Is Stability of the Proximal Tibiofibular Joint Important in the Multiligament-injured Knee?

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Abstract

Background The incidence of proximal tibiofibular joint instability in the setting of the multiligament-injured knee has not been previously reported. The integrity of the proximal tibiofibular joint is required to perform a fibular-based, lateral-sided knee reconstruction.

Questions/purposes We report (1) the frequency of proximal tibiofibular joint instability in patients presenting with multiligament knee injuries and evaluate (2) our ability to restore stability to this joint, (3) patient-reported outcome scores, and (4) complications in patients

surgically treated for proximal tibiofibular joint instability at the time of treatment of multiligament knee instability.

Methods From 2005 to 2013, 124 patients (129 knees) sustaining multiligament knee injuries with Grade 3 instability to at least two ligaments were treated at our institution. We defined proximal tibiofibular joint instability as a dislocated or dislocatable proximal tibiofibular joint at the time of surgery. These patients underwent surgery to restore proximal tibiofibular joint stability and ligament reconstruction or repair and were followed with routine clinical examination, radiographs, and subjective outcome measures, including Lysholm and IKDC scores. Minimum followup was 12 months (mean, 32 months; range, 12–61 months).

Results Twelve knees (12 patients, 9% of 129 knees) showed proximal tibiofibular joint instability. Knee stability in 10 patients was restored to Grade 1 or less in all surgically treated ligaments. No proximal tibiofibular joint instability has recurred. No patients have complained of ankle stiffness or pain. In the ten patients with subjective scores, mean Lysholm score was 75 (range, 54–95) and mean IKDC score was 58 (range, 22–78). There were four complications: one failed posterolateral corner reconstruction, one proximal tibiofibular joint screw removal secondary to pain over the screw head, one deep infection treated with serial irrigation and débridements with graft retention, and one closed manipulation secondary to arthrofibrosis and loss of ROM.

Conclusions In the setting of multiligament-injured knees, our series demonstrated a 9% incidence of proximal tibiofibular joint instability. The technique we describe successfully restored stability to the proximal tibiofibular joint and resulted in satisfactory patient-reported outcomes with low complication rates.

Level of Evidence Level IV, therapeutic study. See Instructions for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

This work was performed at Orthopaedic Associates of Michigan, Grand Rapids, MI, USA.

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Introduction

Injuries to the proximal tibiofibular joint are uncommon and have been primarily reported in the setting of athletic participation [1]. First reported in 1874 [24], these injuries account for less than 1% of all knee injuries and have been reported to occur in isolation and in combination with other bony and ligamentous pathology [8, 9, 16, 27]. Most common associations described in previous studies are those with associated tibial shaft fractures. Injury severity can range from pain to subluxation to dislocation, with both acute and chronic presentations [26].

While two previous case reports [6, 31] have mentioned proximal tibiofibular instability associated with multiligament knee injuries, to our knowledge, no case series or cohort studies have been reported. Numerous structures, including the lateral collateral ligament (LCL), biceps femoris, popliteofibular ligament, and arcuate ligament, play a role in providing stability to the proximal tibiofibular joint, and the fibular head provides the distal attachment [25, 30]. Injury to these structures may also lead to global knee instability, and direct repair of these structures to the fibular head likely needs a stable tibiofibular joint for a successful outcome. Moreover, posterolateral corner reconstruction techniques often use tunnels through or attachments to the fibular head, likely necessitating a stable proximal tibiofibular joint [2, 33]. Because of this, unrecognized tibiofibular joint instability may lead to failure or persistent instability of an otherwise well-performed posterolateral corner repair/reconstruction.

We therefore report (1) the frequency of proximal tibiofibular joint instability in patients presenting with multiligament knee injuries and evaluate (2) our ability to restore stability to this joint, (3) patient-reported outcome scores, and (4) complications in patients surgically treated for proximal tibiofibular joint instability at the time of treatment of multiligament knee instability.

Patients and Methods

Study Cohort

The data for our study were retrospectively collected from a prospectively studied cohort of patients diagnosed and operatively treated for a multiligament knee injury. Data were recorded in our multiligament knee injury database. Institutional review board approval was obtained. From 2005 to 2013, 124 patients (129 knees) sustaining a multiligament knee injury were treated at our Level 1 academic trauma center by a single surgeon (MJ). We defined a multiligament knee injury as a radiographic knee dislocation or Grade 3 instability of two or more ligamentous structures. The grading system used was defined by Hughston et al. [12, 13] in 1976.

