Proximal Tibial Opening Wedge Osteotomy as the Initial Treatment for Chronic Posterolateral Corner Deficiency in the Varus Knee

A Prospective Clinical Study

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Background: Nonoperative treatment of posterolateral knee injuries tends to yield poor results. In patients with chronic posterolateral knee injuries, failure to correct genu varus alignment will often result in failure of the posterolateral knee repair or reconstruction.

Purpose: To prospectively assess the functional outcomes of patients with combined grade 3 posterolateral instability and genu varus alignment initially treated with a proximal tibial opening wedge osteotomy.

Study Design: Cohort study (prognosis); Level of evidence, 2.

Methods: Twenty-one patients with combined chronic posterolateral corner deficiency and genu varus alignment were initially treated with a proximal tibial opening wedge osteotomy and observed prospectively. Second-stage ligamentous reconstruction was performed in patients with continued clinical and functional instability after the osteotomies had healed and they had undergone at least 3 months of rehabilitation.

Results: At a mean follow-up of 37 months, 8 of 21 patients (38%) had sufficient improvement in knee function that a subsequent posterolateral corner reconstruction was not necessary. There was a significant difference in coronal alignment between the preoperative and postoperative mechanical axis action point. There were no significant differences in the preoperative and postoperative posterior tibial slope. Thirteen patients underwent a second-stage ligament reconstruction at an average of 13.8 months after the initial osteotomy procedure. Final postoperative Cincinnati Knee Rating System scores were significantly lower for those patients who required a subsequent posterolateral corner reconstruction than for those patients who did not have a reconstruction. The *P* value for the preoperative differences between groups was not significant ($P = .11$). Seven of 9 patients with high-velocity knee injuries required a second-stage reconstruction. Ten of 14 patients (71%) with multiligament knee injuries required a posterolateral corner reconstruction. In contrast, 4 of 6 patients (67%) with an isolated posterolateral corner injury did not require a second-stage ligament reconstruction.

Conclusion: Proximal tibial opening wedge osteotomy can be an effective first method of treatment for patients with chronic combined posterolateral knee injuries and genu varus alignment. Patients with low-velocity knee injuries and isolated chronic posterolateral knee injuries may not require a second-stage soft tissue ligament reconstruction after healing the osteotomy and undergoing a program of rehabilitation.

Keywords: posterolateral knee; genu varus; proximal tibial osteotomy

Injuries to the posterolateral structures of the knee are uncommon and have been estimated to account for approximately 6% to 8% of acute knee injuries.[4,22] Despite their relative infrequency, these injuries often cause significant disability if left untreated. Additionally, posterolateral corner (PLC) injuries often occur in association with other ligamentous knee injuries, which makes the dysfunction and subsequent treatment more complex.[7,11,16,17,25]

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No potential conflict of interest declared.

The American Journal of Sports Medicine, Vol. 35, No. 11
DOI: 10.1177/0363546507304717

Patients with concurrent genu varus alignment and chronic PLC deficiency present an even more challenging treatment problem. Failure to correct the genu varus alignment before a soft tissue PLC reconstruction has been shown to result in high rates of graft failure because excessive tension across a malaligned knee often causes the grafts to stretch out and fail over time.[7,14,15,21,23-26,28] As such, it has become accepted practice to correct the mechanical axis before any soft tissue posterolateral reconstruction in patients with concurrent genu varus alignment.[24,25]

It has been our practice to treat patients with combined chronic posterolateral knee injuries and genu varus alignment with a 2-staged approach: a first-stage proximal tibial opening wedge osteotomy to correct the genu varus alignment, followed by a second-stage PLC reconstruction[12] to correct further knee instability if functional limitations persist due to continued knee instability. We have found that a number of these patients, after healing the osteotomy procedure and undergoing rehabilitation, had sufficiently improved knee function and stability that a subsequent second-stage ligament reconstruction was unnecessary.

