CURRENT CONCEPTS IN DIAGNOSIS AND TREATMENT OF POSTERIOR CRUCIATE LIGAMENT INJURY

F. MARGHERITINI[1], P. F. MARIANI[1], P. P. MARIANI[2]

Injuries to the posterior cruciate ligament (PCL) have traditionally been reported to be rare but in the last decade, this ligament has captured the attention of orthopaedic surgeons world-wide. While new or improved surgical techniques involving the PCL have achieved attractive results, accurate evaluation of the PCL-deficient knee still remains a challenge. Despite the greater use of new, more sensitive clinical testing, stress radiography and MRI, correct diagnosis and staging of the PCL tear is still difficult. The objective of this paper is to provide an up-to-date review regarding diagnosis and treatment of the PCL tear.

Key words : posterior cruciate ligament ; arthroscopy ; diagnosis ; treatment ; knee.
Mots-clés : ligament croisé postérieur ; arthroscopie ; diagnostic ; traitement ; genou.

There has been increasing interest in the posterior cruciate ligament (PCL) recently, so much that it has replaced the anterior cruciate ligament (ACL) as being the new challenge in knee diagnosis and surgery.

Biomechanical studies (22, 40) have shown that the PCL is the primary restraint to posterior tibial translation and secondary restraint to external rotation, sustaining 85% to 100% of the posterior force at both 30° and 90° of flexion. It is the strongest ligament of the knee, with 38mm in length and 11 mm in diameter, although it has been shown that its load capacity only slightly exceeds that of the ACL. Hughston stressed the importance of the PCL as the prime stabilizer of the knee joint and emphasized it as the central axis about which normal and abnormal rotations occur (24).

Injury diagnosis is now made more frequently due to increased diagnostic skills, as well as improvement in physical examination and understanding of the injury. The optimal treatment choice is still controversial. It has been demonstrated that all PCL lesions do not do well if treated conservatively, as previously claimed by different authors (13, 14, 18, 38, 45), while surgical reconstruction has achieved diverse results (11, 15, 27, 29, 32, 36, 50).

During the last two decades more than 200 papers (Medline® source) have addressed the diagnosis and the treatment of the PCL. The aim of this review is to give a practical guideline in approaching PCL pathology.

DIAGNOSIS

Diagnosis of PCL injuries is best made by a thorough history and physical examination in conjunction with appropriate radiographic studies. Patient history allows the first approach to the patient with PCL injury. Regardless of whether the injury is due to sports activity or a motor vehicle accident, the mechanism of injury remains fairly constant : posterior force on the proximal tibia. In motor vehicle accidents this is commonly known as the dashboard injury. A PCL injury from sports

[1] Laboratory of Arthroscopic Surgery, Rome, Italy.
[2] University of Motor Science, Rome, Italy.
Correspondence and reprints : Fabrizio Margheritini, L.A.S., Via Trionfale 5952, 00135 Rome, Italy.

activity can occur when an athlete falls to the ground with the knee flexed and the foot plantarflexed, causing the proximal tibia to strike the ground first or hyperflexion of the knee (18). Less common mechanisms of injury include severe twisting with valgus or varus force and hyperextension.

Patients with acute PCL injury do not usually have incapacitating pain, reporting vague symptoms such as unsteadiness or insecurity of the knee, while those with chronic PCL injury may report patellofemoral symptoms (11, 14, 49).

The incidence of PCL injuries reported in the literature varies between 3% and 37% among all knee injuries. This large variability is probably related to the type of investigations performed by different authors. We agree with Fanelli *et al.* (15) who reported the incidence to be 37% of all cases with acute hemarthrosis. There exists a great deal of controversy regarding the incidence of PCL injuries in an athletic population. While Arendt and Dick (1) reported a rate of 0.01(based on injuries per 1000 athlete-exposures) of PCL lesions in basketball players and a rate of 0.04 of PCL lesions in soccer , we suspect the incidence to be sport-specific. Parolie and Bergfeld (38) reported approximately 2 to 3% of the selected players at the annual NFL (National Football League) draft present with a PCL lesion.

PCL injuries may be classified in several ways. We find injury severity (isolated or combined) the most helpful. Isolated injuries can be classified into partial (Grade I and II) or complete (Grade III). Distinguishing isolated Grade III from combined PCL injuries may be difficult, but this distinction is critical. Associated injuries must be ruled out because the prognosis of these injuries is different. Several tests aid in the diagnosis of PCL injuries. The most commonly performed tests include the posterior drawer, posterior sag, step-off, quadriceps active and Whipple test. Evaluation of the posterolateral compartment, which is often involved in posterior compartment injuries, includes the popular reverse pivot shift test and the external rotation test. These tests are extremely important in assessing the degree of PCL involvement and the most appropriate surgery for the patient.