Grade 1 injuries have less than 5 mm of joint surface separation (opening or subluxation) during stress testing. Grade 2 injuries have between 5 mm and 10 mm of separation. Grade 3 injuries have greater than 10 mm of separation. Combined ACL and medial collateral ligament injuries were not included in this cohort. Combination medial-sided injuries were included if there was significant valgus instability at full extension (Grade 3) and at 30° of knee flexion. Structures routinely evaluated, both clinically and with imaging (Fig. 1 A–B), included the collaterals, cruciates, posteromedial corner, and posterolateral corner.

In addition, we defined proximal tibiofibular joint instability as either a clinically dislocated or dislocatable joint during the examination under anesthesia and/or during the operative exposure. Evaluation of this joint was performed in all 129 knees in the study cohort. Patients were excluded if skeletally immature.

Twelve knees (12 patients) had associated proximal tibiofibular joint instability (Table 1). There were nine males and three females, with a mean age of 32 years (range, 15–63 years). Eleven of these 12 patients had polytrauma (Table 2). Injury mechanisms were motor vehicle accident (car [n = 9], motorcycle [n = 2]) and industrial accident (n = 1). Three patients had open knee injuries. Of note, 10 patients had associated ipsilateral knee posterolateral corner injuries as defined by injury requiring repair or reconstruction of one or more of the following: popliteus, LCL, and/or lateral capsule. One patient had preoperative peroneal nerve palsy. One patient had an external fixator temporarily applied before definitive treatment. Mean timing for surgery was 6.3 days from injury (range, 1–22 days). Five patients were treated in a staged fashion, repairing or reconstructing all injured structures except for the ACL, which was reconstructed at a later date. Minimum followup was 12 months (mean, 32 months; range, 12–61 months).

Patients were treated acutely if associated injuries allowed. Spanning external fixators were used to stabilize the knee if closed reduction and/or bracing did not keep the knee anatomicallly reduced as evaluated by radiography and/or intraoperative fluoroscopy. Surgical repair of the posterolateral corner was done for bony avulsions, while a reconstruction technique using tibial and fibular head tunnels with screw fixation on the femur was performed for midsubstance or irreparable injuries. All patients were treated with mechanical deep vein thrombosis prevention and chemical prophylaxis (enoxaparin) as indicated by their associated injuries.

Operative Technique

Patients were managed in a standardized fashion. Patients were positioned supine on a radiolucent operating bed. General anesthetic was administered. Preoperative timeout

Fig. 1 A–D Images illustrate the case of a 19-year-old patient with bilateral multiligament-injured knees. (A) A coronal MR image shows the left knee with a concomitant dislocated proximal tibiofibular joint. Note the intact LCL. (B) A coronal MR image shows the contralateral knee with a normal proximal tibiofibular joint (arrow). (C) An intraoperative view of the left knee shows the tibial articular

facet of the proximal tibiofibular joint (arrow). The fibular head is covered by soft tissue attachments near the inferior arm of the retractor. (D) In a lateral intraoperative view of the left knee, the proximal tibiofibular joint has been anatomically reduced with provisional fixation with a K-wire. Final fixation was obtained with a single 4.5-mm screw.

and prophylactic antibiotics were administered in all patients. A thorough examination under anesthesia was performed on the operative leg and the nonoperative leg for assessing ligamentous pathology. The operative leg was prepared entirely and the foot of the table was left in the upright (fully extended) position. This allowed the leg to rest comfortable in full extension, and the leg could be flexed and supported with the use of a sterile bump.

Arthroscopic evaluation was then performed with the pump on gravity or very low pressure. The calf was continually monitored throughout the arthroscopic portion of the procedure. If the pressure in the calf was believed to be increasing, the lateral incision was immediately made to allow fluid extravasation to occur while continuing the arthroscopy. Cruciate ligament reconstruction was performed and any associated meniscal or articular cartilage abnormalities were treated. The femoral side of the cruciate graft was secured, while the tibial side was left for later fixation.

