

Outcomes for Surgical Treatment of Posterolateral Instability of the Knee

Jaron P. Sullivan, MD, Moira McCarthy, MD, and Robert G. Marx, MD

Abstract: Injuries to the posterolateral corner (PLC) of the knee can be associated with a variety of additional ligamentous and soft-tissue injuries. The clinical outcome of a PLC injury is dependent on associated injuries, the chronicity of injury, and the method of reconstruction. This chapter discusses the current literature regarding outcomes of surgical treatment of acute and chronic injuries. The majority of the current literature includes level IV case series evidence. Anatomic reconstruction of the PLC with concomitant treatment of associated knee ligament injuries in acute and chronic cases is the preferred treatment. There are mixed outcomes with acute repair of injured tissues as well as advancement procedures. The surgical treatment must be tailored to the specific needs of the patient and the ligament injury pattern.

Key Words: posterolateral corner, posterolateral complex of the knee, multiligament knee injury, surgical outcomes, PLC repair, PLC reconstruction

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OUTCOMES BACKGROUND

Treatment outcomes for the posterolateral corner (PLC) of the knee are expected to have high levels of variation because they occur with knee injuries of variable severity and heterogenous-associated ligament pathologies. Injuries to the PLC of the knee occur in isolation < 2% of the time.^{1,2} They frequently occur in combination with an injury to the anterior cruciate ligament (ACL) and/or the posterior cruciate ligament with an incidence ranging from 43% to 80%.^{1,3,4} In the setting of a knee dislocation, injuries to the PLC could also involve the medial collateral ligament or the posteromedial complex. As there are many associated pathologies that can present with PLC injuries, the outcomes can have significant variations depending upon the nature of the injury.

Associated injuries that occur with multiligament knee injuries can have a dramatic effect on outcomes. These include vascular or neurological injuries, fractures, muscle injuries that may involve compartment syndromes, and the severity of the injury to the soft tissue and skin envelope. The incidence of vascular compromise in knee dislocations has been reported to occur with an incidence of 32% to 50%.^{5,6} Neurological injuries that compromise the peroneal or tibial nerves also have a high incidence of up to 20% to 30% in the reported literature.^{6–12} Multiligament knee injuries will have associated fractures with rates of occurrence as high as 60%.¹⁰ A motor vehicle accident high-energy PLC injury that occurs as the result of a knee dislocation with an associated vascular injury could result in

compartment syndrome and permanent nerve damage, which would have a far poorer prognosis than an athletic injury that occurs as a basketball player goes in for a lay-up without neurovascular injury. As injuries of the PLC occur frequently with associated injuries, the outcomes will vary depending on the associated injury.

The outcomes of treatment for PLC injuries will also vary depending on the chronicity of the injury. The literature reports variations in treatment strategies from acute repair to chronic reconstruction. The diagnosis of a PLC injury frequently is missed at the time of the initial evaluation and treatment. It can present later as a failed ACL or posterior cruciate ligament reconstruction. If the diagnosis is made at the initial evaluation, superior outcomes have been reported by acute surgical intervention and repair of the injured tissues.^{1,3,4,13,14} After the acute period when tissue repair can no longer be attempted, reconstruction options become the primary consideration.

When treating multiligament knee injuries, consideration has to be given to the grafts that will be utilized for treatment as a limited supply of autograft is available. In a severely injured knee, autograft harvesting may be adding insult to an already injured knee. Graft choice is an additional factor that may affect outcomes. Studies have found a high-failure rate in young, active patients who undergo ACL reconstruction using allograft.¹⁵ Grafts that have had exposure to > 2.5 Mrd of radiation, or possibly even lower doses, may have adversely affected mechanical properties.¹⁶ Current trends are to avoid using highly radiated grafts due to the risk of damage to the mechanical properties. The chemical sterilization process may also affect the graft durability and strength. It is important to recognize that when comparing treatment outcomes in the literature, failures may have occurred as a result of factors unrelated to the reconstruction technique (such as use of a highly radiated graft that would have failed regardless of the reconstruction). In our current review of the literature regarding outcomes of PLC injuries, only 4 of 19 articles state that the grafts used for reconstruction were radiated.^{17–20} The other articles in our review do not affirm or deny whether grafts used underwent radiation sterilization procedures.

