Surgical Treatment of Acute Knee Dislocations

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Abstract: Knee dislocation is a rare and devastating injury, and the current literature is sparse regarding its outcomes. Significant controversy exists surrounding treatment methods, timing, and technique. In this report, we describe our preferred approach to the acute management of a dislocated knee, consisting of early simultaneous reconstruction of the anterior cruciate ligament and posterior cruciate ligament with repair or reconstruction of the medial and lateral structures. Despite our promising results with this technique, further studies are required to determine the most appropriate treatment algorithms for dislocated knees.

Key Words: knee dislocation, multiligament knee injury, ligament reconstruction, single-stage protocol, acute surgical management

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HISTORICAL PERSPECTIVE

Knee dislocation is a rare and devastating injury comprising <0.2% of reported orthopedic injuries, and only 0.5% of all joint dislocations.[1–3] Dislocations likely remain underreported owing to spontaneous reduction before presentation.[1,2,4] Published literature on knee dislocation is comprised mostly of small retrospective reviews, and significant controversy surrounds treatment protocols in terms of invasiveness of approach, timing of intervention, and operative technique (Table 1).

INVASIVENESS OF APPROACH

Although initial debate surrounded the success of operative management versus cast immobilization, most recent evidence has supported the role of surgical stabilization in improving postoperative range of motion (ROM), increasing subjective outcome scores, reducing pain, and facilitating return to full activity.[15,26–30] Within the operative management spectrum, both open and arthroscopic techniques are used. Eranki et al[6] performed open autograft reconstructions of cruciate ligaments with medial and/or lateral repairs within 2 weeks of injury and reported that 69% of patients had no fixed flexion deformity and at least 130 degrees flexion. Arthroscopic techniques yield similarly good results and hold certain advantages over open treatment, including improved visualization of intra-articular pathology and a decreased risk of intraoperative articular insult.[1,26]

TIMING OF INTERVENTION

A meta-analysis of 24 studies with heterogeneous treatment protocols demonstrated an advantage to delayed treatment (>3 wk) in terms of reduced anterior instability on Lachman and instrumented translation, and decreased rates of flexion loss of $\geq$ 10 degrees.[31] However, no differences were shown in posterior instability, collateral instability, average ROM, fixed flexion deformities, average Lysholm scores, or return to work, and subjective outcomes were significantly better in the acutely managed knees. Further studies have in general supported the acute treatment of knee dislocations,[3,11] whereas others have recommended a staged management.[32]

OPERATIVE TECHNIQUE

Further debate continues regarding whether to reconstruct or simply repair collateral ligament injuries.[26] Levy et al[5] in 2010 demonstrated significantly higher failure rates of repair compared with reconstruction of fibular collateral ligament (FCL)/posterolateral corner (PLC) injuries, although differences in staging of interventions was a confounding factor in this retrospective review. Conversely, Shelbourne et al[11] advocate an en masse lateral repair approach, with anterior cruciate ligament (ACL) reconstruction, leaving the torn posterior cruciate ligament (PCL) in situ, and have reported good results with their approach, with most patients demonstrating minimal subjective instability and being able to return to preinjury levels of activity at a mean of 4.6 years. It should, however, be noted that 90% of dislocations included in their case series were as a result of sporting injuries or falls, and their results cannot be generalized to high-energy dislocations and those with involvement of the medial structures.

In this report, we describe our preferred approach to the acute management of a dislocated knee consisting of early simultaneous reconstruction of the ACL and PCL with repair or reconstruction of the medial and lateral structures.

INDICATIONS AND CONTRAINDICATIONS

The described operative technique is indicated for injuries to two or more ligaments in the knee. It requires adequate time for preoperative planning and mobilization. Additional appropriate surgical interventions[33] for the treatment of dislocations with associated arterial injury, open injuries, irreducible dislocations, and intra-articular fractures will not be addressed.

After successful limb salvage, ligamentous reconstruction or repair can be performed, although results may be less predictable.[34] The technique for delayed reconstruction mirrors that of acute treatment as described below, most often with reconstruction of collateral structures as required rather than simple repair.