The posterolateral corner was addressed through a separate laterally based incision centered over the lateral epicondyle proximally and carried distally between the fibular head and Gerdy's tubercle. Full-thickness flaps were raised off the iliotibial band and biceps femoris. The peroneal nerve was carefully identified and dissected free to allow gentle mobilization and protection during the surgery. All lateral-sided structures were then carefully identified from superficial to deep.

There were five repairs of the LCL, specifically, bony avulsion repairs to the fibular head ($n = 3$), femur ($n = 1$), and soft tissue only to the fibular head ($n = 1$) (Table 3). Popliteus reconstruction was performed via transtibial tunnel with screw fixation on the femur. PCL reconstructions were arthroscopically assisted using Achilles allograft through transtibial tunnel and outside-in femoral tunnel. ACL reconstruction was accomplished arthroscopically with transtibial tunnel and medial portal technique for femoral tunnel

Table 1. Patient demographics

Patient	Age (years)	Sex	Side	Mechanism	Open/closed	Timing (days)	Staged	Ligaments injured
1	45	Female	Right	Motor vehicle accident	Closed	4	No	PCL, LCL, pop
2	63	Male	Left	Industrial	Closed	10	No	ACL, PCL, LCL, pop
3	22	Male	Right	Motor vehicle accident	Closed	3	Yes	ACL, LCL, pop
4	25	Female	Right	Motor vehicle accident	Open	3	Yes	ACL, LCL, pop
5	34	Male	Right	Motorcycle accident	Closed	3	Yes	ACL, PCL, LCL, pop
6	62	Male	Right	Motorcycle accident	Open	1	No	ACL, PCL, MCL, LCL, pop
7	15	Male	Right	Motor vehicle accident	Closed	7	No	LCL, pop
8	38	Female	Left	Motor vehicle accident	Closed	5	No	PCL, LCL, pop
9	24	Male	Left	Motor vehicle accident	Open	18	No	LCL, pop
10	16	Male	Left	Motor vehicle accident	Closed	5	Yes	ACL, PCL, MCL
11	19	Male	Left	Motor vehicle accident	Closed	8	Yes	ACL, MCL
12	18	Male	Right	Motor vehicle accident	Closed	12	No	PCL, pop

LCL = lateral collateral ligament; pop = popliteus tendon; MCL = medial collateral ligament.

Table 2. Associated orthopaedic injuries

Patient	Associated injuries
1	Ipsilateral femur, midfoot fractures
2	Contralateral ankle fracture
3	Ipsilateral proximal tibia, sacrum, olecranon fractures
4	Ipsilateral distal radius fracture; contralateral acetabulum fracture
5	Ipsilateral tibial plateau fracture
6	Ipsilateral femur, open patella fractures
7	Ipsilateral traumatic below-knee amputation, femur, open patella fractures; contralateral femur fracture
8	Ipsilateral open tibia, ankle fractures; contralateral femur, radius fractures
9	Ipsilateral open tibial plateau fracture; contralateral patella, open distal femur fractures
10	Ipsilateral femur, tibia, pelvis fractures
11	None
12	Ipsilateral open tibia and femur fractures; contralateral femur fracture

placement. Two patients had hamstring autograft, and in three patients, soft tissue allograft was utilized. The ACL was repaired in one patient, and another patient has yet to have his ACL reconstructed. All three medial collateral ligament repairs were direct repairs using suture anchors and all were distal based avulsions. Meniscal tears were repaired using open technique as part of capsule repair in all knees except one knee that was repaired using an all-inside technique.

Stabilization of the Proximal Tibiofibular Joint

The proximal tibiofibular joint was palpated for location and stability. If the fibular head was clearly dislocated (Fig. 1C), an attempt was made to reduce the joint and then further

assess for stability. If the joint was still dislocatable, temporary stabilization was obtained by manual reduction and fixation with a 0.062 K-wire (Fig. 1D). Permanent stability was achieved with the use of an AO 3.5- or 4.5-mm cortical screw across all four cortices using a standard technique. In one knee, a lateral-sided bony avulsion from the femur contained the insertions of the LCL, popliteus, and lateral capsule. After stabilization of the bony fragment to the femur, the dislocated tibiofibular joint was stable on stressing and was left in position without the addition of a screw. Once the tibiofibular joint was stabilized, the remainder of the posterolateral repair and/or reconstruction was completed. Reconstruction was performed via transtibial (popliteus) and transfibular head (LCL) bony tunnels with screw fixation on the femur. Direct repair of structures was performed for bony avulsions or large soft tissue avulsions that could be sutured to the fibular head. Again, the femoral side of all structures was fixed initially, and then sequential final fixation on the tibial side of all structures was carried out in the following sequence: meniscal/capsular repair, PCL, LCL, popliteus, iliotibial band, biceps femoris, and finally ACL.