THE LITERATURE REVIEW

Clinical decisions are ideally based upon the best level of evidence available. Each patient may have particular problems that can be addressed by the application of relevant literature. As surgeons evaluate the relevance of the literature, it is imperative to understand the level of evidence to prioritize the best treatment recommendations. Levels of evidence ratings for each study are now a reported standard for most major medical journals in the orthopedic literature.^{21–23} Most level of evidence ratings have a tiered program with level I being the best available evidence such

From the Hospital for Special Surgery, New York, NY.
Disclosure: The authors declare no conflict of interest.
Reprints: Robert G. Marx, MD, Hospital for Special Surgery, 535 East 70th Street, New York, 10021 NY.
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as a randomized control trial, and level V or expert opinion being the lowest. Level IV studies involve a case series with no control group, or a historical control group. Out of the studies identified in our literature review, the majority were case series that were level IV evidence. The highest level of evidence in our literature review included 2 level II studies, and only a few level III studies.²⁴⁻²⁸ Studies with lower levels of evidence have higher potential for bias.

A literature review was performed to identify outcomes for treatment of posterolateral knee instability. We identified 31 papers that evaluated treatment outcomes for PLC injuries. The literature can roughly be divided into the treatment of acute and chronic injuries. Surgical treatment strategies were developed in an attempt to address patients who had poor outcomes from conservative management. In the 1980s, there were 2 predominant treatment strategies: repair of the injured structures for patients presenting with an acute injury or advancement procedures for chronic injuries. Reconstruction methods were developed to address the surgical problem of patients who were not good candidates for advancement procedures secondary to deficient ligament tissue from prior gross disruption and poor healing.¹⁸ Reconstruction methods for the PLC subsequently expanded to include the treatment of acute and chronic knee injuries.

OUTCOMES OF ACUTE REPAIR

During the first few weeks after an injury, acute repair of the injured tissues has been one of the mainstay options for treatment of the posterolateral knee injury since the 1980s. In 1983, Baker et al⁴ reported the results of 17 patients who were treated with direct repair of the injured structures with suture. Of them, 85% were good subjectively, 77% were good objectively, and 85% returned to the preinjury activity level. Direct repair was felt to be a major improvement over nonoperative management. This study also addressed the challenge of when repair cannot be accomplished due to tissue injury severity by utilizing gastrocnemius bone block advancement. That same year, DeLee et al²⁹ published less favorable results on 10 patients with lateral instability. They reported that at 7½ years' follow-up, 4 had good results, 1 fair, and 2 were poor. Three of the 10 patients were lost to follow-up. Although the results were not excellent, they were fairly long term and considered to be better than conservative treatment even though there was no comparison by a control group. The following year, Baker et al³⁰ published a follow-up series of 13 patients who had repair of the posterior cruciate and PLC of the knee. They reported good objective (10/11), functional (11/11), and subjective (8/11) outcomes. In 1998, Krukhaug et al¹⁴ retrospectively reviewed patients who had been treated with acute repair or conservative management in a case series and demonstrated that patients treated with acute repair had improvement in stability and subjective outcomes, whereas those who were treated conservatively had no improvements in stability. These level III/IV evidence studies combined demonstrated improved stability, subjective outcomes, and objective outcomes with acute repair over conservative management.^{4,14,29,30} This remains today as a viable option as will be addressed later when repair versus reconstruction is discussed.

OUTCOMES OF ADVANCEMENT PROCEDURES

Although acute repair of the injured knee with posterolateral instability provided a better solution than

conservative management, repair was not always possible. Chronic posterolateral instability of the knee was initially treated with tissue advancement procedures. In a case series in 1981, Fleming et al³¹ reported the outcomes of 28 patients who had undergone arcuate complex advancement and/or biceps femoris tenodesis and posterior cruciate ligament reconstruction using semitendinosus autograft. They utilized this approach to address pathology in both acute (18) and chronic (21) patients. There were 3 poor results in the acute repair group. In the chronic group, 3 patients had recurrent laxity. The overall outcome was reported to be "good." These results set the bar for several case series to be reported over the ensuing 30 years. Hughston and Jacobson³ reported on 140 patients who were treated for posterolateral instability with a bone block advancement on the lateral femoral condyle. They reported 85% good objective results, 78% good subjective results, and 80% good functional results. Fanelli and colleagues added to the literature by reporting on 21 patients who were treated with biceps femoris tenodesis with statistically significant improvements in outcomes scores that included the Tegner, Lysholm, Hospital for Special Surgery knee, and KT-1000 both preoperatively and postoperatively. All of their patients had functionally stable knees.

