

LONG-TERM FOLLOW UP OF POSTERIOR CRUCIATE LIGAMENT RUPTURE: A STUDY OF 116 CASES

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With adequate quadriceps exercises, the prognosis of a ruptured posterior cruciate ligament can be greatly improved. Of the 116 cases followed in this report, 55 were sports injuries while most of the remainder were traffic accidents. An excellent or good result was obtained in 47 sports injured patients, while only 5 involved in road trauma obtained this result. Surgery was used to improve the eventual result and this was successful in nine cases. Early repair is still the treatment of choice. Eighty percent of ruptures can have a good or excellent result with effective management.

Introduction

Tears of the posterior cruciate ligament (PCL) are most common than was previously thought. These may be isolated or associated with other injuries to the knee joint. The injury has been frequently missed during the acute examination only to manifest itself at a later date.. It is now recognised that the damage is related to the severity of the injury rather than the mechanism involved. In this study, 116 patients were followed in order to determine the natural history of such injuries. Previous studies have contained fewer cases and have concentrated on surgical aspects of the injuries.

Anatomy and Biomechanics

There have been many interpretations made about the function of the cruciate ligaments. Hertzmark considers them to be vestigial structures while Hughston⁷ maintains they are the all important structures governing rotary stability and knee joint function.

The PCL forms the lateral border of the medial compartment of the tibio-femoral joint. It extends from the medial femoral condyle, downward, posteriorly and laterally to insert into the posterior aspects of the tibia.⁸

The femoral attachment is on the anterior juxta-articular part of the lateral wall of the medial femoral condyle. Its curved shape represents the centres of rotations of the knee joint. The lower border of the attachment corresponds to the shape of the condyle. The tibial attachment lies in a depression behind the articular surface of the tibia. At this point, the ligament gains attachment to the posterior horn of the lateral meniscus.

The ligament itself consists of two parts: the anterior portion, the largest, and an oblique posterior part. The fibres are twisted to accommodate the perpendicular attachments. Its dimensions are 38mm in length and 13mm in width. Synovial membrane, reflected from the posterior capsule, covers the medial, lateral and anterior aspects. The posterior aspect blends with the capsule. Hence, it is entirely extraarticular.

The PCL is extremely strong. Injuries involving the ligament often avulse the bony tibial attachment rather than rupture the ligament. Some of its fibres are taut in all degrees of knee movement. Hey Groves⁹ maintained that it only tightened in flexion. In conjunction with the anterior cruciate ligament (ACL), it maintains lateral stability, even if the collateral ligaments are ruptured. Anteroposterior stability is maintained in extension should the ligament be ruptured, but is lost in flexion. In full extension and hyperextension, it maintains stability, aiding the ACL, collaterals, posterior capsule and arcuate complex as well as anterior horns of the menisci.

The PCL fixes the medial femoral condyle firmly in all degrees of normal movement. The instant centres of rotation of the medial and lateral femoral condyles are different and move independently even though they are fixed through the intercondylar ridge. The axis of rotation of the femur is shifted medially by the action of the ligament during flexion. This limits medial rotation and abduction of the femur.

Literature Review

Hey Groves⁹ in 1920 recognised that little was known about the derangement of the knee joint. He produced some of the earliest definitive work of classifying injuries and also exploring treatment, having seen that the diagnosis of ‘slipped cartilage’ did not satisfy all cases. He differentiated that minor twists gave rise to cartilage injuries while PCL injuries resulted from severe direct trauma.

Ivar Palmer¹⁶, in 1938, produced the first complete review of knee ligament injuries. He included a comprehensive literature review of the available material in the period. Using rigorous examination techniques, and correlating these with clinical findings at operation, he was able to classify most common ligamentous and bony injuries of the knee joint. He recognised that inadequate muscular protections of the joint is the most important predisposing factor for ligamentous injury and for further rehabilitation. He also recognised the benefits of arthrography in elucidating meniscal and cruciate ligament tears of the joint.

In 1941, Abbott et al.¹ and Brantigan and Voshell² produced extensive work in correlating the anatomy and the biomechanics of the cruciate ligaments. This work has formed the basis of much current work on the function of the knee joint and its pathology.

