



Ligament repair and reconstruction in traumatic dislocation of the knee

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We treated 21 patients with 22 dislocations of the knee by repair or reconstruction of all injured ligaments. Eight knees were treated in the acute phase (less than two weeks after injury); the remainder were treated more than six months after injury (6 to 72). Reconstructions were carried out with a combination of autograft and allograft tendons and by direct ligament repair where possible. At a mean follow-up of 32 months (11 to 77) the mean Lysholm score was 87 (81 to 91) in the acute group and 75 (53 to 100) in the delayed group. The mean Tegner activity rating was 5 in the acute group and 4.4 in the delayed group.

The International Knee Documentation Committee assessment revealed no differences between the two groups. Instrumented testing of knee stability indicated better results for anterior cruciate ligament reconstructions which had been undertaken in the acute phase, but no difference in the outcome of posterior cruciate ligament reconstructions. There was no difference in the loss of knee movement between the two groups. Although the differences were small, the outcome in terms of overall knee function, activity levels and anterior tibial translation were better in those knees which had been reconstructed within two weeks of injury.

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Traumatic dislocation of the knee, confirmed by clinical and radiological evidence of tibiofemoral disarticulation is a rare injury although this definition of dislocation may underestimate the true incidence.¹ An injury to two or more of the main ligament structures - anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), lateral ligament complex or medial collateral ligament (MCL), will result in a significant, but momentary displacement of the joint surfaces (Fig. 1). There is a risk of periarticular fracture and neurovascular damage and, if the extent of the injury is underestimated, the patient will develop symptoms of instability and in the long term, premature osteoarthritis.

The most effective treatment for traumatic dislocation of the knee remains controversial. Some surgeons have advocated POP immobilisation,² while others have approached this complex problem by primary repair of all the injured structures. The results of this approach are disappointing, with a high incidence of persistent instability and loss of movement.³⁻⁹ The advent of reliable methods for reconstructing both cruciate ligaments by using autogenous tendons has seen a shift towards early bicruciate ligament reconstruction, either simultaneously or as a staged procedure.¹⁰⁻¹⁵

Experience in our unit suggests that knees which have undergone ligament reconstruction have better function than those which have been treated non-operatively.¹⁶ A protocol was established for the early repair of the collateral structures and reconstruction of both the ACL and PCL. Later referrals were subjected to a thorough assessment in order to determine the patterns of instability before reconstruction was undertaken. The purpose of this study was to evaluate the clinical results of this protocol, in which contemporary surgical techniques have been employed.

Patients and Methods

Between 1994 and 2001, 21 patients with 22 dislocations of the knee presented to our unit. A dislocation was defined as an acute injury resulting in complex, multidirectional instability. For inclusion in this study, multiple ligaments must have been injured, with at least two of the four major ligaments torn.¹⁷ All patients were managed by repair or reconstruction of the injured structures. Patients included both acute admissions and late referrals from outside the region. The details of the injuries are summarised in Table I.