In an effort to reduce the number and complexity of surgeries for this patient population, we attempted to more closely define those patients who would benefit from a proximal tibial opening wedge osteotomy alone and thereby avoid the potential downtime and complications associated with a second-stage PLC and potential simultaneous cruciate ligament reconstruction. Therefore, our purpose is to prospectively assess the outcomes of patients who underwent a proximal tibial opening wedge osteotomy for treatment of a combined symptomatic grade 3 chronic posterolateral knee injury and genu varus alignment to determine those factors that demonstrate improved function without the need for a second-stage ligament reconstruction.

MATERIALS AND METHODS

Patients with concurrent chronic unilateral posterolateral knee injuries and genu varus alignment were included in this study, which was approved by the Institutional Review Board at the University of Minnesota. Inclusion criteria were that patients have functional instability, pain, or failed previous ligament reconstructions with combined genu varus alignment and posterolateral knee instability at a minimum of 3 months after sustaining their posterolateral knee injury. Varus alignment was defined as being present in those patients whose mechanical axis, as drawn on the long leg alignment radiographs, passed medial to the tip of the medial tibial spine. Patients were excluded from the study if they had a history of significant arthritis, tibial nerve injury, or bilateral injured lower extremities. All patients who underwent an osteotomy were evaluated preoperatively for increased varus opening at 30°, increased external or posterolateral rotation at 30° and 90°, increased subluxation on the reverse pivot-shift test, increased anterior translation on the Lachman test with an anterior cruciate ligament (ACL)-deficient knee, and increased posterior translation on the posterior drawer test for a posterior cruciate ligament (PCL)-deficient knee compared with the normal contralateral knee. All patients obtained anteroposterior (AP) and lateral radiographs, a 45° patellar sunrise view, and a single long leg standing AP alignment radiograph on initial clinic presentation. In addition, all patients completed the modified Cincinnati Knee Rating System preoperatively and at their follow-up visits.

All patients were initially treated with a proximal tibial opening wedge osteotomy using a medial plate (Arthrex, Naples, Fla) and allograft bone graft (Opteform, Regeneration Technologies Inc, Alachua, Fla). In each patient, an attempt was made to correct the genu varus alignment such that the corrected mechanical axis passed through the downslope of the lateral tibial spine. Plates with an anterior sagittal plane slope were used in patients with a concurrent ACL deficiency in an attempt to decrease the sagittal tibial slope, and plates with a posterior sagittal plane slope were used in patients with a concurrent PCL deficiency in an attempt to increase the posterior tibial slope. Enteric coated aspirin, 325 mg daily, was provided for 8 weeks for prophylaxis against deep vein thrombosis. After the osteotomy, patients were prescribed a knee immobilizer and given instructions on isometric quadriceps exercises and straight-leg raises performed with the knee immobilizer in place. Patients were nonweightbearing for the first 8 weeks. Patients were encouraged to remove the knee immobilizer and to work on full knee motion out of the immobilizer 4 times daily. The use of a stationary bicycle and leg presses at one-quarter body weight were started at 8 weeks postoperatively. Patients then slowly progressed on weightbearing by one-quarter body weight per week at 8 weeks until they were full weightbearing by 12 weeks postoperatively. They were then allowed to wean off of crutch use once the osteotomy showed good evidence of radiographic healing starting at 12 weeks postoperatively. Patients were then enrolled in a progressive strengthening program. The use of increased resistance on a stationary bicycle, an elliptical machine, and progressive weight training was initiated at this time. Patients were allowed to jog and participate in twisting and turning activities 5 months postoperatively if they were able to tolerate these exercises.

At the time of enrollment in the study, it was explained to all patients that it has been anecdotally reported that some patients who had a proximal tibial osteotomy who were bowlegged (in varus alignment) and had chronic posterolateral knee injuries do not always need a second-stage ligament reconstruction. The decision of a second-stage reconstruction would be made based on their function after the osteotomy healed and if they felt they still had residual knee instability that did not let them participate in their desired occupational or recreational activities. Patients who reported continued functional deficits and instability after a minimum 6-month period of convalescence after the osteotomy were subsequently treated with a second-stage posterolateral and other necessary cruciate ligament reconstruction. A PLC reconstruction[12] was performed after the initial osteotomy if patients reported any problems with functional instability in their affected knee. For these patients, modified Cincinnati scores were compared at baseline (just before osteotomy) and before the second-stage ligament reconstruction. Patients who required a subsequent ligament reconstruction were deemed to have failed the treatment algorithm for this study and further follow-up and results are not reported for these patients.