O’Donoghue,¹⁵ writing in 1955 on a study of 84 major injuries to the knee, found that 62 had an injury to the cruciate ligaments. Of these, only eight involved the PCL and three involved isolated injuries. He advocated early surgical repair of all ligamentous injuries. Follow-up studies produced the following year supported this concept.

That PCL injuries are relatively uncommon can be seen in broader studies of knee injuries. Pickett and Altizer, in a study of 129 ligamentous injuries of the knee, found only three isolated injuries of the PCL. A further eight showed PCL damage associated with other major trauma to the anterior cruciate, medial and lateral ligaments with the majority of their study being concerned with the ACL injuries. A small number of patients reviewed in other studies bears witness to the rarity of the lesions, Trickey’s work²⁰ showed seventeen.

Hughston,⁸ while writing extensively on knee joint injuries, recognised the importance of standardising the clinical examination of the knee in order to determine the instabilities present. A positive abduction stress test at full extension in acute injuries was the most significant test for PCL ruptures. He also recognised the importance of examining for recurvatum of the joint. This condition is commonly misdiagnosed as a PCL injury. He has advocated that palliative and conservative methods should not be considered and immediate repair instituted in ruptures of the PCL.

McMaster¹³ carried out an extensive literature review of posterior cruciate ligament injuries stressing the rarity of such injuries. His conclusion showed that the trauma involved must be extremely violent and hence is often associated with other knee disorders.

Jones and Smith,¹⁰ in a study of vascular and orthopaedic complications of dislocation of the knee, found that in 10 cases out of 22, dislocations had major vascular problems. These included thrombosis or transection of the popliteal artery. However, they found that only seven of the dislocations were posterior and of these, only one was complicated by vascular injuries. Orthopaedic complications uncovered in the series showed that of the seven posterior dislocations, all had significant rupture of the posterior capsule requiring extensive repair.

Work by Meyers¹² in isolated avulsion fracture of the PCL in 14 cases showed that this injury occurred more frequently than previously expected. Results if immediate repair were very encouraging, seven out of eight having good results following open reduction. Similar work by Torisu¹⁹ in Japan showed equally encouraging results. Other authors dispute isolated avulsion of the PCL saying that other trauma is always evident.

Materials and Methods

The patient material selected in this study came from patients seen by the senior author in his own practise from years 1975 to 1980. This provided continuity in assessment and treatment of all cases. No new cases were included after December 1980. One hundred and sixteen cases were reviewed in full, only three of which were seen in the acute stage of injury. The remainder were all referrals from both city and country general and orthopaedic practices. Only traumatic cases were reviewed and those due to diseases of the knee joint such as rheumatoid arthritis were excluded.

The patients were grouped into the activity resulting in the injury to the knee. These were further subdivided into sporting injuries, motor vehicle accidents, work related injuries, and those which were unknown. A second division was carried out showing the mechanism of the injury. This included anteroposterior force, twisting, compression, and hyperextension.

Assessment was carried out by personal interview and examination of each patient. A standardised format was applied in all of these cases. Each patient was interviewed, eliciting the chief complaint involved with the knee and a detailed history of the mechanism of injury and subsequent clinical course. A standard clinical examination was carried out on each patients as described by Hughston et al.⁸ All follow-up

examinations were conducted in a similar manner. The initial history and examination was recorded on a standardised knee sheet as described by Slocum. Follow-up examinations and histories were recorded on a standardised sheet devised specifically for the study. The patient's own satisfaction of the results of treatment was used in assessment of the success as well as a clinical assessment of the joint.

The initial assessment and end results of treatment were graded using a system modified from Moore and Larson:

Excellent: The patients could carry out his normal daily activities and occupation as before his accident.

