

# Tibial Inlay Technique for Posterior Cruciate Ligament Reconstruction: Minimum 2-Year Follow-up.

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**Abstract:** Surgical treatment of posterior cruciate ligament (PCL) injuries is controversial except where there is multiple ligamentous injury. The purpose of this prospective study was to evaluate the surgical outcomes of PCL reconstruction using the more recent tibial inlay, to determine if the inlay technique yielded more stable reconstructions. Prospective study of surgical outcome. Between 2004 and 2005, five patients underwent surgery for PCL injuries at our institution with a tibial inlay technique using quadriceps tendon- patella bone autograft. No patient was lost to follow-up and all were evaluated at a mean follow-up of 2 years and 8 months (range, 26 to 36 months). The average age at surgery was 30.8 years (range, 24 to 39 years). The primary indication for surgery was instability (100%). The surgical procedure included 5 tibial inlay (all quadriceps tendon-bone autograft). Each patient was evaluated using the Tegner, Lysholm, physical examination, functional testing, and radiographs. Overall, 100% of patients were satisfied with their surgery. The postoperative posterior drawer test result improved in all 5 of 5 (100%) patients. The mean preoperative Tegner score was 7. The mean postoperative Tegner score was 8.00. The mean Lysholm score was 88. There was no change in the radiographic progression of Fairbanks changes in the medial and patellofemoral compartments. **Conclusions:** The tibial inlay technique appears to give good results in terms of posterior drawer testing functional testing, or Lysholm, Tegner, knee scores at a minimum 2 year follow-up. **Clinical Relevance:** The results of this study suggests that inlay method of PCL reconstruction consistently restores anteroposterior stability to its original state.

**Key Words:** Posterior cruciate ligament, Tibial Inlay, Single-bundle.

## INTRODUCTION

The incidence rate of posterior cruciate ligament (PCL) tears ranges from 3% of acute knee injuries in the general<sup>1</sup>. Clancy and Sutherland<sup>2</sup> reported that 40% of PCL injuries are isolated to the ligament remaining 60% involve multiple ligaments. The treatment of isolated PCL injuries still remains controversial in the field of sports medicine. Isolated PCL tears have traditionally been treated nonoperatively because most patients do well with conservative care<sup>3</sup>.

Despite encouraging results with the nonoperative management of isolated PCL tears, a certain percentage of patients will develop chronic, symptomatic posterior instability and may require surgical reconstruction. Numerous studies have shown that patients with isolated PCL tears treated nonoperatively can develop increased clinical instability and arthritic changes over time<sup>4-6</sup>. However, few studies have been published on the surgical treatment of isolated PCL injuries.

The primary goal of surgical reconstruction of the PCL is to restore its normal anatomy. The PCL consists of 2 bundles: the larger, stiffer, and longer anterolateral bundle, which tightens in flexion, and the smaller, weaker, and shorter posteromedial bundle, which is taut in extension<sup>7</sup>. Traditionally, the aim of arthroscopic transtibial techniques has been to reconstruct the stronger anterolateral bundle. Unfortunately, as the graft exits the tibial tunnel it must make an acute bend around the proximal posterior tibia, termed the “**Killer turn**,” and stresses on the graft caused by this bend can lead to attenuation and late graft failure<sup>8</sup>. The tibial inlay technique was developed to reduce the acute bending of the graft as it exits the tibial tunnel<sup>9</sup>.

The purpose of the present study was to evaluate the surgical outcome of PCL reconstructions for PCL injuries using the tibial inlay technique.

## METHODS

From January 2004 to December 2005, 5 patients underwent

surgery for an PCL injury. One patient had isolated PCL injury, three had PCL and posterolateral corner injury and one had combined ACL, PCL and posterolateral corner injury. All patients underwent tibial inlay reconstruction with a single femoral tunnel. Inclusion criteria consisted of a PCL tear with or without other ligamentous injury detected by physical examination and confirmed by magnetic resonance imaging. Patients had a minimum 2-year follow-up after a PCL reconstruction. There was one surgeon involved in the series. There were 5 patients in the group. Average patient age at the time of surgery 30.8 years (range, 24 to 39 years) (Table 1). We believe that the traditional grading system for the posterior drawer of 1+, 2+, and 3+ is inherently ambiguous because it relies on the subjective estimation by the examiner of the number of millimeters of posterior displacement of the tibia on the femur<sup>10</sup>.