PREOPERATIVE PLANNING

Emergency Care

Fifty percent to 60% of patients with knee dislocation have associated fractures, and 27% of dislocations occur within the context of life-threatening head, chest, or abdominal injuries.[1,27] A high index of suspicion is necessary in the emergency room care of these patients to accurately and efficiently

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TABLE 1. Characteristics of Knee Dislocation Studies From 1985-2010

Study	Design	Time Span	No. Subjects (Follow Up, FU)	Surgery (S) No Surgery (NS) Acute (A) Chronic (C)	Subjects Age at Surgery (Mean)	Time Injury-Surgery Injuries Type	Follow-up Years (y; Mean)	Knee Function	Radiological Outcome
Levy et al[5]	Retrospective	2004-2007	9	S: 9 C: 9 2-stage protocol for gross instability (4), vascular injury (2), open injury (2), inadequate mobilization (1)	30.4 y Males: 67%	Surgery mean 75 d KD-I: 4 KD-III: 4 KD-IV: 12	Lysholm: 76.7 IKDC: 62.9	Heterotopic ossification: 44%	
Eranki et al[6]	Retrospective	1995-2005	20	S: 20	34 y Males: 70%	Surgery within 2 wk	2	35% able to return to preinjury activity level 68% able to perform most ADLs	NR
Hirschmann et al[7]	Retrospective	1983-2006	26 (FU: 24)	S: 24 A: 16 C: 7	24 y	Surgery within 1 wk (12), 2-3 wk (5), after 3 wk (7) KD-III: 83% KD-IV: 17%	8 (median)	Lysholm: 85 IKDC Normal: 4 Nearly normal: 12 Abnormal: 6 Severely abnormal: 2	K&L 0: 63% K&L I: 13% K&L II: 13% K&L III: 8% K&L IV: 4%
Engebretsen et al[1]	Prospective	1996-2004	121 (FU: 85)	S: 85 A.: 50 C: 35	35.2 y Male: 64%	Surgery mean 14 mo KD-II-III: 88% KD-IV: 12%	5.3 (2-9)	Lysholm: 77 IKDC2000: 64 Single leg hop tests:83%-88%	86.7% (K&L grades 2,3,4)
Ibrahim et al[8]	Case series	1995-2002	36 (FU: 20)	S: 36 A: 36	27.3 y	Surgery mean 2 wk KD-III: 25% KD-IV: 75%	3.6 (3-8)	Lysholm: 91 KOS-ADLS: 90 IKDC Nearly normal: 9 Abnormal: 9 Severely abnormal: 2	NR
Bin and Nam[9]	Case series	1997-2001	14	S: 14 A: 2-stage surgical approach: MCL/LCL: within 2 wk ACL/PCL in 9 patients	30.4 y Male: 86%	Surgery within 2 wk KD-III: 47% KD-IV: 33% KD-V: 20%	7.4 (2.9-9.2)	Lysholm mean 87.6 IKDC Normal: 3 Nearly normal 8 Abnormal 4	NR

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TABLE 1. (*continued*)