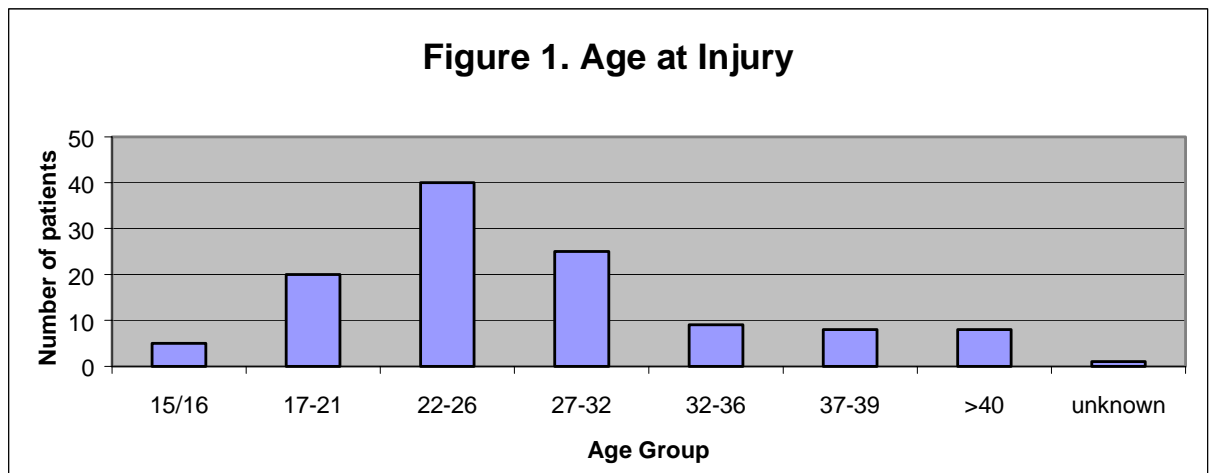
Good: The patients could carry out his normal daily activities but the knee showed signs of strain when put under sever stress.

Fair: Some degree of discomfort was experienced while carrying out normal daily function and high stress situations need to be avoided by the patients.

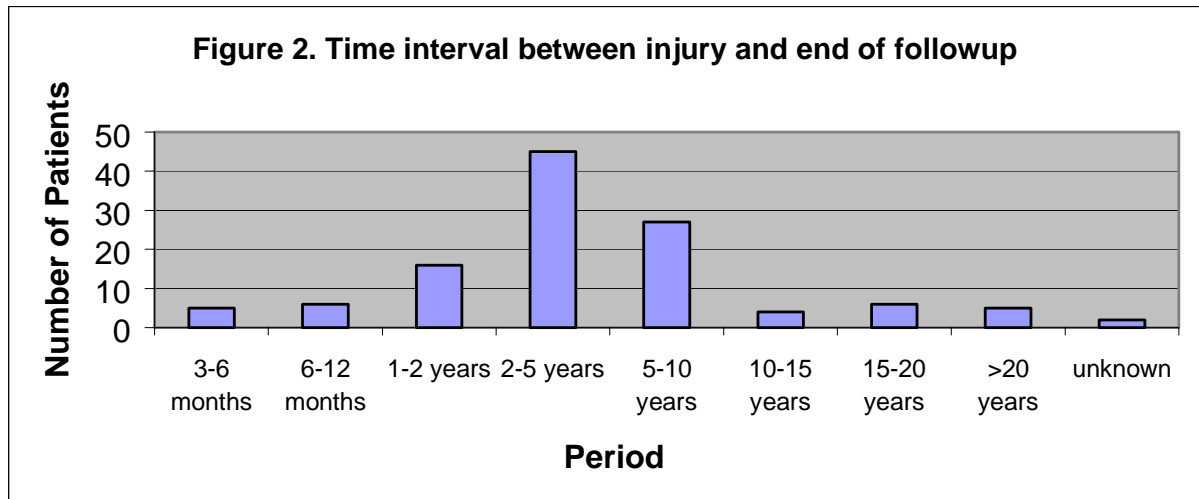
Poor: The patient was unable to carry out his normal activities without a severe degree of discomfort arising from the knee.

Results

The age of patients at time of injury ranged from 15 to 56 years with 42 cases (36%) occurring between the age of 20 and 24 years. A further 17% occurred between the ages of 15 and 19 years. The mean age was 22 years. Seven patients had an injury at greater than 40 years of age (Fig. 1).



The time interval between the injury and the end of follow-up ranged from 3 months to 20 years. Of these patients, 45 patients had a 2-5 years follow-up. The other periods of follow-up were less than 2 years. Five patients were evaluated more than 20 years after the injury (Fig. 2).



The mechanism of injury was usually of fairly violent nature. Fifty-five patients were participating in some form of contact sport; 48 of these patients were playing football and the remainder were engaged in soccer, hockey, skiing or water skiing. Road accidents accounted for 29 patients of which 16 were involved in motorcycle accidents and 12 in car accidents. There was only one pedestrian. Of the remainder, 10 patients were involved in a fall and 2 in falls from ladders. The remaining 20 patients were unable to give an accurate account of what they were doing at the time of injury.