**Table 1. : Preoperative Data**

Patient	Age	Sex	Mechanism of Injury	Posterior Drawer	Radiographic Changes	Tegner Score	Cartilage Grade: MC	Cartilage Grade: PF
1	24	M	MVA	C	0	7	NL	NL
2	23	M	Basketball	C	0	7	NL	NL
3	27	M	Fall	B	0	7	NL	NL
4	39	M	Martial Arts	B	0	8	Grade III	NL
5	31	M	MVA	C	0	6	NL	NL
Mean	30.8					7		

PF, patellofemoral; NL, normal; MVA, motor vehicle accident; MFC, medial femoral condyle; TP tibial plateau

Mostly, published reports quote posterior drawer results as 1+, 2+, or 3+ and interchange these with grade 1, 2, 3, or grade 4 injuries to the PCL, without indicating where the tibia is in relation to the femur. Noyes et al.<sup>11</sup> have abandoned this grading system altogether stating that dividing PCL tears into 2 groups based on the millimeters of increased posterior tibial displacement, indicating either undamaged (<10 mm) or insufficient (>10 mm) secondary restraints is somewhat arbitrary because it is difficult, without using stress radiography under defined loading conditions, to determine the exact increase in posterior tibial translation with PCL ruptures.

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We, therefore, have used a more simplified grading system for the posterior drawer test devised by J.D. Macgillivray et al.<sup>12</sup> The system does not seek to determine if an injury is partial or complete. Rather, it assesses the competence of whatever ligament, or ligament remnant is present. The grading system is: normal, indicating no loss of tibial offset; grade A, slight loss of tibial offset when applying a posterior force to the tibia at 90°; grade B, the tibia is flush with the femur; and grade C, the tibia is able to be displaced behind the femur. This grading system has been more reproducible because it relies on displacement of the tibia relative to basic landmarks, rather than displacement based on number of millimeters though we feel that the degree of injury to the PCL in the B or C category is debatable. This is complicated by the presence of partial injuries and the fact that PCL injuries will often heal in an elongated, nonfunctional position. Thus, grading as to the degree of injury is somewhat arbitrary and a system that simply states the position of the tibia on the femur will be easier to use and eliminate biases in reporting results.

All patients had surgery for chronic PCL deficiency, which was defined as more than 12 weeks from the time of injury to surgery. The primary indication for surgery was functional instability in all (100%). Instability in all cases was defined as either partial or complete giving way episodes with desired activities of daily living, despite having undergone a complete physical therapy and strengthening program for a minimum of 6 weeks.

All patients were evaluated postoperatively using the Tegner and Lysholm<sup>13</sup>. Each subject underwent an objective evaluation postoperatively, which included a physical examination by the lead author. Functional testing consisting of the single leg hop test, and radiographs of both knees consisting of standing anteroposterior, posteroanterior at 40° of flexion, lateral at 90° of flexion, and Merchant views. The radiographs were compared with ipsilateral preoperative radiographs. Articular degeneration was graded on a 0 to 3 scale<sup>4,6</sup>. Grade 0 corresponded to a normal appearing radiograph. Grade 1 corresponded to evidence of mild degeneration, slightly decreased joint space, mild osteophytes, and subchondral sclerosis. Grade 2 corresponded to degenerative changes such as moderate joint space narrowing and subchondral sclerosis without articular bony contact. Grade 3 corresponded with radiographs that showed bone-on-bone articular contact.

## SURGICAL TECHNIQUE

### Tibial Inlay Technique

Because of concerns about late laxity associated with endoscopic transtibial PCL reconstruction the tibial inlay technique was described in 1992<sup>9,14</sup> and we followed the procedure as mentioned by them.