Study	Design	Time Span	No. Subjects (Follow Up, FU)	Surgery (S) No Surgery (NS) Acute (A) Chronic (C)	Subjects Age at Surgery (Mean)	Time Injury-Surgery Injuries Type	Follow-up Years (y; Mean)	Knee Function	Radiological Outcome
				within 6 mo					
Owens et al[10]	Retrospective	1994-2002	25 (FU: 25)	S: 25 A: 25	35 y (14-67) Male: 68%	Surgery within 14 d KD-III: 4% KD-IV: 59% KD-V: 37%	4 (1.1-6.8)	Lysholm : 89	NR
Shelbourne et al[11]	Case series	1988-	23 (FU: 21)	S: 21 A: (0.7-5.9 wk)	21.4 y (16-32) Male: 95%	Surgery within 2.4 wk KD-I: 9% KD-IV: 91%	4.6 (2-8.9)	Noyes score: 93 IKDC Normal 10 Nearly normal: 7 Single leg hop test 97%. Isokinetic quadriceps muscle strength 97%	IKDC: all normal (one mild patellafemoral joint space narrowing)
Patterson et al (LEAP study; only vascular injury)[12]	Prospective		585 (FU 18)	S: 18	All but one <55 y Male: 61%	Limb salvage: 14 Amputation: 4	2	Severe lower extremity injuries—high-energy injuries—all vascular injuries	NR
Robertson et al[13]	Review	1992-2004	226		29 y (28-32) Male: 76%-84%.	KD-I: 12% KD-II: 8% KD-III: 41% KD-IV: 28% KD-V: 11%	NA	IKDC Normal: 0% Nearly normal: 39% Abnormal: 40% Severely abnormal: 21%	Only one study: 50% risk of OA after knee dislocation[14]
Harner et al[15]	Retrospective	1990-1995	47 (FU: 31)	S: 31 A:19 (<3 wk) C: 12 (5 wk-22 mo	28.4 y (16-51)	Surgery mean: 12 d KD-II: 16% KD-III: 52% KD-IV: 32%	3.7 (2-6)	Lysholm: 91 (acute) 80 (chronic) KOS-ADLS: 89 (acute) 69 (chronic) IKDC: Nearly normal: 35% Abnormal: 39% Severely abnormal: 26%	NR
Stannard et al[16]	Diagnostic s tudy	1996-2002	130 (FU: 126)	S: 130	34.1 y (16-70)	Reporting only v ascular injuries (n=9) KD-III: 11% KD-IV: 78% KD-V: 11%	1.6 (8 mo-4 y)	Physical examination as screening tool for vascular injuries	NR
Richter et al[17]	Retrospective	1974-1999	89	S: 63 Acute: 63 NS: 26	33.5 y (15-76). Male: 78%	Surgery mean 10.6 d KD-III: 62% KD-IV: 60%	8.2 (2-25)	Lysholm: 75 IKDC: Nearly normal 21% Abnormal: 55% Severe abnormal: 25%	89% (Jager and Wirth)
					NR	NR			NR

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Dedmond and Almekinders[18]	Meta-analysis 12 retrospective, 3 prospective	1966-1999	295 (meta-analysis)	S: 56% NS: 44%			4.4 (6 mo-10 y)	Lysholm: 81 (67-91)	
Yeh et al[19]	Prospective	1993-1996	31 (FU: 23)	S: 25	37.8 y (16-65)	Surgery mean 11.1 d KD-III: 65% KD-V: 17%	2.3 (2-2.7)	Lysholm: 84.1	No OA (Merchant view)
Wascher et al[20]	Retrospective	1991-1994	14 (FU: 13)	S: 13	27.5 y (14-51)	Surgery within 3 wk KD-III: 54% KD-IV: 46%	3.2 (2-4.5)	Lysholm: 88 IKDC: Nearly normal: 46% Abnormal:38% Severe abnormal: 1% Isokinetic quadriceps muscle strength: 89%, Single leg hop test (− 11-23 cm difference between injured/uninjured).	NR
Wascher et al[21]	Retrospective	1987-1994	50	NR	28 y Male: 77%	Surgery mean 11 d (5-25) KD-II: 12% KD-III: 49% KD-IV: 16% KD-V: 12%, ACL/PCL+periarticular fracture: 10%	NR	NR	NR
Noyes and Barber-Westin[22]	Case series (all surgically treated; acute 7, chronic 4)	1983-1993	11	S: 11 A: 7 C: 4	27 y Male 91%	Surgery mean 14 d (acute), 22 mo (chronic) KD-III: 45% KD-IV: 45% KD-V: 10%	4.8	Overall rating score: Excellent: 9% Good: 18% Fair: 9% Poor: 64%	NR
Almekinders and Logan[23]	Retrospective	1963-1988	31 (FU: 16)	S: 11 NS: 20	31.5 y Male 94%	Surgery within 14 d KD: Not adequately reported	3.4	Modified Marshall score (0; normal—10; worst): Self-score: 5.1 Pain: 3.5 Swelling: 3	Radiological evaluation (0; normal-10; severe): 2.95
Frassica et al[24]	Retrospective	1977-1984	17 (FU: 12)	S: 12 NS: 5	33 y (16-60) Male: 95%	Surgery mean NR KD-III (operative): 13	4.8 (1.8-8.3)	Excellent: 5 Good: 6 Fair: 1 NS data not given	NR
Roman et al[25]	Retrospective	1975-1985	30 (FU: 20)	S: 15 NS: 5	28.5 y (15-78) Male: 93%	Surgery mean 7.4 wk (6-8) KDI-V: NR	Minimum 2 y	NR	NR

Adapted with permission from Engebretsen L, Arna Risberg M, Robertson B, et al. Outcome after knee dislocations: a 2–9 years follow-up of 85 consecutive patients. *Knee Surg Sports Traumatol Arthrosc.* 2009;17:1013–1026.