In 29 patients, the mechanism of injury was found to be a severe twist with a valgus or varus force. An anteroposterior force on a flexed knee resulted in 26 injuries and, in a further 20, this was combined with a twisting force. There were nine cases in which hyperextension was the mechanism of injury and dislocation of the knee joint accounted for two patients. The remaining 30 patients were unable to give a precise mechanism of injury.

The chief complaint in 44 patients was a straight instability of the knee, which lacked the precipitancy of anterior cruciate insufficiency. Forty patients complained of pain in the right knee, the majority of which was retropatellar. This usually develops some time after the initial injury. Forty-three patients developed clinical chondromalacia patellae in period ranging from 3 months to greater than 5 years from injury. A feeling of weakness in the knee with no instability was described by seven patients and a further six complained of swelling in the joint. Four patients complained of stiffness in the knee. Associated trauma to other structures within the joint was also noted. Twenty patients showed collateral ligament damage, 12 to the medial ligament and 8 to the lateral ligament. Internal derangements of the knee were noted at arthroscopy or arthrotomy. The medial meniscus was involved in 46 cases and the lateral meniscus in 24 cases. Sixteen patients had pathology in both menisci. Four patients had fractures involving the knee joint.

In patients with longer follow-up periods, the changes of osteoarthritis were noted. Medial compartment wear was noted in 20 patients and lateral compartment wear in a further 8 cases. Only four patients had developed tri-compartmental osteoarthritis at the end of the follow-up.

Forty-nine had some form of operative intervention. Three patients had an acute repair while 27 had reconstructive surgery, which altered the dynamics of the knee joint. This usually involved a reconstruction using semitendinosus tendon or a collateral ligament or capsular reconstruction. A further 19 patients had palliative surgery which usually involved medial or lateral meniscectomy. Arthroscopy alone with no other procedure was employed to assess the joint in 16 patients. The remaining 67 patients had not form of procedure (Table 1).

Table 1. Knee joint function versus surgical intervention

Assessment	Acute Repair	Reconstructive Surgery		Palliative Surgery	
		Pre-Op	Post-Op	Pre-Op	Post-Op
Excellent	1	-	8	-	12
Good	1	8	10	14	3
Fair	-	7	4	1	-
Poor	1	10	5	4	4
Unknown	1	2	-	-	-
Total	3	27		19	

The tone of the quadriceps muscle was graded at the beginning of treatment and at the end. These were graded as good where resting tone was high and muscle bulk, especially of the vastus medialis obliquus, was well developed. A poor quadriceps did not show these features. In the initial assessment, 74 patients showed good quadriceps while 42 had poor quadriceps. At the end of the treatment, 101 patients were graded as good while 15 were graded as poor. Quadriceps bulk and tone was then correlated against the eventual functional test (Table 2).

Table 2. Final functional result versus quadriceps development and tone

Quadriceps	Result				Totals	
	Excellent	Good	Fair	Poor	Presentation	Evaluation
Good	54	35	6	6	74	101
Poor	-	2	-	13	42	14

The posterior drawer test was also used to assess the progress of all joints in the series, The grading used was as follows:

- 1+ being less than 1 cm of drawer
- 2+ being 1 to 3 cm
- 3+ being greater than 3 cm

At the initial consultation, 44 patients showed a 2+ posterior drawer and a further 32 had a 3+. In seven patients, the posterior drawer was not known while the remainder showed a 1+ posterior drawer.

The posterior drawer sign was tabulated against the eventual functional result and this can be seen in Table 3. Patients in whom the posterior drawer sign may have been changed by reconstructive surgery were excluded from this table. IN those patients treated entirely conservatively, 32 showed an excellent result while 22 showed a good result. A further four showed a fair result and nine a poor result.

Table 3. Posterior drawer versus final result in conservative and palliative surgery cases

End Result	Posterior Drawer			
	0	1+	2+	3+
Excellent	2	10	24	8
Good	-	6	14	5
Fair	-	-	3	3
Poor	-	1	6	7
Total (N=89)	2	17	47	23

A final table (Table 4) correlates the activity resulting in injury and the eventual result for both operative and non-operative patients. This reveals that people involved in sporting activities have an overall better result than those involved in motor vehicle accidents.

