Arthroscopic Suture Fixation for Avulsion Fracture of the Tibial Attachment of the Posterior Cruciate Ligament: 6- to 8-Year Follow-up Results

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Introduction

• The motorcycle population density of Asia is the greatest in the world.
• Thus, motorcycle-related injury is very common in Asia.

Rare PCL avulsion fractures?

• In Asia, where motorcycles are numerous and motorcycle-related injuries are frequent, PCL injuries are not infrequently seen.

The Mechanism of PCL avulsion fracture

1. Dashboard injury
2. Hyperflexion with a downward force applied over the femur
3. Hyperextension of the knee joint
4. Posterior rotational injury of the knee

Treatment Options

• Fragment non-displacement
  – Casting
• Fragment displacement
  – ORIF: high morbidities and disadvantages
  – ABRF: preferred treatment recently

ORIF


ORSF Complications

Why using ARSF for PCL avulsion fracture?

ARSF: Arthroscopic Reduction and Suture Fixation

Advantages of ARSF for PCL avulsion Fractures
• Provides direct visualization of the intraarticular fracture
• More accurate reduction of the fracture
• Decreased morbidity compared with open exposure or arthrotomy
• Facilitates diagnosis and treatment of meniscal and ligamentous injuries

Purpose
• This study prospectively evaluated 36 patients treated consecutively to determine patient outcome efficacy and complication potential of Arthroscopic Reduction and Suture Fixation (ARSF) using four-strand No. 5 Ethibond sutures to treat tibial attachment fractures of PCL at 6-8 year follow-up.

Hypothesis
• The hypothesis of the study is that arthroscopic suture fixation using four-strand No.5 Ethibond sutures to treat PCL avulsion fracture can restore PCL length, stabilize fragments, promote early motion and minimize morbidity.

Materials and Methods
• 36 patients (M:F = 24:12) with image proof PCL avulsion fracture in tibial attachment
• Motorcycle accidents (32 cases)
• Sports injury (4 case)
Materials and Methods

- Average time from injury to operation
  - 15 days (2 to 30 days)
- Mean age at operation
  - 35 years old (18 to 61 years old)
- The average follow-up period
  - 84 months (range, 72 to 96)
- The average hospital day
  - 3.2 days (3 to 4 days)
- The fragmentation size around 10-32 mm in longest diameter

According to our modified Meyers and McKeever classification

- Four (11.7%) of 36 patients were diagnosed to have type II fractures in this study.
- 25 (70.6%) were type III fractures
- 7 (17.6%) were type IV fractures.
  - Completely displaced fragmentation (Type III) is the most common type.

Assessment

- Lysholm knee score
- Tegner activity score
- International Knee Documentation Committee (IKDC) score
- KT-1000 arthrometer
- Radiographic evaluation

Diagnosis

- History
- Physical examination
- Image study

Surgical Technique

- General anesthesia
- Supine position with a thigh holder
- Standard PCL reconstruction instrument
- Portal: AM / AL / PM high and low / PL portal
- Fixation: four-strand No.5 Ethibond pull-out suture

Classification of PCL avulsion fracture

- Meyers and McKeever classification for ACL avulsion fracture
Case Presentation

Preop displaced PCL fracture

Postop mini-wounds

Healed PCL fragment

Post-OP Rehabilitation Protocol

- Knee functional ROM brace protection
- First post-op week
  - full weight-bear, isometric straight-leg raise
- Week 2 to 4
  - 0~60 degree ROM in flexion
- Week 4 to 8
  - 0~120 degree flexion, closed-chain kinetics exercise
- Over 2 months
  - stationary bicycling

Result

- All 36 cases achieved osseous union or stable fibrous union at final follow up.
- Complication
  - No major complication, such as neurovascular injury, loss fixation or wound infection

Return to Sports: 6 months postoperatively!
**Lysholm knee score**

<table>
<thead>
<tr>
<th>Lysholm Knee Score</th>
<th>Preoperative</th>
<th>Final follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent (95-100)</td>
<td>0</td>
<td>26</td>
</tr>
<tr>
<td>Good (84-94)</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Fair (65-83)</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>Poor (&lt;65)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mean</td>
<td>26</td>
<td>0</td>
</tr>
<tr>
<td>Range</td>
<td>26-66</td>
<td>0-100</td>
</tr>
</tbody>
</table>

* p<0.05 (Mann-Whitney U test)

**Tegner activity score**

<table>
<thead>
<tr>
<th>Tegner activity level</th>
<th>Preoperative</th>
<th>Final follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 3</td>
<td>36</td>
<td>9</td>
</tr>
<tr>
<td>4 to 6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7 to 10</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Mean</td>
<td>0.5</td>
<td>4.8*</td>
</tr>
<tr>
<td>Range</td>
<td>0-2</td>
<td>2-7</td>
</tr>
</tbody>
</table>

* p<0.05 (Mann-Whitney U test)

**IKDC score**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Preoperative</th>
<th>Final follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (normal)</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>B (nearly normal)</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>C (abnormal)</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>D (severely abnormal)</td>
<td>28</td>
<td>0</td>
</tr>
</tbody>
</table>

* p<0.05 (chi-square test) for final rating in the normal to nearly normal groups against the abnormal to severely abnormal rating

**KT-1000 Arthrometer**

- **Final follow-up:**
  - mean side-to-side difference:
    - 0-2 mm: 34 (94.6%)
    - 3-5 mm: 2 (5.6%)
  - The mean difference at final follow-up was 0.8 mm (range, 0–3 mm).
  - There was no statistically significant difference in the postoperative KT-1000 scores, in comparison with the contralateral uninjured limb data (P > 0.05).