Rubinstein *et al.* (44) assessed the accuracy of PCL injury diagnosis. The posterior drawer was the most sensitive test (90%) and highly specific (99%). Both the quadriceps active test and reverse pivot shift both had high specificity (97% and 95%, respectively) but low sensitivity (58% and 26%, respectively). The authors found an overall accuracy of 96% during clinical examination. The posterior drawer test appears to be most accurate in detecting posterior ligament injury.

The biomechanical basis for this test is that the maximum posterior translation of the tibia on the femur occurs between 70° and 90° of knee flexion with PCL deficiency. Proper technique in performing the posterior drawer test is critical. The examiner sits on the patient's foot in order to prevent sliding and has the patient relax his thigh muscles. The test is done with the patient supine, knee flexed at 90°, and foot flat on the table. With the knee flexed at 90°, the medial tibial plateau normally lies approximately 1 cm anterior to the medial femoral condyle. This can easily be felt by running the thumb or index finger down the medial femoral condyle toward the tibia. However, this relationship will not be present in a PCL-deficient knee.

Upon clinical testing, the posterior drawer test is graded according to the amount of posterior subluxation of the tibia. Tibial translation between 1 and 5 mm is considered a grade I injury. The tibial condyle translates posteriorly with the tibia remaining slightly anterior to the femoral condyle. A grade II injury exists when posterior tibial translation is between 5 and 10 mm and the tibia is flush with the femoral condyles. Further posterior subluxation is considered a grade III injury. This is seen when the tibia translates greater than 10 mm posterior to the femoral condyles. Moreover, Parolie and Bergfeld (38) have found the posterior drawer test with the knee at 90° in neutral position and internal rotation helps differentiate between isolated and combined PCL and capsuloligamentous injury in a PCL-deficient knee clinically.

The tibio-femoral relationship can also be checked with the posterior sag test. This is performed with the hip and knee flexed at 90° and usually produces a more obvious sag in a PCL-deficient knee.

The step-off test checks for posterior tibial translation with the knee flexed at or greater than 90 °.

If a PCL injury is present, active contraction of the quadriceps muscle performed when the patient's knee is flexed 60° to 90° will visibly and palpably eliminate the posterior sag.

Whipple and Ellis (49) describe a test with the patient prone and the knee flexed at approximately 70°. PCL insufficiency is demonstrated by grasping the lower leg with one hand and posteriorly displacing the tibia by pushing on the tibial tubercle with the other (fig. 1). This test allows accurate clinical evaluation while avoiding quadriceps contraction, which may interfere with the examination.

Fig. 1. — The Whipple test allows a good evaluation of the posterior tibial subluxation, while avoiding the quadriceps contraction, due to patient position.

The reverse pivot shift test helps identify posterolateral rotatory instability due to associated injuries of posterolateral structures. In this test the patient is supine and the examiner stands on the side of the injured leg. One hand is placed on the lateral aspect of the knee, the other hand grasping the foot and rotating the tibia externally, causing posterior subluxation of the lateral tibial plateau when posterolateral instability is present. The test starts from a flexed position while maintaining foot valgus as the knee is gradually extended.

The external rotation test can be performed with the patient either prone or supine at 30 or 90° of knee flexion. Differences in external rotation between the two feet are indicative of posterolateral compartment involvement.

Diagnostic tools include plain radiographs, which may reveal bony avulsion, stress radiographs and MRI. Stress radiographs can be obtained using a Telos GA II stress device (Telos®, Weterstadt, Germany) with the knee flexed at either 30 or 90°. The reproducibility of the technique allows application of equal tibial forces at different times through the Telos load arm. Alternatively, a variety of techniques utilizing muscle contraction or gravity force have been advocated. In our clinical practice we use the dynamic technique with hamstring contraction proposed by Chassaing *et al.* (10) and the axial view proposed by Puddu *et al.* (39). Dynamic radiographs are performed with the patient in the lateral decubitus position and the knee flexed at 90°. Hamstring contraction causes marked posterior displacement of the proximal tibia. To analyse the radiographs, tangents are drawn to fixed landmarks, such as the posterior borders of the medial and lateral femoral condyles and the medial and lateral tibial plateaus, parallel to the posterior tibial cortex. The degree of compartmental displacement can be measured in millimeters as the distance between the posterior tangents of the corresponding compartments. As shown by Chassaing dynamic radiograph results do not differ significantly compared to those obtained with Telos® (10). We agree with Hewett *et al.* (23) who state that stress radiography is superior to both the arthrometer and clinical posterior drawer testing for assessing the posterior cruciate ligament status. Puddu's method is performed with the patient supine, knee flexed at approximately 70° and the x-ray beam angled superiorly (fig. 2). The resulting image is evaluated based on the location of the tibia in relation to the femur as compared with the controlateral, normal side (fig. 3).