ACL indicates anterior cruciate ligament; MCL, medial collateral ligament; NA, not available; NR, not responding; PCL, posterior cruciate ligament; KD, Knee Dislocation.

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identify all associated injuries before definitive management of the knee dislocation.[1]

Careful neurovascular examination must occur before and after urgent joint reduction. Patients are placed in hinged knee braces after successful reduction, or in spanning external fixators for any remaining subluxation on lateral radiographs after reduction.[3] Whenever possible, ROM exercises are performed in the preoperative period.

Neurologic Injury

Tethering at the fibular head and a thin epineural connective sheath make the peroneal nerve vulnerable to injury.[35] Peroneal nerve injuries occur in 15% to 40% of knee dislocations,[1,6,27,36,37] and carry the poorest prognosis of peripheral nerve injuries.[38] Bonnevialle et al,[36] in a multicenter study, demonstrated a 50% spontaneous recovery rate that was independent of surgical management and of initial motor and sensory examination. However, this is not in keeping with our experience which indicates that all patients presenting with complete paresis fail to regain clinically useful function, whereas those presenting with incomplete paresis regain function.[1,38]

Exploration and neurolysis of the common peroneal nerve can be performed acutely at the time of ligamentous surgery for patients with lateral-sided injuries.[36,39] In cases of discontinuity, there is generally a long associated area of traction and primary repair is prone to failure.[3,35,36] In select centers, acute nerve transfers are advocated.[40,41] More commonly, foot drop splints, physiotherapy, and observation form the basis for acute management.[11,35] Unexplored persistent palsies should undergo electromyography and nerve conduction studies at 4 to 6 weeks (baseline) and 3 to 6 months postinjury, with neurolysis warranted for absence of recovery.[35,36] Our long-term management in the setting of persistent palsies and nerve discontinuities consists of delayed posterior tibial tendon transfers to improve ankle dorsiflexion function.

Vascular Injury

The popliteal artery is also vulnerable to injury owing to its tethering within the popliteal fossa.[2,4] Vascular injury occurs in 10% to 40% of patients with dislocation,[1,4,6,12,27,37] and prompt diagnosis is critical owing to an increased rate of amputation with prolonged warm ischemia time.[12] The presence of any hard signs of vascular insult such as absent distal pulses, ischemia, active bleeding, or expanding hematoma are indications for immediate exploration by a vascular surgeon[3] and placement of an external fixator. At our institution, the external fixator is removed after 4 weeks and replaced with a brace. The patient is then started on ROM exercises, and ligamentous surgery is delayed for a minimum of 3 months after vascular surgery.

In the absence of an ischemic limb, all patients with knee dislocations are closely monitored clinically for evidence of vascular injury. Several retrospective reviews have supported the use of selective arteriography in the management of knee dislocations and have failed to report any cases of clinically important undiagnosed vascular lesions.[4,16,26,42,43] We currently use computed tomography angiograms for any patients with asymmetrical peripheral pulses or an ankle-brachial index under 0.9.[1,4,26,44,45]

Injury Classification

Accurate preoperative classification of knee dislocations guides management. Dislocation has historically been described based on the static displacement of the tibia in relation to the femur as detected from plain radiographs. However, this approach leads to underdiagnosis of this serious problem owing to spontaneous reduction, and does not reliably determine ligamentous injury.[46] A radiologic study by Bui et al[2] demonstrated anatomic alignment on imaging at presentation of 80% of knees with three or more ligament tears.