Patients who did not complain of further instability and had no noted requirements of modification in their activities continued to be followed both subjectively and objectively throughout the study period. For these patients, modified Cincinnati scores are reported at baseline (just before osteotomy) and at the last available follow-up.

The mechanical axis was defined as a line passing from the center of the femoral head to the center of the ankle mortise on the long leg AP alignment radiograph, while the mechanical axis action point was defined as the point where the mechanical axis transected the tibial plateau, as measured from medial to lateral, and defined as a percentage of the width of the tibial plateau. Radiographic analysis was performed on both the preoperative and postoperative coronal mechanical axis action point and the preoperative and postoperative posterior tibial sagittal slope on the lateral radiographs.[3]

Statistical analysis of the differences between the baseline and final postoperative modified Cincinnati scores for patients was performed using a group *t* test. Statistical analysis of the differences between the baseline and final postoperative radiographic measurements were performed using a paired *t* test. Significance was reported for $P < .05$.

RESULTS

Twenty-one patients with chronic combined PLC deficiency and genu varus alignment were prospectively evaluated during the period of May 2000 to August 2005. There were 20 men and 1 woman. The average patient age at the time of surgery was 32 years (range, 18-49 y).

All patients had sustained an injury to the posterolateral structures of the knee occurring at least 3 months before presentation in our clinic and had genu varus malalignment as determined from standing long leg radiographs taken at the initial office visit. Six patients had isolated PLC deficiency, 6 patients had ACL and PLC deficiency (1 with an associated lateral femoral condyle fracture), 6 patients had PCL and PLC deficiency, 2 patients had ACL, PCL, and PLC deficiency, and 1 patient had an isolated PLC ligament injury and also had associated intra-articular medial tibial plateau fracture that had been treated elsewhere and had subsequently healed.

Clinical Evaluation

At a mean follow-up of 37 months (range, 19-65 mo) after the initial first-stage osteotomy, 8 of 21 patients (38%) reported satisfaction with their results after the osteotomy and felt that a second-stage ligament reconstruction was not necessary (Table 1). None of these patients required a brace for activities. Thirteen patients underwent a second-stage ligament reconstruction at an average of 13.8 months after the initial osteotomy procedure. No patients were lost to follow-up.

Mechanism of Injury

The mechanism of injury for patients was a motor vehicle or motorcycle accident in 9, sports injuries in 10, and work-related falls in 2 (Table 1). Six of the 10 patients with low-velocity sports-related injuries did not require a second-stage ligament reconstruction. Comparatively, 7 of the 9 patients involved in high-velocity motor vehicle accidents and both work-injured patients required second-stage ligament reconstructions (Table 1).

Associated Injuries

Ten of 12 patients (83%) with a history of knee surgery for any reason required a second-stage ligament reconstruction (Table 2). Ten of 14 patients (71%) with multiligament knee injuries required a second-stage ligament reconstruction.

Cincinnati Scores

Baseline modified Cincinnati scores were an average of 43.3 (range, 8-83) for patients who had a subsequent PLC reconstruction. The final modified Cincinnati scores before the posterolateral reconstruction averaged 47.8 (range, 16-77) (Table 1). There was no significant difference between the preoperative and final modified Cincinnati scores for this group of patients.

The baseline modified Cincinnati scores for patients who did not require a second-stage reconstruction were an average of 61.5 (range, 21-90) and averaged 68.1 (range, 40-100) at the latest follow-up (Table 1). There was no significant difference in the baseline or latest modified Cincinnati scores for these patients who did not need a second-stage PLC reconstruction. While there was no significant difference between the preoperative scores between groups, there was a significant difference between the final postoperative modified Cincinnati scores for patients who needed a posterolateral construction and the scores in those patients who did not need a second-stage posterolateral reconstruction ($P < .03$).