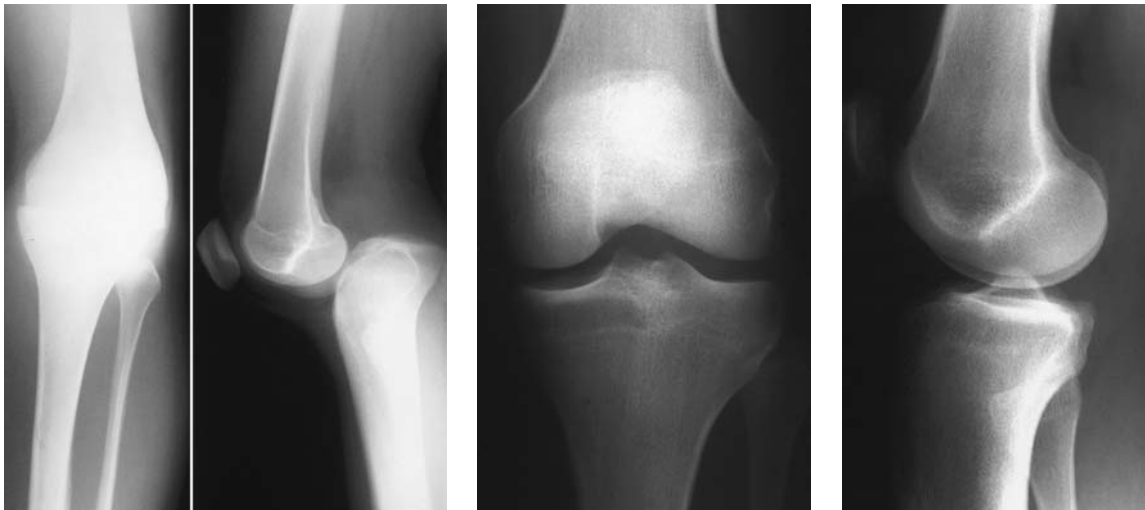


Fig. 1a

Fig. 1b

Fig. 1c

Radiographs showing dislocations of the knee. a) Anteroposterior (AP) and lateral radiographs of a 20-year-old woman (case 16) with an obvious dislocation. b) An AP and c) a lateral view of a 19-year-old man (case 4) who presented with the knee reduced. Examination under anaesthesia confirmed ruptures of the ACL and posterolateral complex. Any injury that produces complete tears of two of the four ligament complexes is now regarded as a dislocation of the knee.¹⁷

Table I. Injury details of the 21 patients with traumatic dislocation of the knee

Case	Age (yrs)	Gender	Mechanism of injury*	Associated injuries and complications†	Early treatment	Time interval before definitive treatment		Follow-up interval (mths)
						Days	Months	
Acute reconstruction								
1	25	F	Contact sport		POP immobilisation	7		28
2	22	M	RTA			13		31
3	30	M	RTA	Possible compartment syndrome, blunt abdominal trauma, ISS >15	Compartment pressure monitoring, laparotomy	3 (right knee)		36
						5 (left knee)		36
4	19	M	Jump			10		18
5	16	M	Contact sport			12		8
6	34	M	Non-contact sport			14		8
7	35	M	Jump	Peroneal nerve injury, marginal medial tibial condyle fracture	Examination under anaesthesia, aspiration	9		11
Chronic reconstruction								
8	46	F	RTA		Examination under anaesthesia, arthroscopy		12	20
9	46	M	RTA	Multiple injuries, ISS >15	Stabilisation of fractures		13	42
10	29	M	Contact sport		Early MCL repair		16	26
11	43	M	Contact sport				17	15
12	21	M	Trampolining				6	6
13	18	F	RTA		Early MCL repair		11	65
14	22	M	RTA	Contralateral tibial fracture	Open reduction and internal fixation tibia		30	39
15	15	M	RTA				60	27
16	20	F	Trampolining	Popliteal artery injury	Examination under anaesthesia, external fixation, vascular graft		6	84
17	39	F	RTA	Open dislocation, contralateral femoral fracture	Wound debridement, open reduction and internal fixation femur		27	77
18	26	M	Contact sport				63	11
19	19	M	Contact sport				9	18
20	18	M	Jump		Examination under anaesthesia, repair LCL		60	44
21	21	M	RTA	ISS >15, brachial plexus injury			72	56

*RTA, road traffic accident

†ISS, injury severity score

Table II. Details of surgical reconstructions of ACL, PCL, MCL, LCL and the posterolateral corner (PL) for traumatic dislocation of the knee

Case	Injured structures	Reconstructions				Posterolateral corner
		ACL	PCL	MCL	LCL	
Acute reconstruction						
1	ACL, PCL, LCL, PL	Patellar autograft	Hamstring + augment*		Repair	Repair
2	ACL, PCL, LCL, PL	Patellar allograft	Achilles allograft		Repair	Repair
3 Right	ACL, PCL, MCL	Patellar autograft	Achilles allograft + augment*	Repair		
3 Left	ACL, LCL, PL	Patellar autograft			Repair	Biceps advancement
4	ACL, LCL, PL	Hamstring			Repair	Repair
5	ACL, LCL, PL	Hamstring			Repair	Repair
6	ACL, LCL, PL	Hamstring			Repair	Repair
7	PCL, LCL, tibial fracture		Achilles allograft		Repair	
Chronic reconstruction						
8	ACL, PCL, LCL, PL	Patellar allograft	Achilles allograft + augment*			Larson's reconstruction with hamstring
9	ACL, PCL, LCL, PL	Patellar allograft	Achilles allograft + augment*			Larson's reconstruction with hamstring
10	ACL, PCL, LCL, PL	Hamstring	Achilles allograft + augment*		Acute repair	Biceps advancement
11	ACL, PCL, LCL, PL	Patellar autograft	Achilles allograft + augment*			Larson's reconstruction with hamstring
12	ACL, PCL, MCL	Hamstring	Achilles allograft + augment*			
13	ACL, PCL, MCL	Patellar autograft	Patellar allograft			
14	ACL, PCL, MCL	Patellar autograft	Achilles allograft + augment*	Femoral advancement		
15	ACL, PCL, MCL	Patellar autograft	Achilles allograft + augment*	Tibial advancement		
16	ACL, PCL	Patellar autograft	Achilles allograft			
17	ACL, PCL	Patellar autograft	Achilles allograft + augment*			
18	ACL, PCL, LCL, PL	Patellar autograft				Larson's reconstruction with hamstring
19	ACL, LCL, PL	Hamstring				Trouser Achilles allograft with augmentation*
20	ACL, LCL, PL	Hamstring				Trouser Achilles allograft with augmentation*
21	PCL, MCL		Achilles allograft + augment*	Semitendinosus		