At our institution, anatomic diagnosis of injuries is carried out on the basis of serial clinical examinations and a magnetic resonance imaging protocol that includes fine cuts posterior to the fibula for detection of PLC injuries. The Schenck classification is used, where a Knee Dislocation I (KDI) is an ACL or PCL-intact knee dislocation with variable collateral involvement, KDII consists of bicruciate tearing with functionally intact collateral ligaments, KDIII consists of bicruciate tearing with either lateral (KDIIIL) or medial (KDIIIM) injury, and KDIV consists of 4 ligament tearing.[46] Additional neurovascular injuries are indicated with "C" (arterial) or "N" (neural). Anatomic classification is associated with greater prognostic value, and provides information useful for surgical planning in terms of the required number and most appropriate source of ligamentous grafts.[1,2,38,46,47]

Surgical management is delayed for 7 to 14 days after injury to allow capsular sealing and minimization of arthroscopic fluid extravasation, and the knee is mobilized with continuous passive motion during this time.

TECHNIQUE

Setup and Preparation

Under general anesthesia supplemented by epidural anesthesia for postoperative pain control, the patient is placed supine on the operating room table with a tourniquet about the thigh for use as needed only. A lateral post is used at the level of the tourniquet, and a distal bump is positioned to aid with 90 degrees flexion of the knee intraoperatively.

A thorough examination under anesthesia is then performed and all ligamentous injuries are graded according to the American Medial Association guidelines. Subjective side-to-side differences of <5 mm are graded 1+, differences of 6 to 10 mm are graded 2+, and differences greater than 10 mm are graded 3+. The ACL is evaluated by pivot shift, Lachman (20 degrees), and anterior drawer (90 degrees) tests. The PCL is evaluated by posterior drawer test (90 degrees), and the posterolateral structures by reverse pivot shift, recurvatum, and dial tests. The collateral ligaments are examined at both 0 and 20 degrees.

The affected limb is then prepared and draped, and a diagnostic arthroscopy is performed with careful attention to and documentation of meniscal, cartilage, and cruciate injuries. Meniscal injuries are repaired or resected, and tendon harvesting is performed. Our current practice is to use autograft tendons for all cruciate reconstructions. Hamstring tendons are used for the PCL, and bone-patellar tendon-bone (BPTB) for the ACL. Ipsilateral hamstring tendons are harvested unless there is evidence of medial-sided injury, in which case contralateral tendons are used.

After tendon harvesting, all ligament insertion sites are debrided in the femoral notch with a standard 5.5 mm shaver and a thermal probe, taking care to preserve bony anatomic landmarks. The tourniquet is inflated as required to aid with visualization. To facilitate exposure of the tibial PCL insertion, a posteromedial portal is established to introduce the shaver, and a 70 degrees arthroscope is used through the inferolateral portal. All soft tissue is carefully and thoroughly removed from the insertion site to achieve optimal visibility at all times. This

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technique provides excellent visualization of the tibial PCL insertion as the capsule moves away from the joint.

Tunnels

The first tunnel drilled is the tibial PCL tunnel. The start point is placed as distally as possible within the site of the previously harvested tibial bone plug, and a K-wire is aimed using an arthroscopic PCL guide toward the tibial footprint, just lateral within the notch (Fig. 1). The wire is visualized as it enters the joint, and a large curette or empty shaver is used over its tip to prevent inadvertent penetration into the popliteal fossa during overdrilling. Wire placement can be checked under fluoroscopy during the early learning phases of this technique. The PCL tibial tunnel is overdrilled 0.5 mm larger than the diameter of the harvested tendon graft.

The tibial ACL tunnel is then prepared. Using a start point removed from the PCL tunnel, the ACL guide is positioned using the footprint and the posterior edge of the anterior horn of the lateral meniscus as references. The tunnel is reamed to the size of the tibial bone plug.