Ten patients required fixation across the proximal tibiofibular joint to maintain stability. A 4.5-mm screw was used in six patients while a 3.5-mm screw was used in the other four patients. In one patient, the joint remained stable after fixation of a bony avulsion from the lateral femur, and in one patient, the joint remained stable after reduction.

Wounds were copiously irrigated and closed in a layered fashion. Sterile dressings were applied, and the knee was placed in a hinged knee brace, locked in full extension. The use of preoperative adjunctive nerve blocks was avoided to allow accurate assessment of peroneal nerve function and compartment monitoring during the postoperative recovery phase. Patients were admitted overnight for monitoring and pain control.

Table 3. Surgical procedures performed

Patient	ACL	PCL	LCL	Pop	MCL	Medial meniscus	Lateral meniscus	Tibiofibular joint
1		Reconstruction	Reconstruction	Reconstruction				ORIF
2	Reconstruction	Reconstruction	Repair	Reconstruction			Repair	ORIF
3	Reconstruction		Repair	Repair		Partial meniscectomy	Partial meniscectomy	ORIF
4	Reconstruction		Repair	Reconstruction		Repair	Repair	ORIF
5	Nonoperative	Reconstruction	Reconstruction	Reconstruction				ORIF
6	Repair	Reconstruction	Repair	Reconstruction	Repair	Repair	Repair	ORIF
7			Repair	Repair				ORIF
8		Reconstruction	Reconstruction	Reconstruction				ORIF
9			Repair	Reconstruction		Repair		None
10	Reconstruction	Reconstruction			Repair	Repair		ORIF
11					Repair			ORIF
12		Reconstruction		Reconstruction				None

LCL = lateral collateral ligament; pop = popliteus tendon; MCL = medial collateral ligament; ORIF = open reduction and internal fixation.

Patients were instructed to remain toe-touch weight-bearing on the operative leg, with the brace on at all times except for hygiene. Gentle passive flexion began at 2 to 4 weeks postoperatively, as did weightbearing in the brace. At 3 months, the brace was discontinued and active flexion was allowed. Formal hamstring strengthening was delayed until 3 to 4 months postoperatively. Full return to activities was allowed at 9 to 12 months and when strength was approximately 80% to 85% of the nonoperative leg as determined clinically.

Patient Evaluation

Patients were followed routinely at 2, 6, 12, 24, and 52 weeks during the first year and then yearly thereafter, including physical examination (assessment of ROM, stability, and ankle stiffness or pain), radiographs, and subjective functional outcome questionnaires (Lysholm knee scoring system [3] and IKDC subjective knee evaluation score [10]). Scores in the Lysholm and IKDC systems range from 0 to 100, with a higher score representing a better functioning knee with less activity restrictions. The subjective data were collected on ten patients only. Mean, minimum, and maximum values were calculated for patient demographics and outcome data.

Results

Twelve of the 129 knees with multiligament knee injury had associated proximal tibiofibular joint instability, representing a frequency of 9%.

At latest followup, there was no recurrent instability of the proximal tibiofibular joint (Table 4). No patients complained of ankle stiffness or pain. Knee stability in 10 patients was restored to Grade 1 or less in all ligaments that were surgically treated. In the other two patients, one remained with a Grade 2 PCL, and the other remained with Grade 2 instability of the posterolateral corner despite revision.

In the ten patients with subjective data, mean Lysholm score was 75 (range, 54–95) and mean IKDC score was 58 (range, 22–78) (Table 4).

There were four complications (Table 4): one failed posterolateral corner reconstruction, one proximal tibiofibular joint screw removal secondary to pain over the screw head, one deep infection treated with serial irrigation and débridements with graft retention, and one closed manipulation secondary to arthrofibrosis and loss of ROM.