Radiographic Analysis

The average preoperative mechanical axis action point passed through the 26.7% point of the tibia (range, 9.2%-38.8%) (Table 3). This compares with the average postoperative mechanical axis action point passing through the 57.5% point of the tibia (range, 50.7%-65.9%) ($P < .0001$). The average preoperative mechanical axis action point in patients who needed a second-stage ligament reconstruction was 27.5%, while it was 25.2% in patients who did not need further reconstruction surgery ($P > .05$). The average postoperative mechanical axis action point was 57.3% in patients who needed a second-stage reconstruction and 57.9% in patients who did not need further reconstruction surgery ($P > .05$).

The average preoperative posterior tibial sagittal slope was 9.0° (Table 3). The average preoperative posterior tibial sagittal slope was 8.7° in the 6 isolated PLC patients, 10.3° in the 6 combined ACL-deficient knees, and 8° in the

TABLE 1
Patient Demographics and Details of Treatment[a]

Patient No.	Sex	Age, y[b]	Mechanism of Injury	Interval From Injury to Presentation	Diagnosis	Meniscus Injury	Stability After PTO	Second-Stage Ligament Reconstruction[c]	Follow-up, mo	Baseline Cincinnati Score	Follow-up Cincinnati Score	History of Knee Surgery
1	M	29	MVC	7 mo	ACL, PLC	No	No	9		13	16	
2	M	33	MCC	3 mo	ACL, PLC	No	No	10		30	N/A	
3	M	39	MVC	11 mo	MTP fx, PLC	No	No	12		8	64	Yes
4	M	18	Sports	5 mo	PLC	No	Yes	Not required	51	69	43	
5	M	41	MVC	22 y	PLC	Lateral	No	7		36	21	Yes
6	M	21	Sports	4 mo	PLC	No	Yes	Not required	65	90	100	
7	M	32	Work, fall	8 mo	ACL, PLC, LFC fx	Lateral	No	9		74	30	Yes
8	M	19	Sports	55 mo	PCL, PLC	Medial	No	35		74	60	Yes
9	M	30	Sports	8 y	PCL, PLC	Medial	No	12		54	77	
10	M	22	Sports	12 mo	ACL, PLC	Lateral	Yes	Not required	44	89	69	
11	M	27	Sports	14 y	PCL, PLC	Lateral, medial	No	12		83	55	Yes
12	M	32	Sports	6 y	PLC	Medial	Yes	Not required	19	68	83	Yes
13	M	49	MVC	15 mo	PCL, PLC	Lateral	Yes	Not required	33	63	85	
14	M	20	Sports	3 mo	PLC	No	No	19		26	63	
15	M	36	MVC	17 y	ACL, PCL, PLC	No	No	15		41	40	Yes
16	F	41	Sports	10 mo	PLC	No	Yes	Not required	24	58	88	
17	M	35	Work, fall	26 mo	ACL, PCL, PLC	Lateral, medial	No	7		18	34	Yes
18	M	19	MVC	8 mo	PCL, PLC	Lateral	No	12		52	67	Yes
19	M	38	MVC	20 y	ACL, PLC	Lateral, medial	No	21		54	46	
20	M	47	MCC	4 mo	PCL, PLC	No	Yes	Not required	24	21	37	
21	M	34	Sports	15 y	ACL, PLC	Medial	Yes	Not required	34	34	40	

[a]M, male; PTO, proximal tibia opening wedge osteotomy; MVC, motor vehicle crash; ACL, anterior cruciate ligament; PLC, posterolateral corner; MCC, motorcycle crash; N/A, data not available in patients undergoing a PTO for combined posterolateral knee instability and genu varus alignment; MTP, medial tibial plateau; fx, fracture; LFC, lateral femoral condyle; PCL, posterior cruciate ligament; F, female.
[b]Age at presentation.
[c]Months after osteotomy.