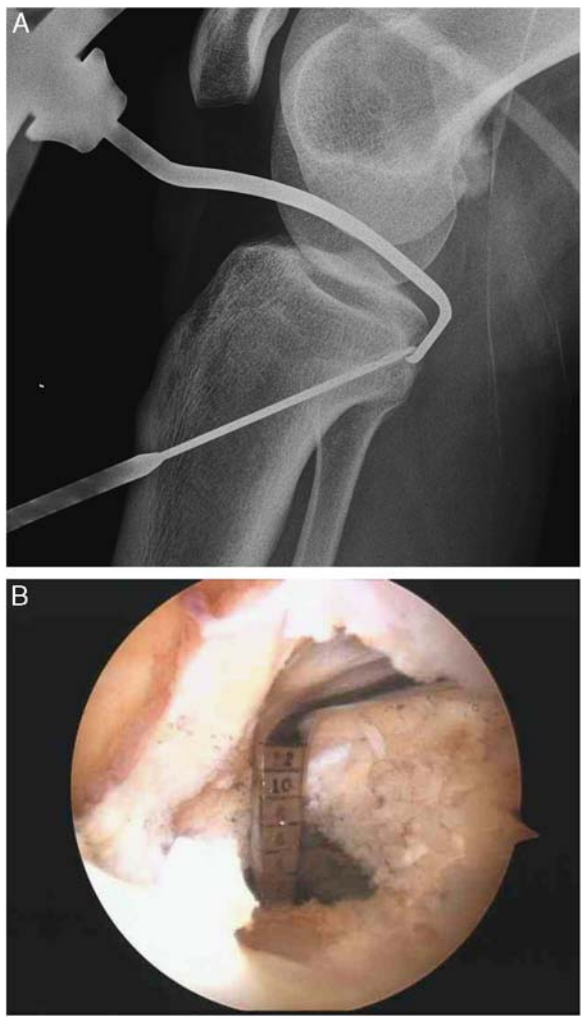

FIGURE 1. A, Intraoperative localization of tibial PCL tunnel with arthroscopic guide in place. Reproduced with permission from Dr RF LaPrade. B, Arthroscopic view of tibial PCL tunnel and guide. Reproduced with permission from Dr RF LaPrade.

FIGURE 2. Fibular collateral ligament reconstruction in place. Reproduced with permission from LaPrade RF, Spiridonov SI, Coobs BR, et al. Fibular collateral ligament anatomical reconstructions: a prospective outcomes study. *Am J Sports Med.* 2010;38:2005–2011.

The ACL femoral tunnel is then localized according to the technique described by Brown et al[48] using an accessory medial portal, and reamed to the diameter of the femoral bone plug. The tunnel abuts the posterior cortex, and the start point is located midway between the lateral intercondylar ridge and the chondral surface, and centrally within the anteromedial bundle footprint. These anatomic landmarks are used whenever possible rather than clock face referencing to improve accuracy and reproducibility.

Finally, the PCL femoral tunnel is prepared using a K-wire through the lateral portal. The clock face is used in this case owing to lack of reliable anatomic landmarks. The start point is 5 to 6 mm deep to the chondral surface at approximately the 10:30 or 1:30 position on the clock face along the medial wall. The tunnel is drilled to a diameter 0.5 mm larger than the PCL graft.

The PCL hamstring graft is passed first, followed by the ACL BPTB graft. Femoral fixation is achieved with a closed loop button for hamstring grafts, and an interference screw for BPTB grafts. Lateral and/or medial injuries are then fully prepared for repair or reconstruction before cruciate graft tensioning.

Medial and Lateral Injuries

Lateral-sided injuries are addressed from a seated position from the ipsilateral side of the table with the knee in approximately 60 degrees of flexion, and approached through a 15 cm curvilinear incision between Gerdy's tubercle and the lateral epicondyle. Full thickness skin flaps are developed anteriorly and posteriorly, and the peroneal nerve is identified and protected throughout the procedure. The local anatomy is complex and the surgical approach to PLC injuries has been documented elsewhere.[49]

The FCL is first identified through a short longitudinal incision at the level of the biceps bursa 1 cm proximal to the fibular head, and then followed to its origin and insertion to determine the location of the injury. Popliteus tendon and popliteofibular ligament injuries are identified through the same approach. All proximal and distal avulsions are repaired with suture anchors when possible. In the setting of an isolated nonrepairable FCL tear, a hamstring autograft is used for

