six knees had lateral patellar subluxation and 34 knees had simple lateral patellar tilting. In this study, patellar malalignment was defined as lateral patellar subluxation with an abnormal congruence angle (>0°)²⁰,²¹ and lateral patellar tilting with a normal congruence angle but abnormal lateral patellofemoral angle (<0°)²⁰,²³,²⁴

Operative Technique

Under spinal anesthesia, patients were placed in the supine position with the affected hip elevated. With the hip in full flexion and adduction, a 2-cm skin incision was made longitudinally along the posterior border of the femur, just distal to the greater trochanter. The skin was extracted and the underlying fascia was exposed. The fascia was transversely dissected with a scalpel from the posterior toward the anterior aspect of the thigh. The hip was gradually extended, allowing the contracted fascia to slide backward. Dissection continued until all snapping resolved.

With index finger palpation, only involved contracted soft tissues were released. Contracted soft tissues that did not contribute to the snapping hip were preserved without release. The hip was tested in adduction-flexion to adduction-extension and back and forth to ensure complete release. After hemostasis was achieved, the wound was closed with absorbable sutures. A closed drain was inserted according to the amount of bleeding.²⁵

Postoperatively, patients were permitted to ambulate without aids as early as possible. Daily activity was increased as tolerated. Patients underwent 1-month, 6-month, 1-year, and annual follow-up. Clinical features and Merchant radio-graphs were recorded. Quadriceps strengthening and hamstring stretching exercises were encouraged.

Knee function was evaluated using Micheli’s grading and four grades were divided. A satisfactory result included an excellent or good outcome.¹⁸ Patellar tracking was evaluated by congruence angle and lateral patellofemoral angle.

Computed Tomography Study

From August 1998 to July 2000, all consecutive new patients were examined with CT (HiSpeed Advantage; GE Medical Systems, Milwaukee, Wis) over the upper, middle, and lower patella with knee bending at 0°, 20°, 45°, 60°, and 90°.

Eight patients were included in this study. Average patient age was 29 years (range: 22-34 years) with a 1.2 male to female ratio. All patients had bilateral disorders, and no abnormal patellofemoral articulation or lower extremity malalignment was noted.

Computed tomography was obtained preoperatively and 1 month postoperatively. Further CT could not be obtained due to monetary expense. Consequently, only a Merchant radiograph was regularly taken at follow-up. Daily activity was not restricted postoperatively.

Patellar location in the patellofemoral articulation was investigated. The best (clearest) of three scans over different levels of the patella was chosen. In addition to the congruence and lateral patellofemoral angles, patellar tilt angle also was measured. Patellar lateral subluxation was determined by congruence angle and patellar lateral tilting, lateral patellofemoral, or patellar tilt angles (<8°).²⁶

Statistical Analysis

In the pilot study, knee function improvement was evaluated using Fisher’s exact test and change of congruence angle and lateral patellofemoral angle was evaluated using two-tailed paired Student’s \( t \) test. \( P<.05 \) was considered statistically significant.

The correlation of lateral patellofemoral angle and patellar tilt angle was evaluated using Pearson correlation coefficient (r).

RESULTS

Pilot Study

Thirty patients with 49 knees underwent minimum 2-year follow-up (average, 4.6 years; range: 2-9 years). Knee function improved in 41 knees (P<.001). Seven patients could not be contacted. Congruence angle improved from \( 8°±9.6° \) to \( 1.6°±7.8° \) (P=0.004). Lateral patellofemoral angle improved from \( -1.3°±5.8° \) to \( 7.5°±4.9° \) (P<.001) (Figure 1).

No wound infection or other complications were noted.

Computed Tomography Study

All 8 patients (16 knees) underwent CT. Preoperatively, patellae were laterally subluxed (congruence angle >0°) with 0°, 20°, or 45° knee bending (Table 1). However, because the femoral articular surface was partly blurred, patellar location could not be measured with 60° or 90° knee bending.

One month postoperatively, patellar subluxation was not significantly improved with 0° knee bending. However, significant improvement was noted with 20° and 45° knee bending (P<.01), and the laterally subluxed patellae had been reduced to normal location (Figure 2).