6 combined PCL-deficient knees. The average postoperative posterior tibial slope was 10.9° overall, with the average postoperative tibial sagittal slope 10° in isolated PLC patients, 11.7° in combined ACL-deficient knees, and 11.3° in combined PCL-deficient knees. The average preoperative posterior tibial sagittal slope was 8.8° in patients who needed a second-stage ligament reconstruction and 9.1° in patients who did not require a second-stage surgery. The average postoperative posterior tibial sagittal slope was 10.9° in patients who needed a second-stage ligament reconstruction and 10.9° in patients who did not require a second-stage surgery. There were no significant differences in the preoperative or postoperative posterior tibial slopes among any of these conditions.

Complications

There were 1 major and 4 minor complications. The major complication was in a patient who developed an infection after the second-stage PCL and ACL reconstruction, which required a deep irrigation and debridement with removal of the allograft PLC reconstruction grafts. After treatment of the infection, the patient had a revision posterolateral knee reconstruction without further sequela. Four patients had irritation from the osteotomy plate that required a separate surgery for plate and screw removal.

DISCUSSION

Posterolateral knee injuries generally do not heal and often function poorly if left untreated.[9,18,20] In patients with chronic PLC injuries, it is recommended to correct any concurrent genu varus alignment before any attempt at ligamentous reconstruction. In patients with combined genu varus alignment and chronic PLC deficiency, we found that correction of the genu varus alignment alone will create sufficient clinical functional improvement and subjective stability such that a subsequent second-stage ligament reconstruction was unnecessary in 38% of the patients we studied.

Part of the reason that posterolateral knee injuries heal poorly if left untreated may be related to the inherent bony instability of the lateral knee compartment.[8] Although the concavity of the medial tibia plateau and the matching convexity of the medial femoral condyle provide inherent stability to the medial compartment, the 2 convex opposing surfaces of the lateral femoral condyle and lateral tibial plateau provides no such bony stability. In addition, the increased mobility of the lateral meniscus provides much less of a stabilizing effect to increased motion than the more stable medial meniscus.[5] In patients with associated genu varus alignment, this inherent instability is worsened because a weightbearing axis that passes through the medial compartment may place excessive tension on soft tissue PLC reconstruction grafts, which may cause them to stretch out over time. As such, chronic posterolateral knee instability in patients with concurrent genu varus alignment will often lead to functional instability, which may show as a varus thrust gait pattern.[11,25]

In treating patients with posterolateral knee injuries, it is essential to obtain a complete and accurate diagnosis of all potential concurrently injured structures, because PLC injuries rarely occur in isolation.[2,4,16] Numerous studies

TABLE 2
Previous Knee Surgeries in Patients With Chronic Grade 3 Posterolateral Knee Instability and Genu Varus Alignment[a]

Patient No.	Previous Surgery
3	Tibial plateau fx; ORIF with K-wires; lateral and anterior compartment release; ACL thermal tx
5	Posterolateral reconstruction
7	ORIF of OC lesion of LFC; PLC repair; thermal tx of ACL
8	Arthroscopy; partial medial meniscectomy; PCLR with patellar tendon allograft
9	Arthroscopy; partial medial meniscectomy
11	Arthroscopy; microfracture of medial femoral condyle
12	Arthroscopy with debridement of medial meniscal tear
15	Knee dislocation as child; tibia and femur fracture requiring pinning/plating; multiple arthroscopies; and PLC reconstruction; ACLR
17	ORIF fibular head fx; peroneal nerve repair; PLC repair; ACLR; HW removal
18	ACLR; FCL and lateral meniscus repair; compartment fasciotomy; fasciotomy closure with split thickness skin grafting
19	Knee dislocation resulting in popliteal artery repair; fasciotomy with skin grafting
21	ACLR; arthroscopy; HW removal

[a]fx, fracture; ORIF, open reduction and internal fixation; ACL, anterior cruciate ligament; tx, treatment; OC, osteochondral; LFC, lateral femoral condyle; PLC, posterolateral corner; PCLR, posterior cruciate ligament reconstruction; ACLR, anterior cruciate ligament reconstruction; HW, hardware; FCL, fibular collateral ligament.