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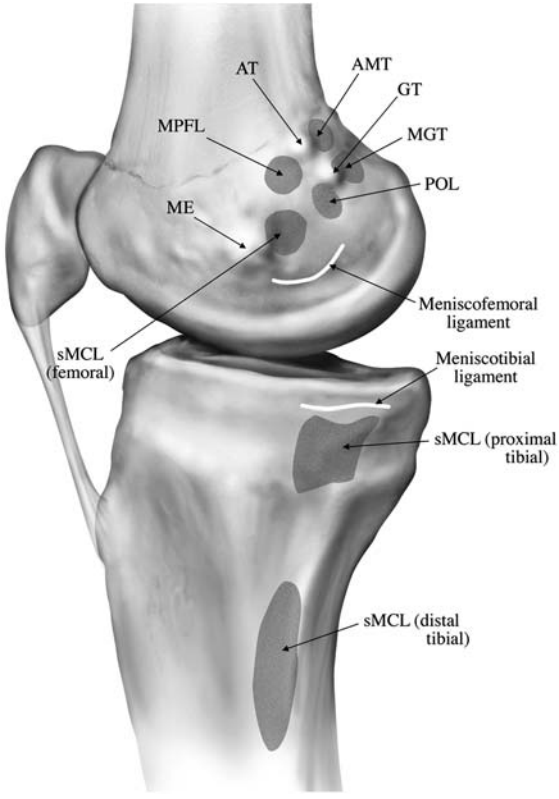

FIGURE 3. Attachment sites of medial knee structures. Superficial medial collateral ligament (sMCL) femoral insertion is anterior and distal to adductor magnus tendon. AMT indiactes adductor magnus tendon; AT, adductor tubercle; GT, gastrocnemius tubercle; ME, medial epicondyle; MGT, medial gastrocnemius tendon; MPFL, medial patellofemoral ligament; POL, posterior oblique ligament. Reproduced with permission from *J Bone Joint Surg Am.* 2007;89:2000–2010. Copyright © 2007 by The Journal of Bone and Joint Surgery, Inc.

reconstruction. The fibular tunnel is drilled from the lateral aspect of the fibular head to the posteromedial aspect of the styloid, and a 30 mm femoral tunnel is prepared at the site of femoral attachment just posterior to the lateral epicondyle.[50] The semitendinosus graft is first fixed proximally with a bioabsorbable screw, passed from lateral to medial through the fibular tunnel, secured within the tunnel with the knee flexed to 20 degrees using a second screw, and sutured back to itself (Fig. 2).[50]

In cases of nonrepairable midsubstance injuries to both the FCL and the popliteus, a full PLC reconstruction is carried out acutely with a split Achilles tendon.[51] The graft is split longitudinally and the bone plugs sized to 9 by 20 mm. Fibular and femoral tunnels are prepared as for isolated FCL reconstruction. In addition, an anteroposterior tibial tunnel is drilled from just adjacent to Gerdy's tubercle to the tibial popliteal sulcus posteriorly with the use of a cannulated cruciate reconstruction aiming device. Also, a second femoral tunnel is prepared at the insertion site of the popliteus tendon, 18.5 mm anteroinferior to the center of the FCL insertion. The graft bone plugs are first secured proximally with interference screws. The posterosuperior graft is then passed through and secured within the fibular tunnel to reconstruct the FCL, and the remaining portion is passed from posterior to anterior through the tibial tunnel to reconstruct the popliteofibular ligament. The second graft is used to reconstruct the popliteus tendon and is passed through the tibia in conjunction with the popliteofibular graft. See LaPrade et al[51] for a detailed description of PLC surgical technique and outcomes.

Medial-sided injuries are approached through a 10 cm incision centered over the medial epicondyle. Once the injury is localized, suture anchor repair of avulsions is performed where possible, including the tibio-meniscal and femoral-meniscal ligaments. When repair is not possible, medial collateral ligament reconstruction using semitendinosus autograft is performed. The semitendinosus is harvested with the tendon stripper and left attached to its distal pes anserinus insertion. The femoral insertion site is reliably localized by palpating the adductor magnus tendon and moving slightly distally (12.1 mm) and anteriorly (6.5 mm).[52] The tendon is then brought up to the medial femoral condyle subcutaneously, fixed to the native proximal insertion site of the medial collateral ligament (Fig. 3) with a screw and washer, and sutured back to itself.[1]

Graft Tensioning

After cycling the knee 20 times, final graft tensioning is performed of the PCL first, followed by the ACL, and finally the collateral repairs or reconstructions. Medial and lateral injuries are prepared for final tensioning by placing all sutures and anchors for repairs, or by fixing reconstructions proximally before cruciate fixation. However, these are tensioned after tibial cruciate fixation to obtain optimal anteroposterior reduction.

