Posteromedial Versus Direct Posterior Approach for Posterior Cruciate Ligament Reinsertion

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**Abstract:** Avulsion fractures of the posterior cruciate ligament (PCL) are usually found in pediatric populations. This study investigated which of 2 approaches—posteromedial or direct posterior—enables easier PCL reinsertion. Ten fresh cadavers were studied using direct posterior (10 knees) and posteromedial (10 knees) approaches. In both, a guidewire was inserted into the tibial insertion of the PCL as perpendicular as possible to the coronal knee axis. Then, the angle between the guidewire and the horizontal plane of the table was measured. The mean angle of the guidewire was 8.6° (SD=7.3°) with the direct posterior approach and 36.6° (SD=14.3°) with the posteromedial approach (P=.005). The direct posterior approach allows a greater degree of freedom compared with the posteromedial approach to reach the PCL tibial insertion.


Despite controversy regarding the natural history and protocol for treatment of posterior cruciate ligament (PCL) injuries, there is a consensus that injuries by bone avulsion in the tibia should be treated by surgical repair in the acute phase. However, orthopedists have a wide arsenal of surgical techniques at their disposal, including access approach, different types of fixation, and arthroscopic repair. In general, studies have shown good functional outcomes associated with a low rate of serious complications. However, in each of the described techniques, fixation of whole bone fragment is recommended, preferably perpendicular to the fracture line with an interfragmentary compression technique. In this context, most common intraoperative complications involve fractures or comminution of the avulsed bone fragment, neurovascular injury resulting from access approach, loss of reduction, or compression that potentially causes pseudarthrosis. Proper placement of fixation devices is vital to avoid complications and poor outcomes.

The aims of this study were to (1) establish which of the 2 classic techniques used to approach the posterior region of the knee—the posteromedial approach described by Burks and Schaffer in 1990, and the posterior approach described by Abbott and Carpenter in 1945—provides a better attack angle to fix PCL avulsion fractures in the tibia; (2) determine which of the approaches allows more perpendicular positioning of fixation devices in relation to the fracture line; and (3) scan for increased neurovascular injury in either access.
**Materials and Methods**

The study was conducted in November 2014 in Coroners Service of Hospital das Clínicas in São Paulo, Brazil. Ten fresh cadavers (20 knees) were evaluated and placed in a prone position to perform the access approach. All dissections were performed by the same physician (L.F.M.A.), an experienced knee surgeon and orthopedic trauma evaluator, who had knowledge of both access approaches but no preference for either technique. All procedures were conducted in a single-blind manner. The side (right or left) of each approach was randomized using sealed envelopes; the sequence in which the approaches were made was also randomized. The physician responsible for taking the measures (L.G.M.W.) was blind to the type of approach performed. Only 1 cadaver was dissected per day, providing an appropriate period for washout.

**Surgical Technique**

For the posterior approach described by Abbott and Carpenter, a skin incision was performed in the shape of an “S” and initiated medial-proximally, transversely crossing the popliteal skinfold with a lateral longitudinal extension of approximately 5 cm (Figure 1). Then, the fascial plane was found, explored, and released, avoiding the medial sural cutaneous nerve, which is an important marker of the vascular-nervous bundle. Once the fascial plane was identified, a parallel blunt dissection medial to the bundle, which was placed laterally, was performed (Figure 2). Deeply, the joint capsule was approached and PCL insertion in its fossa, approximately 0.5 to 1 cm distal to the tibial articular surface, was reached (Figure 3). At this point, the guidewire tip was positioned in the center of the tibial PCL footprint, to reach the perpendicular coronal axis of the knee (Figure 4).

In the contralateral knee of the same cadaver, the postero-medial approach, as described by Burks and Schaffer, was performed. A skin incision in the shape of an “L” was made, starting on the proximal side. The surgeon continued this incision parallel and distal to the popliteal skinfold, bending the obtuse angle distally when reaching the medial edge of the fold (Figure 5) approximately in the region of the tendon of the medial head of the gastrocnemius, which can be identified by superficial palpation. Next, blunt dissection of the subcutaneous tissue was performed along the fascial plane (Figure 6). As deep dissection, the plane between the semi-membranous and medial gastrocnemius was used (Figure 7), until the attached structures could be palpated to the posterior cortex of the tibia. These structures were dissected and retracted with the assistance of a Hohmann retractor positioned on the lateral side of the tibia, taking all subsequent structures along with the medial head of the gastrocnemius muscle to the side and leaving the posterior edge of the tibia exposed. Thus, the posterior capsule and the tibial insertion of the posterior cruciate ligament could be identified (Figure 8). After that, the guidewire was inserted using the previously described technique (Figure 9). After com-
Completing the access approach and positioning the wires, a digital photograph was taken, parallel from caudal to cranial, with a stabilized camera. All cadavers were accurately positioned with the heel perpendicular to the table and with the longitudinal axis of the tibia parallel to the table plane (Figure 10). After a digital image was recorded for each technique, the angle between the guidewire and the horizontal plane of the table was measured using the PixelStick application version 1.0 for Mac OS (Plum Amazing, Princeville, Hawaii). For comparative purposes, the angle used was complementary to the angle formed between the guidewire and the sagittal axis of the tibia.