*augment: graft reinforcement with Leeds-Keio neoligament

Operative strategy and techniques. The senior authors (JFK and RWN) favoured early repair and reconstruction. For this reason, seven patients (eight knees) underwent exploration and repair or reconstruction within 14 days of injury. In this group, the collateral ligaments and posterolateral corner were repaired when indicated, and the cruciate ligaments reconstructed. Both the ACL and PCL were reconstructed simultaneously if required. Fresh frozen allografts were used as shown in Table II. Five patients had reconstructions within 12 months of injury and the remainder had late reconstructions, more than one year from injury.

The pattern of ligament disruption was defined at the time of surgery in the acute referrals. The remainder underwent detailed examination in order to assess the integrity of the ACL, PCL, MCL, lateral collateral ligament (LCL) and posterolateral complex. MR scans were obtained and the patterns of instability were finally confirmed on examination under anaesthesia immediately prior to the reconstructive operations. The patterns of instabilities are summarised in Table II.

Collateral ligaments were repaired if there was a midsubstance disruption, or reattached if avulsed from their insertion (Fig. 2). Tears of the LCL often accompanied

disruption of the posterolateral complex. In the acute setting, the posterolateral structures were repaired (five patients), and, in one patient, the repair was augmented with a biceps femoris advancement. Late reconstructions of the posterolateral corner used the modified Larson repair (four knees) with hamstring autografts or a 'trouser legs' tendo Achillis allograft technique (two patients).^{18,19}

The cruciate ligament reconstructions were through an open approach when undertaken early and arthroscopically when carried out late. For anterior cruciate reconstruction we used patellar tendon-bone autografts in ten patients, host four-strand hamstrings in seven, and patellar tendon-bone allograft in three patients (Table II). PCL reconstructions were undertaken in 15 knees, 13 with tendo Achillis allograft. Ten were augmented with a synthetic ligament. One PCL reconstruction required autogenous hamstrings augmented with a prosthetic ligament. In combined ACL and PCL reconstructions, the PCL grafts were tightened in order to re-establish the central pivot of the knee²⁰ before the ACL grafts were secured. In the event of an additional MCL disruption, its repair or reconstruction followed the bicruciate reconstruction.²¹ With the combination of ACL, PCL, LCL and posterolateral injuries, the PCL was stabilised



Fig. 2a



Fig. 2b



Fig. 2c

Acute surgery involved repair of the collateral ligaments and posterolateral complex, with reconstruction of the cruciate ligaments. The lateral collateral ligament and posterolateral structures were repaired with ligament washers as shown in the AP radiograph of case 2 (a) and suture anchors as shown in the AP and lateral radiographs of case 4 (b and c).



Fig. 3

PCL reconstructions were assessed with stress radiographs. The technique was modified from that of Staubli et al.²⁵ The displacement of the tibia against the femur was measured.

first, followed by the LCL and posterolateral corner, before the final fixation of the ACL graft.²²

Postoperative management entailed protection of the knee in a hinged knee brace for eight to 12 weeks. Patients

were initially allowed flexion to 30° for four weeks, increasing progressively to 90° by the twelfth postoperative week. They were allowed touch weight-bearing mobilisation for six weeks, progressing to full weight-bearing by three months. We stressed the avoidance of open chain active knee flexion in the early healing phase in order to minimise the forces which may sublux the tibia posteriorly and compromise the PCL reconstruction. Bracing was discontinued at three months.