Magnetic resonance imaging (MRI) is also useful in confirming the diagnosis, with a reported sensitivity and specificity of 100% (21). MRI proves especially helpful in acute lesions when accurate physical examination is difficult, and aids in ruling out concomitant injuries. However, chronic lesions on MRI may show an apparently normal PCL with increased posterior translation. An intact

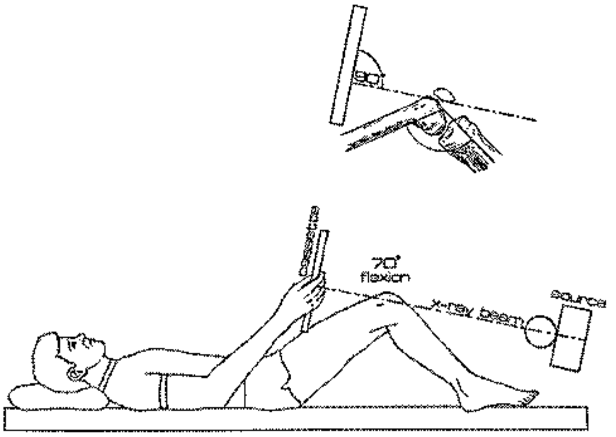

Fig. 2. — Axial view for demonstration of the posterior displacement of the tibia. The patient lies supine with the knee flexed at 70° and the xray beam is directed from distal to proximal and parallel to the longitudinal axis of the patella (reproduced with the author's permission Puddu G., Gianni E., Chambat P., De Paulis F. The axial view in evaluating tibial translation in cases of insufficiency of the posterior cruciate ligament. Arthroscopy 2000, 16 : 217-220).

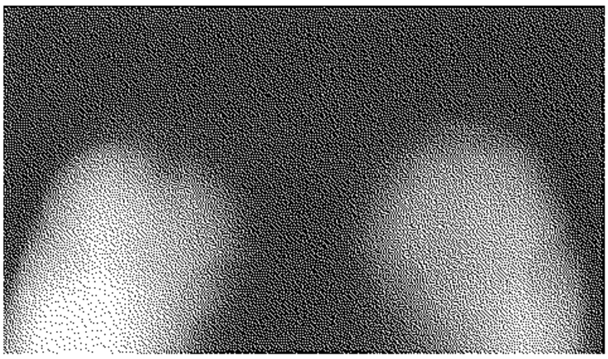

Fig. 3(a-b). — Radiographic axial view. Note the different distance between the femoral groove, and the anterior tibial border of the injured right knee, on the left compared with the contralateral healthy side, on the right.

ligament may be subdivided into three morphological groups : arcuate, U-shaped and linked. While the normal PCL most commonly appears as a smooth arc on MRI scan, variations in shape do not necessarily indicate injury. MRI shows PCL tears as increased intensity within the substance as well as fiber disruption. The chronically torn PCL ligament will appear thin or completely absent. The exact significance of post-traumatic areas of increased intensity within the ligament remains unclear.

Recently, we have proposed the use of MRI in aiding tunnel placement in PCL reconstruction (30) and evaluating graft maturation (31). Data have showed that MRI can clearly detect femoral tunnel position, which is a key-point in surgical technique for achieving good results (30). Moreover we have shown the graft maturation process to be regionalized, time-dependent and requiring more than one year. It is impossible to perform correct evaluation of graft healing before that period. The graft area located near the femoral tunnel undergoes a faster and higher maturation process than the tibial tunnel graft, probably due to the abnormal stresses on the latter (31).

CONSERVATIVE TREATMENT

A great deal of controversy exists concerning proper treatment of posterior cruciate ligament injuries.

The etiology of the torn PCL has been well documented (9, 13, 14, 18, 26, 38, 45, 48). Injuries are divided into two main categories : (1) isolated PCL injury, and (2) combined PCL and capsuloligamentous lesions of the knee. Treatment of PCL injuries is dependent upon several factors, including : degree of injury, associated injuries, occupation, activity level, symptoms and sport. Most authors agree upon operative treatment for combined PCL lesions and capsuloligamentous injuries, while controversy regarding the treatment of the isolated PCL rupture still exists.

There is a general agreement that an isolated PCL tear does not usually require repair or reconstruction (45, 48) although it has been suggested (9, 26) that patients treated conservatively with isolated posterior cruciate ligament injuries "...may maintain excellent muscle strength, but significant symptoms and degenerative changes increase with increasing interval from injury (26)". On the other hand, some authors have reported that patients do not complain of significant instability at middle- and long-term follow-up and that return to previous sports activity can be achieved in the majority of patients (38, 45). Shelbourne *et al.* (45) have presented the largest and most recent study, including patients with less than 10 mm of posterior displacement on stress radiographs. It appears that only patients with mild injuries, not requiring surgical treatment, have been included in this long-term follow-up study.