The patient is placed in a supine position. The graft used was autologous quadriceps tendon along with patella bone plug in all five patients. The autologous quadriceps tendon with a bone plug was harvested from the same or the opposite knee. We fashioned the bone block for the inlay in a rectangular fashion with the dimensions 15-mm wide, 25-mm long, and 5-mm thick. The femoral tunnel was created with an ACL guide from outside in or from inside out. The tip of the ACL guide is placed in the center of the anterolateral bundle and a K-wire drilled from outside in. A 1.5 cm skin incision is made to accept the 10 mm drill bit. The tunnel is drilled from outside in. In the other technique, a K-wire is introduced from the far low anterolateral portal. The K-wire is placed in the center of the anterolateral bundle, the knee is flexed to 120 degrees, and is drilled

through to the outside. The tunnel is then drilled from outside in with the appropriate size drill bit. A folded-over AO wire is introduced down the femoral tunnel from outside in and pushed to the back of the joint.

The back of knee is approached as described below. The skin incision is a gentle curve with a horizontal end near the flexion crease of the knee and a vertical limb overlying the medial aspect of the gastrocnemius muscle. Dissection is carried to the deep fascial layer, which is incised vertically over the medial head of the gastrocnemius. The medial sural cutaneous nerve (posterior cutaneous nerve of the calf) must be kept in mind, although this structure usually perforates the deep fascia distal to the horizontal limb of the incision. The medial border of the medial gastrocnemius is identified, and the interval is developed between it and the semimembranosus tendon. This plane is easily developed by blunt dissection until the posterior joint capsule is reached. The middle geniculate artery may be encountered near the midposterior capsule and can be ligated if necessary. The only motor branch from the tibial nerve in the popliteal fossa that traverses medially is the motor branch to the medial head of the gastrocnemius. By lateral retraction on the medial head of the gastrocnemius, no tension is directly applied to neural structures. The thick muscle belly protects the neurovascular structures as the capsule is exposed. Dissection on this protected medial side of the popliteal fossa is therefore relatively safe. The posterior aspect of the proximal tibia and posterior portions of the femoral condyles are easily palpable. If any further lateral exposure is necessary, a portion of the tendinous origin of the medial head of the gastrocnemius may be released from the distal femur and joint capsule. However, slight knee flexion will aid exposure, and complete sectioning of the medial head of the gastrocnemius is never needed. At this point a vertical incision is made through the posterior capsule. The contents of the posterior intercondylar notch and the tibial attachment of the PCL are easily accessible. The extent of the exposure is sufficient to easily apply a staple to the posterior aspect of the proximal tibia. Femoral fixation was consistent with primary bioscrew fixation backed up with either a screw and washer, or a staple. The bony plug was fixed in tibia with a staple. Closure is accomplished by suturing the capsular incision. The gastrocnemius settles into position, the subcutaneous layers are approximated, and the skin is closed in a routine fashion.

### Postoperative Management

The operative knee was braced in extension for 4 weeks. The patient was allowed toe-touch weight-bearing for the first 4 weeks, then progressed to partial weight-bearing for 2 weeks, and then full weight bearing was permitted thereafter. In the early postoperative period, passive range of motion to 90°, isometric quadriceps strengthening and straight-leg raises were allowed. The patient was allowed to return to full activities 9 to 12 months postoperatively.

## RESULTS

A summary of the results is presented in Table 2. The mean duration of follow-up was 2 years and 8 months (range, 26 to 36 months).

Table 2: Postoperative Data

Patient	Follow-up (mo)	Posterior Drawer	Radiographic changes	Tegner Score	Lysholm Score
1	36	A	0	8	85
2	28	A	0	8	78
3	28	A	1	8	87
4	32	A	0	9	89
5	26	B	0	7	100
Mean	30			8	88

**Associated Arthroscopic Findings and Procedures**

There was 1 patient who had a medial meniscal tear and required a concomitant partial medial meniscectomy, removal of multiple loose bodies, and debridement of grade III chondromalacia of the medial femoral condyle and medial tibial plateau. Rest all had near normal findings.