Assessment. An independent observer made a detailed objective and subjective assessment of all patients. This comprised a physical examination which included measurement of the range of knee movement with a goniometer, instrumented Lachman and posterior drawer tests at 80° using the Rolimeter (Aircast, Summit, New Jersey), assessment of opening of the joint line on varus and valgus stressing, the 'dial test' for posterolateral instability and the pivot and reverse pivot tests.^{23,24}

In order to evaluate the competence of the PCL reconstruction, we employed a radiological technique modified from that of Staubli, Noesberger and Jakob.²⁵ This comprised a posterior stress lateral radiograph at 80° of knee flexion with a 10 kg weight against the tibia in order to assess the translation of the tibia relative to the femur (Fig. 3).^{25,26}

Knee function was assessed using the International Knee Documentation Committee (IKDC) chart²⁷ and the Lysholm Score.²⁸ Physical activity levels were measured using the Tegner Activity scale.²⁹

Results

We assessed 21 patients (22 knees) at a mean follow-up of 32 months (11 to 77). The mean age at the time of injury was 27.7 years (15 to 46). There were 16 men and five women. The causes of injury and the interval between injury and surgery are shown in Table I. Three patients had multiple injuries (Injury Severity Score >15). One had a concomitant disruption of the popliteal artery which required a vascular reconstruction and one had a common peroneal nerve injury.

Nine (41%) of the dislocations were documented radiologically, while four (18%) were recognised clinically and had undergone immediate reduction. The remaining nine (41%) were recognised as having severe, acute, complex ligamentous injuries either on clinical examination, MRI or examination under anaesthesia in the days after their admission. Seven patients (36%) (eight knees) underwent surgical treatment in the acute period, between two and 14 days. The remaining 14 (64%) were late referrals and underwent reconstruction for chronic instability at six to 72 months after injury. Details of the injured structures and reconstructions are shown in Table II.

The assessment of knee function using the IKDC form showed that eight knees were grade B or 'nearly normal', nine grade C or 'abnormal' and five grade D or 'severely abnormal'. No knees were grade A or 'normal'. Three of the eight knees which were treated acutely scored grade B compared with five of the 14 knees which underwent a delayed reconstruction. The mean Lysholm score for all knees was 79 points (53 to 100) with acute knees scoring a mean of 87 points (81 to 91) and late reconstructions a mean of 75 points (53 to 100). All acutely treated knees had a Lysholm score of >80 compared with only 5 of 14 (36%) of chronically treated knees. The mean Tegner activity level was 4.6 (1 to 7). Five acute knees had levels ≥ 5 , compared with seven of the delayed reconstructions. The mean Tegner level was 5 (3 to 7) following early reconstruction and 4.4 (1 to 7) following late reconstruction.

Knee movement was measured with a goniometer. The mean loss of extension was 8° (acute knees, 10°; late reconstructions, 7°) and the mean loss of flexion was 7° (acute knees, 4°; late reconstructions, 8°). One patient who underwent an early reconstruction developed arthrofibrosis and subsequently required a manipulation under anaesthetic.

Instrumented testing of ACL function was undertaken on 20 knees after ACL reconstruction. No knee had less than 3 mm of side-to-side difference, 15 knees had 3 to 5 mm difference and five knees had more than 10 mm. Six of the seven acute reconstructions had 3 to 5 mm difference on arthrometry compared with nine of 13 delayed reconstructions. PCL reconstructions were carried out in 15 knees. No knee had 0 to 3 mm side-to-side difference using the posterior stress test, three knees had 3 to 5 mm side-to-side difference, eight had 6 to 10 mm and four had more than 10 mm difference. Three of the four acutely treated knees had

less than 10 mm difference while eight of the 11 chronic reconstructions achieved a similar result. The pivot shift test was negative in six knees and Grade 1 positive (a 'glide' of movement) in the remainder. The 'dial' test, at 30° and 90° of knee flexion, was negative (less than 15° of difference between the sides) for all knees.

Collateral ligament function was estimated by manual clinical testing at 20° of flexion. Of the 14 knees with a LCL injury, seven had 3 to 5 mm of opening of the joint line and seven had >5 mm. In the seven knees with injury to the MCL, three had 3 to 5 mm of opening of the joint line and four had >5 mm.