With 0° knee bending, lateral patellofemoral angle and patellar tilt angle was positive pre- and postoperatively. The improvement was not significantly significant.

With 20° knee bending, lateral patellofemoral angle was negative preoperatively and improved postoperatively (P<.01). Patellar tilt angle was positive preoperatively and significantly improved postoperatively (P<.01).

With 45° knee bending, lateral patellofemoral angle and patellar tilt angle, and patellar tilt angle was evaluated using two-tailed paired Student’s \( t \) test. \( P<.05 \) was considered statistically significant.

The correlation of lateral patellofemoral angle and patellar tilt angle was evaluated using Pearson correlation coefficient (r).
Iliotibial Tract With Patellar Tracking

WU & SHIH

external snapping hip. Therefore, iliopatellar ligament and lateral retinaculum. The definite role and importance of the iliotibial tract for lateral patellar supporting structures have not yet been defined. Under common circumstances, directly dividing the iliotibial tract to test the traction effect is impractical. In this prospective study, releasing the iliotibial tract contracture to treat snapping hip also corrected patellar tilt angle was high (0.90<r<1) pre- and postoperatively (Table 2).

No wound infection or other complications were noted.

DISCUSSION

The anatomy of lateral patellar supporting structures has been described and the iliotibial tract does not directly contact the lateral patellar edge.33-37 The connection between the iliotibial tract and lateral patellar edge includes the iliopatellar ligament and lateral retinaculum. The definite role and importance of the iliotibial tract for lateral patellar supporting structures have not yet been defined. Under common circumstances, directly dividing the iliotibial tract to test the traction effect is impractical. In this prospective study, releasing the iliotibial tract contracture to treat snapping hip also corrected malaligned patella, which proves that the iliotibial tract dominates lateral patellar supporting structures.

Although snapping hip is uncommon, its cause has been studied in detail. Despite the fact that it can be internal or external, the latter is more common. Moreover, the most common cause is iliotibial tract contracture. Contracture of the anterior gluteal fascia also causes external snapping hip.20-25,38 Therefore, when external snapping hip is treated, the incision wound should be proximal to the insertion of the gluteus maximus. In this study, the approach wound is just distal to the greater trochanter.25

Lateral retinacular release also is performed for patellar malalignment, with a reported success rate between 63% and 100%.5,12,17,18,39-41 Theoretically, the effect of iliotibial tract release should be less than lateral retinaculum release, as the majority of lateral patellar supporting structures are divided in the latter. Although CT investigation of the patellar location in the patellofemoral articulation after lateral retinacular release has not yet been reported, significant improvement of the congruence angle has been reported using Merchant tangential radiographs.41 In this study, release of the contracted iliotibial tract resulted in an excellent result.

Patellar malalignment usually is treated nonoperatively initially with a reported success rate as high as 90%.2,7,8,18,26-44 However, when patellar malalignment is associated with snapping hip, theoretically, conservative methods are of no avail. Although muscle power can be enforced by strengthening exercise, the strength of the vastus medialis does not surpass the traction power provided by the contracted iliotibial tract. In other words, when both disorders are present, surgical correction is more practical. In this study, release of the iliotibial tract contracture in the trochanteric area was effective. It is unnecessary to treat both disorders at two different areas, which may result in complications.17,39-41

Traditionally, patellofemoral pain syndrome is diagnosed by clinical features.4,7,45 Compared with CT or magnetic resonance imaging, the Laurin (20° knee bending) and Merchant (45° knee bending) views are considered unreliable when detecting patellar loca-