Although the early results of advancement procedures were good, there were also reports with less favorable outcomes in subsequent years. Noyes and Barber-Westin¹⁹ reported that only 2/23 patients with posterolateral instability treated with advancement procedures returned to high-level pivoting activities, and only 63% were able to do light recreational sports. Other reports described satisfactory results for advancement procedures to be around 68% with complete knee stability postoperatively in 44% to 70% of the cases.^{32,33} Noyes and Barber-Westin¹⁹ made the observation that advancement procedures have good potential only in the setting of good tissue that is slightly lax. Their group was one of the first to describe the outcomes of reconstruction procedures as an alternative to advancement, and this led to a complete shift in practice from advancement to reconstruction in an attempt to obtain better patient outcomes.

OUTCOMES OF RECONSTRUCTION PROCEDURES

Reconstruction procedures that address posterolateral instability have been developed to address varus and rotational instability. Noyes and Barber-Westin¹⁸ reported on 20 patients who presented with varus instability and tissue quality that preempted an advancement procedure. They treated patients with a lateral collateral ligament reconstruction with Achilles tendon allograft through bone tunnels on the femur and the fibula. Their treatment resulted in 76% success for knee stability with regard to outcomes after 2 years. Subsequent scientific investigation evaluated multiple variations of single femur to fibula sling procedures (Larson procedure).³⁴ Several studies demonstrated that variations of a single fibula sling procedure could improve outcomes scores (Lysholm, Tegner, IKDC) significantly in patients with posterolateral instability injury patterns.³⁵⁻³⁷ Although the clinical outcomes scores and subjective evaluations demonstrated improvements almost uniformly, it was also observed that normal knee stability and function was not restored (rotational laxity,³⁸ anterior stress radiography,³⁹ physical examination observations of

abnormal laxity,³⁷ and IKDC functional evaluation of the knee⁴⁰). Yang et al²⁰ reported on a single fibular sling procedure that was effective for the majority of patients, but failed in patients with higher injury severity. A variation in the single fibula sling described in the literature was a single sling through the lateral tibial plateau. Jung et al⁴¹ compared a single lateral sling that was through the fibula with a sling based through the tibia. They had 82% satisfactory IKDC scores equivalent between the 2 groups, but the fibula tunnel was on average 34 minutes faster and restored rotational stability in 85% of the knees compared with 65% in the tibial tunnel. In summary, single fibula sling procedures are able to improve subjective and objective outcomes in the majority of patients, but the literature suggests that they may not completely restore ligament stability.

“Anatomic” PLC reconstructions have been developed to address individual components of the PLC (fibular collateral ligament, popliteofibular ligament, and the popliteus tendon). Stannard et al⁴² reported outcomes of a reconstruction that addressed each anatomic component of the posterolateral corner of the knee in 22 patients. Their reported outcomes were excellent with only 2 failures (13%). Three studies report outcomes for an anatomic reconstruction technique developed by LaPrade et al.⁴³ The first of the 3 studies to be discussed was a 2-center outcomes study that involves 64 patients treated for posterolateral instability with an anatomic reconstruction.⁴⁴ Cincinnati knee score outcomes were 65.7, but no preoperative score was available which limits relevance. IKDC scores were available for preoperative and postoperative comparisons, which demonstrated objective stability of the knee. There were 3 revisions for failure of the procedure to restore stability. In the second study, Jakobsen et al⁴⁵ reported on 27 patients who were treated with the LaPrade anatomic reconstruction. At a minimum of 24 months’ follow-up, 95% of the knees were stable, IKDC results were 71% normal, and the Knee Injury and Osteoarthritis Scores were comparable with patients who underwent a meniscectomy. The third study involving an anatomic reconstruction involves patients with grade III varus instability without injury to the popliteus or the popliteofibular ligaments as determined by physical examination and intraoperative findings.⁴⁶ This case series of 20 patients underwent isolated fibular collateral ligament reconstruction. There were significant improvements in the Cincinnati (28.2 to 88.5) and IKDC (34.7 to 88.1) scores from preoperative to postoperatively. Stress radiographs demonstrated complete resolution of lateral gapping postoperatively. The anatomic reconstruction methods seem to demonstrate the highest outcomes scores with excellent knee stability.