Discussion

The definition of dislocation of the knee which was used in this study differs from that used in earlier reports, which required clinical or radiological evidence of dislocation.^{7,8,30} More recent studies have altered the definition to include all knee ligament injuries, which involve two or more main ligament structures.^{1,17} This appears to be appropriate as severe injuries may cause a momentary dislocation, which reduces spontaneously. This may result in severe soft tissue disruption, but without clinical or radiological evidence of dislocation.^{5,31}

Opinions on the best method of treatment of an acute dislocation of the knee vary widely. Advocates of a nonsurgical approach recommend POP immobilisation after reduction of the dislocation and vascular repair if this is required.² Others have reported a poor outcome of conservative treatment and have recommended early surgical exploration and attempted repair of all damaged ligaments.⁶ Repair of mid-substance ligamentous tears has generally been unsuccessful, although better results have been obtained following reattachment when the ligaments have been avulsed from their insertions.⁹

Recent developments in knee ligament reconstructive surgery for ACL and PCL tears using graft augmentation have been applied to reconstruction for acute dislocation and chronic complex instability of the knee. In addition, the use of allograft tendons has addressed the problem of the morbidity which is created by the use of autogenous tendons from the same leg, although harvesting tendons from the opposite leg remains an option. The risk of arthrofibrosis is a major concern following an acute reconstruction, particularly if this involves both cruciate ligaments. Some authors recommend reconstruction of the PCL and collateral ligament injuries alone, and defer ACL reconstruction until the patient develops rotatory instability. This is said to be rare.^{10-12,32} Others advocate reconstruction of all injured ligaments, including the ACL, and employ early, controlled range of movement exercises in a brace,^{13,14,33} although Shapiro and Freedman¹⁵ acknowledged that arthrofibrosis and heterotopic bone formation may occur.

This study reports our experience with reconstruction of all the injured ligaments in a group of patients with a major

knee injury who were treated either acutely, within two weeks of injury, or by delayed reconstruction. We have previously reported better results with reconstruction than with nonsurgical treatment after dislocation of the knee and wished to determine if early surgical repair produced better results than late reconstruction.¹⁶ Knee function, as measured by the IKDC scale, rated no knee as 'normal' (Grade A) and eight knees as 'near normal' (Grade B). This poor result may be due to the harsh standards set by the IKDC scale compared with the Lysholm score. The Lysholm score is more subjective, and resulted in a mean score of 79 of a maximum of 100 points, with 60% of knees rated above 80 points. The Tegner activity scale, which rates physical activities as being between 0 and 10, revealed that 54% of patients had a rating ≥ 5 . All knees which were treated acutely had a Lysholm score of >80 and a mean Tegner activity level of 5. This compared with 36% of the chronic reconstructions which had a Lysholm score of >80 and a mean Tegner activity rating of 4.4

For an objective measurement of knee stability we used arthrometry and stress radiography. For those knees in which an ACL reconstruction had been undertaken, anterior tibial translation was <5 mm in 66%. The results were better when the ACL had been reconstructed in the acute phase, as six of seven knees had 3 to 5 mm of anterior translation compared with nine of 13 knees which had undergone a delayed reconstruction. The results of PCL reconstruction were less satisfactory due to a persistent posterior tibial subluxation of >5 mm in 12 of 15 knees. There was no difference between acute or delayed reconstructions. The difficulty in abolishing posterior tibial subluxation when undertaking a PCL reconstruction has been highlighted previously and is thought to be due to stresses imposed upon the graft during the healing period by the posterior drawer effect which is created by the hamstring muscles and gravity.^{11,31} In addition, most of the patients with a PCL disruption had their PCL reconstructed with allograft tendon, which may be slower to incorporate than an autogenous graft.³⁴

These results suggest that early repair or reconstruction of all injured ligaments may produce a better functional outcome and a more stable knee, although the risk of arthrofibrosis remains a concern. In this series, the mean loss of flexion and extension in the acute group was 4° and 10° , respectively, compared with 4° and 7° in the late group. These results do not support the view that early intervention runs a higher risk of producing arthrofibrosis and loss of movement.

In summary, repair or reconstruction of the injured ligaments in patients with traumatic dislocation of the knee can improve the stability in these very unstable knees. Early, rather than delayed reconstruction produced better results in terms of function and stability without an increased risk of arthrofibrosis. In our experience, the management of a dislocated knee is a major surgical challenge and should only be undertaken by surgeons with extensive experience of knee ligament reconstruction.

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