TABLE 3
Preoperative and Postoperative Radiographic Measurements of the Mechanical Axis Action Point and Posterior Sagittal Tibial Slopes in Patients Undergoing a Proximal Tibial Opening Wedge Osteotomy for Combined Genu Varus Alignment and Grade 3 Posterolateral Knee Injuries

Patient No.	Mechanical Axis Action Point, %		Posterior Sagittal Tibial Slope, deg	
	Preoperative	Postoperative	Preoperative	Postoperative
1	14.3	61.9	11	12
2	19	57.2	13	14
3	28.6	61.5	9	8
4	21.9	67	8	9
5	22.9	60.1	9	8
6	35	65.9	8	10
7	37.8	53.7	8	9
8	32.5	60.2	9	13
9	31.3	56.5	10	12
10	9.2	56.3	9	13
11	18.2	50.7	3	10
12	9.4	53.8	10	14
13	21.4	53.7	8	8
14	21.2	58.8	9	11
15	38.8	65	6	11
16	35.9	55.1	8	8
17	21.5	52.2	11	12
18	37.2	53.5	8	10
19	34.8	53.3	9	12
20	36	51.2	10	15
21	32.9	60	12	10

have shown increased forces on ACL and PCL grafts after sectioning of the PLC structures.[7,14,15,21,28] Failure to recognize a concomitant posterolateral knee injury when performing an ACL or PCL reconstruction may result in graft failure or residual instability symptoms. The importance of recognizing concomitant posterolateral knee injuries in this circumstance cannot be overemphasized. Additionally, it is essential to determine the mechanical alignment in patients with chronic posterolateral knee injuries. Failure to correct genu varus alignment will often result in failure of the repair or reconstruction.[23-26] It has also been demonstrated that limb alignment is a strong determinant of the knee adduction moment and the corresponding lateral compartment tensile loads.[25,27] Thus, correction of the mechanical axis into neutral or slight valgus alignment decreases the resultant lateral compartment forces, which may also decrease the resultant lateral compartment gapping at foot strike and with functional activities due to the deficient posterolateral knee structures.

Before this study, we could find only limited studies in the literature regarding proximal tibial osteotomy as the initial treatment of chronic PLC deficiency in patients with genu varus alignment. Badhe and Forster[1] evaluated a heterogeneous population of 14 patients with ligamentous instability and genu varus alignment. These patients had a constellation of instability patterns and were treated using various methods. In their study, 9 patients had a posterolateral ligament injury with or without a PCL injury. Six of these patients were treated with a tibial osteotomy and ligament reconstruction, while the remaining 3 were treated with tibial osteotomy alone. The 3 patients without ligamentous reconstruction were reported as having improved from a mean preoperative Cincinnati score of 57 to a postoperative score of 76. Despite further comparisons, the authors concluded that if the posterolateral structures were lax and not completely disrupted, an opening wedge tibial osteotomy without ligament reconstruction may help to stabilize the knee and avoid a ligament reconstruction.

Noyes et al[25] reported on 41 patients with ACL deficiency, varus angulation, and varying amounts of posterolateral ligament deficiency. Most patients (n = 32) were injured in sports. Similar to our study, this was a heterogeneous group of patients. All their patients were treated initially with a proximal tibial closing wedge osteotomy. However, whereas the one constant in their patient population was chronic ACL deficiency, all our patients had a chronic PLC deficiency. They recommended a staged ligament reconstruction for patients with combined ACL and PLC deficiency to avoid potential complications associated with performing an osteotomy and a multiligament reconstruction in the same setting.[25] However, none of their patients were treated with osteotomy alone, and they did not report on postosteotomy knee function.

It is well recognized that the best outcomes for posterolateral knee injuries occur in patients who are treated acutely with surgical repairs.[2,4,10] It has been recommended to treat acute posterolateral knee injuries within the first 2 to 3 weeks after injury for the best outcomes.[11,17] This is because a primary repair of torn posterolateral structures becomes difficult after the first few weeks due to the development of scar tissue planes, tissue necrosis, and tissue retraction. In our clinical experience, a primary repair is very difficult to perform 3 months after injury, and these patients must be treated for a chronic posterolateral knee injury at this point. In patients with ligamentous injuries occurring greater than 3 months before initial examination, it is our practice to obtain long leg standing radiographs to assess the mechanical axis and the mechanical axis action point before any ligamentous reconstruction procedure. We believe that by correcting the mechanical axis out of varus alignment and into neutral or slight valgus alignment, sufficient mechanical and functional stability can be achieved in a significant number of patients (8 of 21; 38%).