**TABLE 1**

<table>
<thead>
<tr>
<th>Knee Bending Measurement</th>
<th>Preoperatively</th>
<th>Postoperatively</th>
<th>P Value</th>
</tr>
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<tbody>
<tr>
<td>0°</td>
<td>26.5±18.4/14±21.8</td>
<td>10.3±17.1/10.4±7.9</td>
<td>.048/33</td>
</tr>
<tr>
<td>Lateral patellofemoral angle</td>
<td>4.2±4.2/5±3.8</td>
<td>6.5±4.9/5.6±4.2</td>
<td>.11/38</td>
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<tr>
<td>Patellar tilt angle</td>
<td>8.8±4.4/10±3.8</td>
<td>11.9±4.6/12.5±2.7</td>
<td>.07/052</td>
</tr>
<tr>
<td>20°</td>
<td>5±9.7/6.8±7.9</td>
<td>-11.5±14.6/-8.6±7</td>
<td>.002/001</td>
</tr>
<tr>
<td>Lateral patellofemoral angle</td>
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<td>8.1±4.6/9.4±3.2</td>
<td>.003/008</td>
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<tr>
<td>Patellar tilt angle</td>
<td>5±3.8/6.6±6.9</td>
<td>13.1±4.6/14±3.2</td>
<td>.007/02</td>
</tr>
<tr>
<td>45°</td>
<td>5.8±6.2/4.8±10.8</td>
<td>-10.6±9.4/-6.9±4.9</td>
<td>.002/01</td>
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<tr>
<td>Lateral patellofemoral angle</td>
<td>2.5±2.7/1.9±7.7</td>
<td>11.3±3.5/13.1±2.6</td>
<td>.001/003</td>
</tr>
<tr>
<td>Patellar tilt angle</td>
<td>8.1±3.7/7.5±6.5</td>
<td>15.6±3.2/17.9±2.5</td>
<td>.003/003</td>
</tr>
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</table>

*Represented as right side/left side.
tion in various angles.\textsuperscript{45-48} However, on the contrary, in this study, 20° and 45° knee bending provided excellent views to evaluate the postoperative results.

With knee extension (0° bending), surgical correction does not significantly alter patellar location. However, in some cases, the subluxed patellae can be reduced to normal location (Figure 2). The assumption is that in these cases, iliotibial tract contracture is so severe that the tension of the resting vastus medialis fails to maintain peripatellar soft-tissue balance. Once the contracture is released, the balance among the resting muscles is recovered. In some cases, less severe iliotibial tract contracture does not significantly alter patellar location postoperatively. A significant improvement in patellar location is only demonstrated postoperatively when the knee is flexed to further stretch the iliotibial tract.

In this study, some patients with patellofemoral pain syndrome and snapping hip were excluded because Merchant radiograph did not reveal patellar malalignment. In these patients, altered patellar location could not be evaluated by plain radiograph. Series CT is effective; however, it is costly.

Clinically, the criteria used to classify patellar malalignment have not been consistent.\textsuperscript{10,28,29,47-50} Roughly classifying patellar malalignment as dislocation, subluxation, or tilting (excessive lateral compression) precludes evaluation of true improvement pre- and postoperatively. Quantitative measurement with congruence angle, lateral patellofemoral angle, and patellar tilt angle has proven effective in this study.

Lateral patellofemoral angle and patellar tilt angle are useful in evaluating patellar lateral tilting. Because the correlation coefficient is high (0.90<r<1), either can be used for clinical evaluation.

The operative results in this study are better than those of patellar malalignment treated with lateral patellar retinacular release.\textsuperscript{3,12,18,39} In the present study, patients were relatively younger (age range: 21-35 years) and degenerative knee change was less likely. Patients
TABLE 2
Correlation Coefficient (r) for Lateral Patellofemoral Angle and Patellar Tilt Angle

<table>
<thead>
<tr>
<th>Knee Bending Preoperatively Postoperatively</th>
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<tbody>
<tr>
<td>0°</td>
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<tr>
<td>20°</td>
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<td>45°</td>
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<tr>
<td>0°</td>
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<td>20°</td>
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<tr>
<td>45°</td>
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</table>

reported in the literature comprise a wider age group, and their knees usually had osteoarthritis as well.5, 7, 41, 44

From a biomechanical standpoint, the iliotibial tract provides the tension band effect for the hip and knee. If this fascia is completely released, both joints will sustain 2-4 times of additional load and degenerative joint diseases may develop earlier.51 In this study, releasing contracted fascia only limited to areas that produce snapping hip may preserve the tension band function to some extent. The long-term effect on patellofemoral and tibiofemoral articulations requires continuous investigation.

REFERENCES

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