**Subjective Results**

All patients 100% (5 of 5) were satisfied with their results, 5 of 5 (100%) reported no instability episodes postoperatively. The postoperative Tegner scores was better than preoperative ones but could not attain statistical significance due to small number of cases (Table 2). Also the mean postoperative Lysholm score was 88.

**Objective Results**

The postoperative posterior drawer testing, postoperative range of motion, or single-leg hop test showed improved results than preoperative ones. The radiographic lesions of Fairbanks changes in the patellofemoral and medial compartments did not appear to progress. (Table 2).

In the study group, 5 of 5 (100%) patients improved with respect to their posterior drawer grade( Table 3).

**Table 3.: Preoperative and Postoperative Drawer Changes**

Patient	Preoperative	Postoperative	Improved	Grade Change
1	C	A	Y	2
2	C	A	Y	2
3	B	A	Y	1
4	B	A	Y	1
5	C	B	Y	1
% Improved			100%	

**DISCUSSION**

In 1995, Berg<sup>9</sup> reported on PCL reconstruction using a new inlay technique. He proposed that transtibial reconstruction was technically difficult, leading to in- effective in situ graft tensioning, and possibly allowing for late failure caused by abrasive wear of the graft at the margin of the tibial tunnel. He claimed that his inlay technique created a more anatomic PCL insertion, allowing easier and more effective graft tensioning. In his limited series of 4 patients treated with the inlay technique, there was an average improvement on KT-1000 arthrometry of 4 mm, no radiographic changes at 2-year follow-up, and significant subjective improvement in all patients.

Bergfeld etal<sup>15</sup> went on to compare this new inlay technique with the standard transtibial technique in a cadaver model. They found that the inlay technique allowed for better graft tensioning with a significant reduction in anterior-posterior laxity when compared with the transtibial tunnel technique. After cycling the knee 72 times, they found evidence of mechanical degradation of the graft in the tibial tunnel group, but not in the inlay group. In our series we had 100% improvement in the anteroposterior laxity as evidenced by posterior drawer test ( Table 3).

Several studies have evaluated surgical reconstruction for PCL deficiency<sup>5,9,16-19</sup>. These studies, however, included both acute and chronic injuries<sup>5,16,18</sup>.

None of these studies addressed only the surgical treatment of chronic PCL deficiency. In our study, only patients with chronic PCL injuries were included. Furthermore, all patients had undergone a trial of nonoperative treatment and failed because of chronic symptomatic instability or pain.

This study reviewed the outcome of PCL reconstruction in a select

group of patients who presented with chronic PCL deficiency. Furthermore, only inlay single femoral tunnel technique and its clinical outcome was evaluated. We found improved laxity on posterior drawer examination. Many authors have noted that the functional results of PCL reconstruction are often better when compared with the objective findings of residual laxity<sup>16,18</sup>. Our study offers similar results, with subjective scores better than the objective measurements of laxity. Shelbourne etal<sup>3</sup> found no correlation between radiographic changes and PCL laxity when examining 133 patients treated nonoperatively for isolated PCL injury. In our study, however the radiographic changes did not appeared to progress.

Most studies comparing PCL reconstruction techniques are burdened by multiple confounding variables in their patient population. Our study was a prospective study that looked only at chronic reconstruction of PCL injuries. We evaluated the results of only single bundle reconstructions using the more recent tibial inlay technique.

Injury to the PCL is not common. Although the numbers in our study are small and so conclusions may be limited. Our data did indicate that the tibial inlay technique is a good reliable option for PCL reconstruction. However, based on our small numbers and control group, we cannot conclude that it is better technique than transtibial technique or conservative treatment. Finally small number of patients and no other comparable group make difficult to conclude results of our study though the results to some extent suggest that tibial inlay is a good technique of PCL reconstruction.

**CONCLUSIONS**

Results of tibial inlay reconstructions, in our small study group, yielded good improvements in posterior drawer testing, Lysholm and Tegner at a minimum 2-year follow-up. The results of this study may indicate that inlay method of PCL reconstruction consistently restores anteroposterior stability to its original state when using a single-bundle femoral attachment site.

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