The PCL is fixed first with an interference screw, holding the knee in 90 degrees of flexion with a normal tibial step off and in neutral rotation when compared with the normal contralateral knee. The graft sutures can be tied around a bicortical screw and washer for extra fixation or when the graft is deemed short. The ACL is then fixed with an interference screw into the tibial tunnel with the knee close to fully extended. After cruciate fixation, final medial and lateral tensioning and fixation is performed.

RESULTS

Our center recently reported on a cohort of 85 consecutive patients with a mean age of 33 years, treated operatively for knee dislocation at Oslo University Hospital, and followed

FIGURE 4. Postoperative posterior cruciate ligament brace with posterior tibial support. Reproduced with permission from Dr RF LaPrade.

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prospectively for 2 to 9 years.[1] Injuries were classified as Schenck II to V, follow-up rate was 70%, and 60% of patients underwent surgical intervention within 14 days of dislocation. The mechanism of injury included high-energy trauma in 51% and low-energy sporting injuries in 33%. Patients sustaining significant vascular or neurologic injuries were included in the analysis.

The median Lysholm score at follow up was 83 (15 to 100), the Tegner activity score was 5 (0 to 9), and the IKDC subjective score was 64 (44 to 84), with no significant differences between early (<14 d) and late intervention. On examination, 90% had a negative or 1+ Lachman, and 94% a negative or 1+ pivot shift. The mean side-to-side difference in KT-1000 was 2.7 mm (±3.7). Radiographs demonstrated 87% with evidence of osteoarthritis in the injured limb (Kellgren and Lawrence grade 2, 3, or 4), compared with 35% in the uninjured limb. On the single leg hop test, injured knees performed to 83% to 89% of the contralateral side. Patients with knee dislocations owing to high-energy trauma had worse outcomes as measured by Lysholm and hop testing.

Similar results were found by Levy et al[32] in patients requiring 3 to 6 weeks of initial spanning external fixation followed by arthroscopic ligament reconstruction, with no apparent effect of on rate of postoperative stiffness requiring manipulation (1%) in their series of 9 knees.

Complications

Postoperative arthrofibrosis occurs in 6% to 10% of patients, and patients with severe medial injuries are at highest risk.[33] Other risk factors include delayed rehabilitation, infection, and complex regional pain syndrome.[53] Prevention is best achieved through preoperative and immediate postoperative mobilization. Treatment consists of early mobilization under anesthesia (4 to 12 wk), with arthroscopic debridement reserved for resistant cases.

Other complications include superficial infections (3%), deep infection (1%), deep vein thrombosis (3%), and anterior knee pain after BPTB graft harvest.[33]

Postoperative Management

Epidural anesthesia is left in place for 2 to 3 days to improve tolerance for ROM. Immediately after surgery, gentle passive and active ROM exercises are performed twice daily, as well as isometric quadriceps exercises and straight leg raises. A brace with a posterior tibial support is worn for a total of 4 months to protect the PCL reconstruction—full time for the first 8 weeks, and part time for the last 8 weeks to allow ROM out of the brace (Fig. 4).

For the first 4 weeks, the patient is kept non-weight bearing, after which partial weight bearing is initiated with crutches. The patient progresses to full weight bearing by 8 weeks, and exercises are introduced to strengthen the quadriceps, hamstrings, and calf musculature. Return to full activity occurs between 9 and 12 months after surgery, when quadriceps muscle strength achieves at least 80% of the uninjured limb and ROM is full.

Possible Concerns, Future of the Technique

Significant controversy continues to surround the acute management of knee dislocations. The combination of the rarity of the injury with the rapid advancement of arthroscopic surgical technique make prospective longitudinal study difficult. Our current clinical outcomes using this technique support acute single-stage arthroscopic reconstruction. However, multicentre randomized trials are necessary to clarify the effects of timing, technique, and perioperative care on long-term outcomes. Our database currently contains over 200 knee dislocations that we intend to follow up and report on prospectively as a cohort.

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