**Radiographic Assessment**

- Three (8%) patients showed stage I degeneration, according to Ahlback classification at 6-8 year follow up.

**Associated Soft-Tissue Injuries**

<table>
<thead>
<tr>
<th>Soft-Tissue Pathology</th>
<th>No. of Injuries</th>
<th>Treatment Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral meniscus tear</td>
<td>2/9%</td>
<td>Partial meniscectomy</td>
</tr>
<tr>
<td>Medial meniscus tear</td>
<td>1/9%</td>
<td>Partial meniscectomy</td>
</tr>
<tr>
<td>Patellar tear</td>
<td>2/9%</td>
<td>Crural suture</td>
</tr>
<tr>
<td>LCL</td>
<td>2/9%</td>
<td>Scorpio fixation</td>
</tr>
</tbody>
</table>

*Abbreviations: LCL, lateral collateral ligament; MCL, medial collateral ligament.*
PCL Avulsion Fracture
Arthroscopic Suture Fixation for Avulsion Fractures in the Tibial Attachment of the Posterior Cruciate Ligament
Szu-Yuan Chen, M.D., Chun-Ying Cheng, M.D., Shib-Sheng Chang, M.D., Min-Chin Tsai, M.D., Chia-Hao Chiu, M.D., Aliun Chau-Yu Chen, M.D., and Wey-Yung Chiu, M.D.

Corresponding author

Discussion

• Meyers JBJS Am 1975
  — Five displaced avulsion fractures of PCL that were treated non-operatively did not unite
  — Early repair of even minimally displaced fracture

• Martinez-Moreno and Blanco-Blanco Clin Orthop 1988
  — experimental percutaneous fixation of PCL fragments in 8 cadaveric knees under arthroscopic control

• Littlejohn and Geissler Arthroscopy 1995
  — first percutaneous fixation in a human knee with 3 cannulated screws.

Mechanical Comparision of Open Screw Fixation Versus Arthroscopic Suture Fixation

• One bicortical 4.5mm screw and washer in screw group, Kim method in suture fixation group
• No differences between two groups in terms of posterior displacement

Sasaki et al. Arthroscopy 2007

Discussion

• Jinzhong Zhao Arthroscopy 2006
  — suture fixation through Y-shaped bone tunnel

• Jianchao Gui Arthroscopy 2009
  — single tunnel suture fixation of PCL avulsion fracture

  Arthroscopic fixation of an avulsion fracture of the tibia involving the posterior cruciate ligament: a modified technique in a series of 22 cases.
In My Study

- In this study no significant complications were noted.
- Use of multiple No. 5 Ethibond sutures allows precise repair of bony fragments, provides consistent fixation strength throughout the fixation site, and allows early.

Results & Conclusion

- The arthroscopic group also reported 100% return to preinjury level of activity, compared with 86.2% in the open group.
- The most common complication in both groups was arthrofibrosis, which was reported more often in the arthroscopic group (0%-35%) versus the open treatment group (0%-25%).

Management of Posterior Cruciate Ligament Tibial Avulsion Injuries

A Systematic Review

Park C, Hooper II, DO; Chris Silko, DO; Tenison L, Malcolm, MD, and Lafal D, Farow, MD

- 1975 to present outlining open versus arthroscopic surgical repair of PCL bony avulsion injuries and comparing subjective and objective ostoperative patient-reported outcomes, including Tegner, IKDC (International Knee Documentation Committee), and Lysholm scoring systems, as well as rates of patient complications.

Results & Conclusion

- In patients with displaced tibial-sided PCL avulsion fractures treated operatively, surgical approaches render similar outcomes and risks.
- While the arthroscopic group had somewhat higher subjective and objective knee outcome scores, it demonstrated a slightly higher rate of arthrofibrosis.
- The clear advantage of the arthroscopic approach is that concomitant intraarticular injuries seen on preoperative magnetic resonance imaging, such as meniscal tears or osteochondral loose fragments, can be addressed at the time of the index operation.
Operative technique presented advantages (I)

- The suture fixation technique requires no further surgery for implant removal.
- Second, the 4 No. 5 Ethibond intraligamentous sutures were sewn into the PCL base rather than into the avulsed bone; thus, reduction and fixation of even comminuted fractures can be performed easily.

Operative technique presented advantages (II)

- Suture fixation is superior to screw fixation for treating avulsion fractures of the PCL because screw fixation may potentially break the bone fragment.
- Moreover, multiple sutures can be used for precise repair of bone fragments.
- It not only decreases surgical morbidities and patient discomfort but also reduces overall cost.

Significance of the findings

Advantages of ARSF for PCL fractures:
- Mini-invasive approach, decrease complication rate
- Less post-operative pain
- Short hospital stay
- Rigid fixation
- Avoidance second operation for fixator removal
- Early knee motion and aggressive rehabilitation
- Early return to sports activity

Disadvantages:
- Learning curve
- Technical demanding

Conclusion

- Treating PCL avulsion fracture by arthroscopic suture fixation using four-strand No.5 Ethibond sutures can restore PCL length, stabilize fragments, promote early motion and minimize morbidity.
Thanks for your Attention!!