As the reported outcomes have improved with reconstruction procedures, the question remains whether patients do better in the acute setting with repair versus reconstruction. Is there a role for a hybrid treatment? Geeslin and LaPrade⁴⁷ treated 26 knees (case series, level IV evidence) that had PLC injuries by repairing ligament avulsions and reconstructing midsubstance tears. IKDC scores improved in all categories and Cincinnati scores improved, both with a statistically significant difference. They recommend that patients should be treated in a single-stage procedure with a hybrid approach to intraoperative pathology. Stannard et al⁴² evaluated whether to repair versus reconstruct the acutely injured posterolateral knee in a level II cohort study. Their series included 39 patients treated

with repair and 25 patients treated with reconstructions using a 2-tailed anatomic technique. The failure rate in the repair group was 37% compared with 9% in the reconstruction group. Levy et al⁴⁸ evaluated the same question of whether to repair versus reconstruct the acute posterolateral knee injury. That study had 10 knees in a 2-stage repair group (stage I repair the collateral ligaments, stage II reconstruct the cruciate ligaments), and 18 patients in the single-stage reconstruction group. There was a 40% failure rate in the repair group versus 6% failure in the reconstruction group. In summary, the outcomes literature supports acute reconstruction over isolated repair.

Anatomic reconstructions have also recently been compared with biceps rerouting procedures for combined posterolateral instability with posterior cruciate ligament reconstruction.²⁴ The study groups were divided into 21 patients who received an anatomic reconstruction of the PLC and 25 patients who received a biceps rerouting procedure. Stress radiography demonstrated no differences between the 2 groups postoperatively. With regard to the outcomes, the dial test, varus stress radiographs, Lysholm score, IKDC, and range of motion were all better for the reconstruction group. The conclusion is that an anatomic reconstruction results in superior outcomes compared with biceps rerouting in this level III evidence study.

Injury severity is an important factor to consider when evaluating PLC knee injuries. Although patients with increased severity of injuries will usually have a worse prognosis, predictions are not always reliable. In some cases, good clinical outcomes may be more reliant on anatomic reconstructions regardless of the ligament injury severity. The senior author evaluated PLC reconstructions at 2 different academic institutions and divided the patients into 2 groups (2 ligament vs. multiligament). Although the numbers were small (7 patients in the 2-ligament group and 9 patients in the multiligament group), there were no significant differences in clinical and functional outcomes between the 2 groups.⁴⁹ The technique used in this series of patients reconstructs the fibular collateral ligament and the popliteofibular ligament and also imbricates the posterolateral capsule to the ligamentous reconstruction to further enhance varus and external rotatory stability. This technique for reconstruction continues to be the senior author’s preference for treatment of posterolateral knee ligament injuries.

CONCLUSIONS

Surgical treatment outcomes for posterolateral knee injuries have improved over the past 30 years. There have been gradual shifts in treatment approaches that have improved patient outcomes. As the majority of the outcomes literature available is from level IV case series, there is need for additional studies to clarify the best treatment options. Posterolateral knee injuries are complex because they rarely occur in isolation. When they occur in combination with other knee ligament injuries, significant disability can occur. The best available evidence currently supports anatomic reconstruction of the PLC with concomitant treatment of the associated knee ligament injuries in acute and chronic cases. There are mixed outcomes with regard to acute repair of the injured tissues as well as advancement procedures. Additional treatment options such as a single fibula sling or isolated fibular collateral

ligament reconstruction may be considered on a case-by-case basis depending on the injury pattern present.

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