### Statistical Analysis

A nonparametric paired Wilcoxon test was used to compare the posteromedial and posterior approaches. All data were presented with 95% confidence intervals. SPSS Statistics for Windows version 17.0 software (SPSS Inc, Chicago, Illinois), Minitab 16 (Minitab, Inc, State College, Pennsylvania), and Excel Office 2010 (Microsoft, Redmond, Washington) were used for the statistical analyses. P values of less than .05 were considered statistically significant.

### Results

Seven of the 10 cadavers were male. Ten knees were dissected using each approach (posteromedial or direct posterior), allowing half of the cases to be evaluated using each technique. No neurological or major vessel injuries were observed during the dissections.

The wire angle obtained for each technique was measured and is listed in the Table. The angles measured during the direct posterior approach ranged from 3° to 21°. In the posteromedial approach, the angles ranged from 17° to 58° (Table). Compared with the posteromedial approach, the direct posterior approach allowed wire placement more perpendicular relative to the tibia axis in all cases. The mean angle of the guidewire related to the sagittal plane of the tibia was 8.6° (SD=7.3°) when using the direct posterior approach and 36.6° (SD=14.3°) when using the posteromedial approach (P=.005). Thus, there was a statistical difference in relation to the wire position, with the direct posterior approach allowing the placement significantly more perpendicular to the tibia axis.

### Discussion

Despite representing only a small group within the larger spectrum of PCL trauma, tibial insertion avulsion injuries are common among young patients. When conservative treatment of PCL trauma results in nonunion, it may predispose patients to joint instability and worsening knee function. Currently, surgical repair is the treatment of choice for avulsions with fixable bone fragment, even if minimally diverted, since this provides the best opportunity for patients to regain a physiologically sound knee.

There is great variability in the characteristics of avulsion injuries related to the fracture line. Many times it is difficult to estimate the size of the main fragment or degree of comminution, particularly in the absence of computed tomography, which is of great assistance in treatment planning for this type of injury. Therefore, the choice of the treatment will depend on the possibility of fixing the fragment. The more fragile the avulsed fragment, the more important it is to find an appropriate and precise approach angle for inserting the fixation device. An exaggerated screw angle on a fragment can cause fracture or comminution, which sometimes impairs the possibility of osteosynthesis.

The posterior approach allows direct access to the PCL insertion, with not only a more appropriate angle but also a greater degree of freedom. This provides a perpendicular position to the longitudinal tibia axis, which facilitates fixation, or even allows the surgeon to perform an easier pull-out suture, passing wires to the anterior or border of the tibia. Therefore, if intraoperative observation of the fracture does not permit screw fixation, it is possible to modify the technique and perform a pull-out suture.

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Direct Posterior Approach</th>
<th>Posteromedial Approach</th>
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<tbody>
<tr>
<td>1</td>
<td>3°</td>
<td>30°</td>
</tr>
<tr>
<td>2</td>
<td>20°</td>
<td>37°</td>
</tr>
<tr>
<td>3</td>
<td>9°</td>
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<tr>
<td>Mean</td>
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<td>36.6°</td>
</tr>
<tr>
<td>Median</td>
<td>7.5°</td>
<td>36°</td>
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Traction screws have their highest efficiency when positioned perpendicular to the fracture line. In avulsion fractures, the fracture line tends to be parallel to the longitudinal axis of the tibia. Therefore, during screw insertion, there is greater freedom in the angle of attack with the direct posterior approach, which allows screw placement in the perfect position (ie, precisely perpendicular to the fracture line).

However, exposure by the direct posterior approach, despite enabling a broader view, is more delicate. Traumatologists tend to prefer the posteromedial approach because the bundle is carefully removed together with the medial head of the gastrocnemius muscle, which allows for anatomical preservation and avoids necessity of dissection. There was no difference between exposure times of the techniques used in this study. However, it is expected that an inexperienced surgeon will need more time to dissect the bundle using a direct posterior approach. While performing the posteromedial approach, a surgeon must take the time to find an angle that allows for reduction and fixation of the avulsed fragment, which does not occur during the direct posterior approach.

Limitations

There were several limitations to this study. First, the study involved biomechanical experimentation without correlation to clinical parameters. Moreover, the elastic resistance tissues of a cadaver present a major contrast to those found in a living patient, but the clinical questions posed in this study could not be answered in vivo. For a biomechanical cadaver study, the authors believe that the sample size used was appropriate. However, future research will need to evaluate beyond degrees of freedom, which is the only parameter that was studied for the fastening device relative to the PCL tibial insertion.

Conclusion

The direct posterior approach allows a greater degree of freedom compared with the posteromedial approach to reach the PCL tibial insertion, permitting placement of fixation devices closest to a right angle in relation to the fracture line. This enhances the interfragmentary compression and, as a consequence, consolidation. Therefore, from a strictly technical point of view, the direct posterior approach is more appropriate than the posteromedial approach to access avulsion fractures of the PCL.

References