A medial proximal tibial opening wedge osteotomy is our preferred osteotomy approach. In contrast to a lateral closing wedge proximal tibial osteotomy, an opening wedge osteotomy has the theoretical advantage of tightening the posterior capsule and oblique popliteal ligament complex,[13] which can ultimately foster additional posterolateral stability. In addition, it has been demonstrated in a cadaveric biomechanical study that the opening wedge proximal tibial osteotomy increases both varus and external rotation stability.[19] Also, an opening wedge osteotomy allows for the potential of improved sagittal plane correction to address instability associated with either an ACL or PCL deficiency. Plates with an anterior sagittal slope were used in patients with solely a concurrent ACL deficiency, and plates with a posterior sagittal slope were used in patients with solely a concurrent PCL deficiency because it has been demonstrated that improved knee stability is seen in patients under these conditions.[6] However, in our study, there was no significant difference between the preoperative and postoperative posterior tibial slopes for any of the patients or within any of the groups, so no definitive conclusion can be made.

We found that the most common factor in determining the need for a second-stage ligament reconstruction was the severity of the initial knee injury as measured by overall patient function on the modified Cincinnati Knee Rating System, concurrent injuries, and injury patterns. Baseline modified Cincinnati scores were on average 18 points lower (indicating more severe baseline functional deficits) for those patients who required a subsequent PLC reconstruction compared with those patients who did not need a reconstruction. In addition, 4 of 6 patients (67%) with an isolated posterolateral knee injury did not require a second-stage posterolateral knee reconstruction. Of the 2 patients with an isolated posterolateral knee injury who did require a second-stage posterolateral knee reconstruction, 1 was a highly competitive professional soccer player, and a second-stage reconstruction was performed given his high demands for side-to-side knee stability. The other patient was involved in a high-energy motor vehicle crash and had a history of failed PLC reconstruction (before his osteotomy) at another institution. We found no significant change between the preoperative and postoperative modified Cincinnati scores in either group. While patients who did not need a second-stage reconstruction reported that their knees felt more stable, these were only minor improvements in the functional portion of the modified Cincinnati Knee Rating System. We are not certain if a different scoring system may have been able to discern a difference.

One limitation of the current study is the inherent heterogeneity of the patient population, and the relatively small number of patients in each group precludes any definitive conclusions being made. However, injuries to the PLC are not common and account for only about 6% to 8% of acute injuries of the knee.[4,22] Additionally, isolated posterolateral knee injuries are infrequent, and 78% of patients with posterolateral knee injuries have been reported to have additional ligamentous injuries.[16] As such, to find a truly homogeneous population of patients with isolated chronic posterolateral knee injuries would dramatically limit the number of patients studied. Another issue is that this is a short-term study with a mean follow-up of 37 months. We recognize that longer follow-up is necessary to determine the efficiency of this procedure in patients for the long term.

CONCLUSIONS

An initial proximal tibial opening wedge osteotomy followed by a period of convalescence to determine subsequent clinical and functional stability is a reasonable approach for the treatment of chronic PLC-deficient knees with concurrent genu varus alignment. Correction of their alignment alone will create sufficient improvement in function in 38% of patients such that a subsequent second-stage ligament reconstruction becomes unnecessary. Patients with multiligament knee injuries, a history of a high-energy injury pattern, and lower baseline functional scores were more likely to require a second-stage posterolateral knee and other necessary concurrent ligament reconstruction. In contrast, patients with isolated posterolateral knee injuries, low-energy injury patterns, and high baseline functional assessments were most likely to benefit from varus malalignment correction alone. Through a careful and thorough evaluation of associated risk factors, we are now better able to counsel our patients with combined posterolateral knee injuries and genu varus alignment regarding the possible need for a second-stage ligament reconstruction after a corrective proximal tibial opening wedge osteotomy.

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