Activity	Final Result			
	Excellent	Good	Fair	Poor
Football	31	15	1	6
MVA ^a	5	9	4	12
Other Sports	3	1	1	1
Others	13	12	1	1
Total	52	37	7	20

^aMotor Vehicle Accidents

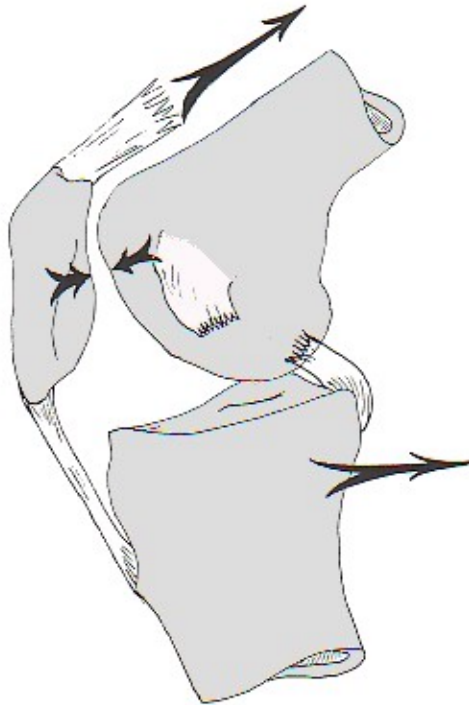
Discussion

When the PCL is ruptured, the posterior control of the joint now falls upon the patella and patella tendon. There is a large increase of force applied to the articular surface of the patella and its femoral groove. Hence, the patella is put at a great mechanical disadvantage due to its change in function, which is now to hold the tibia forward, as well as to control extension of the knee joint (Fig. 3). The eventual result of this abnormal tibio-femoral translation, may be the development of tri-compartmental degenerative changes.

The principles of treatment revolve around three areas. The first is early recognition of the injury and immediate repair, preferably within the first four days. This was not adequately reviewed in this work. Secondly, exercising the supporting musculature is essential. Thirdly, surgery may be indicated, either palliative or reconstructive. This revolves around strengthening of the quadriceps muscle to support the new function of the patella. The basic exercise here is repetitive straight leg raising and static quadriceps exercises. Light weights should be used later in the rehabilitation of the knee joint. Flexion-extension exercises and the use of large weights should be avoided as this tends to aggravate the instability already present. From the preceding work, it is evident that good quadriceps tone correlates well with the eventual result. This rigorous exercise program is undertaken more readily by patients involved in some form of sport. The good results obtained were a reflection of their quadriceps function, except in cases where the trauma was so severe that recovery was limited by

associated injuries. The functional result of the knee joint in this injury is significantly increased by diligent exercise.

Figure 3. Forces acting on the patellofemoral joint following rupture of the posterior cruciate ligament



Surgical intervention, except in acute cases, is indicated for palliation of symptoms or restoration of function. Palliative surgery is used to correct other abnormalities in the joint that cause symptoms. These include arthroscopic shaving of the patella and removal of torn menisci. Reconstructive surgery involves the repair of stabilising structures in the joint. In three cases, an intact medial meniscus was used to replace the PCL by retaining its posterior attachment to the tibia. In others, a tendon graft using semitendinosus tendon by retaining its tibial attachment and transferring it through drill holes in the tibia and femoral condyles, was used. A dynamic reconstruction using medial head of gastrocnemius was employed. Both reconstructive and palliative surgery can be used to gain a higher grade of result in a previously fair to poor knee joint.

The posterior drawer sign was found to show poor correlation with the eventual functional result in a joint with a ruptured PCL. This is not surprising as the laxity produced by a rupture of this ligament will not be compensated for by increased muscle tone in the resting joint on the examination.

Patients with a PCL rupture can have a good or excellent functional result following conservative management based on diligent exercise. With adequate therapy and encouragement, there is no need to consign these patients to a life of pain and stiffness in their knees. A poor result will occur, however, if the initial damage is extremely severe and may also be found in cases where litigation is pending. The prognosis depends on the maintenance of good quadriceps tone but eventual degenerative change is probably inevitable.

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