Discussion

The management of the multiligament-injured knee remains controversial. Many techniques describing repair and/or reconstruction of injured structures provide good guidelines, with reported results showing clinical success [4, 5, 7, 14, 15, 18, 21–23, 32], yet the importance of a stable proximal tibiofibular joint has been only briefly mentioned in two case reports [6, 31]. We therefore report the frequency of proximal tibiofibular joint disruptions among patients treated for knee dislocations, as well as our ability to restore stability to this joint, patient-reported outcome scores, and complications after surgical treatment of proximal tibiofibular joint instability at the time of treatment of multiligament knee instability.

Table 4. Results

Patient	Followup (months)	ROM (°)	Stability*	Lysholm score (points)	IKDC score (points)	Complications
1	36	5–105		87	78	Closed manipulation for arthrofibrosis
2	33	5–120	PCL (Grade 2) Pop (Grade 2)	83	61	Revision posterolateral corner reconstruction
3	61	0–130		54	42	
4	48	0–130		78	68	
5	36	0–115		68	43	
6	24	5–100		54	22	Deep infection
7	37	0–120		63	45	
8	24	0–135				Screw removal from the proximal tibiofibular joint
9	30	0–130		86	70	
10	12	5–125				
11	12	0–130		95	76	
12	36	0–130	PCL (Grade 2)	86	78	
Mean	32			75	58	

*Stability was Grade 1 or less in all ligaments tested except where noted; pop = popliteus tendon.

Our paper has a number of limitations. First, our sample size is small due to the infrequent nature of multiligament knee injuries with associated proximal tibiofibular joint instability. Second, our study is retrospective and does not have a control group. Third, there is significant injury and patient heterogeneity, making it challenging to draw conclusions from such a variety of patients and injury patterns. Fourth, there is performance bias because a single surgeon treated all patients in this series, and therefore, the results may not be generalizable. Furthermore, there is an inherent selection bias as this surgeon selected which patients to operate on. A number of different techniques have also been used to stabilize and/or reconstruct the joint for persistent instability and/or failure of closed treatment in both the acute and chronic setting. Operative stability to an injured proximal tibiofibular joint can be achieved by numerous described techniques, including direct repair, reconstruction of supporting ligament with split bicep femoris tendon, and various screw/pin constructs [11, 20, 28, 29, 34, 35]. In this report, we chose to use 3.5- or 4.5-mm screws inserted across all four cortices to provide stability because of the availability of hardware during the operation, as many of the cases of proximal tibiofibular joint instability were not diagnosed until the time of surgery.

The anatomy and function of the proximal tibiofibular joint have received much less focus in the literature than its neighboring tibiofemoral and patellofemoral joints. Previous authors have noted its importance in weightbearing and mechanical stability of the knee and ankle [17, 26]. The proximal fibula is the attachment site for the LCL,

popliteofibular ligament, and biceps femoris tendon. Kinematic studies have indicated that the LCL serves as the major stabilizer of the proximal tibiofibular joint in extension [25]. Because of the resistance provided by the fibular collateral ligament, most of the joint injuries are thought to occur while the knee is in flexion. This may explain the association between multiligamentous knee injuries and proximal tibiofibular joint disruptions.

The fact that an association between multiligamentous knee injuries and proximal tibiofibular joint instability has never been specifically reported leads us to believe that some injuries may go unrecognized. On review of the current published literature, we found two reports that mention concomitant proximal tibiofibular joint dislocation in the setting of a knee dislocation [6, 31]. One patient was treated with a through-knee amputation, and the other patient was treated by temporary fixation across the tibiofibular joint. Interestingly, this patient's knee reportedly would not remain reduced until the proximal tibiofibular joint had been stabilized.

We did not specifically compare our method of fixation to other described methods for stabilizing the proximal tibiofibular joint, and we cannot say our method of fixation is superior to any other. Our goal was to bring recognition to a possible associated injury. The functional and clinical results obtained in our group of multiligament-injured knees compare favorably to those previously reported in the literature, especially when considering the high rate of other associated extremity injuries in our group [19]. Laterally based knee ligament reconstruction relies on stability of the fibula and in turn the proximal tibiofibular joint. We

believe that failure to recognize proximal tibiofibular joint instability may lead to failure of an otherwise well-performed repair/reconstruction of the posterolateral corner and/or other knee ligament. Future studies may be needed to define the most appropriate fixation technique for this type of injury and the role that the proximal tibiofibular joint plays in combination with the posterolateral corner in providing stability to the knee.

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