Several studies have attempted to identify prognostic factors for clinical outcome in patients who have PCL-deficient knees (13, 48). Associated ligamentous injuries have clearly been shown to contribute to PCL instability. Torg *et al.* (48) found that among patients with unidirectional instability 85% had good or excellent outcomes and 7% poor outcomes, whereas those with multidirectional instability had only 44% good or excellent results and 34% poor results.

Cross and Powell (13) found 88% excellent or good results in patients with good quadriceps function versus 13% of those with poor quadriceps function. Further studies, including patients with more laxity and longer follow-up, will permit a better understanding of this problem.

Finally, conservative treatment is suggested for acute isolated PCL injury or chronic isolated, asymptomatic PCL injury when newly diagnosed with no history of prior rehabilitation.

SURGICAL TREATMENT

Historically, several techniques have been proposed to reconstruct a PCL-deficient knee. Excluding early attempts at the beginning of the century, Lindemann (28) in 1950 reported one of the first reconstruction techniques using the semitendinosus tendon through a bone tunnel within the medial femoral condyle. After being passed through the tunnel, it was then pulled back into the intercondylar sulcus and fixed to the tibia with a T- or U-shaped nail. Ficat (17) modified Lindemann's technique by attaching the semitendinosus tendon to the semimembranosus muscle. Transfer of the medial gastrocnemius was first advocated in the early 1980s for reconstruction of the chronic, symptomatic PCL-deficient knee by Hughston (24) and then Insall (25), however, no further studies regarding the advantages of this technique were performed (43). In the mid 1950s, Augustine (3) proposed hemitransplantation of the patellar tendon (PT) detached from its distal insertion, passed through a tibial tunnel, and then reattached onto the anterior aspect of the tibia.

Despite poor results achieved with these surgical techniques, the operative treatment has been re-evaluated in the last years because of the importance of the posterior ligament in creating a central pivot point.

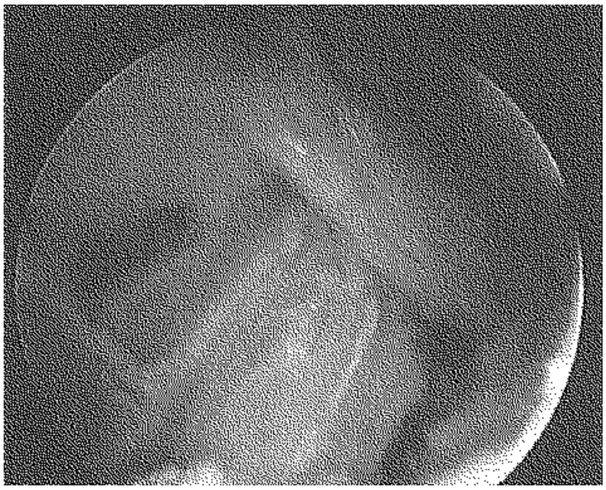

Fig. 4. — Arthroscopic view after simultaneous ACL/PCL reconstruction. Note the strict relation between the two cruciate ligaments, which produces a "cross" shape figure.

In 1995 Morgan *et al.* (34) showed that "the ACL and PCL interact dynamically in terminal extension such that the PCL bends around the posterior margin, creating a central vertical rotation axis (central pivot point) which may direct the screw home rotation mechanism of knee". This theory called "the unique organ theory" focused on how both cruciate ligaments work together in determining correct biomechanics of the knee (fig. 4). More recently Ochi *et al.* (37) have shown in biopsy specimens that isolated rupture of the PCL can cause ultrastructural changes in the ACL with adverse effects. The intimate relationship between cruciate ligaments has also been demonstrated in an anatomical study (35), in which the authors have demonstrated the presence of an interconnecting band, called the "intercruciate band" , between the ACL and PCL. These studies clearly demonstrated how a PCL-deficient knee, even in the absence of symptomatic laxity, can undergo biomechanical changes which could result in long-term changes clinically.

The use of technetium bone scans has also been suggested to evaluate osseous metabolic status of the chronic, isolated PCL-deficient patient who has not shown improvement with rehabilitation. If increased uptake is present within the medial and/or patellofemoral compartment on delayed images, surgery is strongly considered (11).

From our point of view, we recommend operative treatment for acute and chronic PCL injury combined with capsuloligamentous injury, and chronic isolated PCL injury which has not improved with rehabilitation. We frequently use stress radiography to stage the ligament lesion corresponding to the degree of posterior displacement of the tibia. Ten mm of posterior subluxation is used as the end-point value as to when operative treatment with or without peripheral reconstruction should be considered.

Surgical treatment of PCL injury involving bony avulsion is not under debate : several studies in the literature have attested good or excellent results achieved with stabilisation and bony union (42, 46).

The best type of graft utilized for posterior cruciate ligament reconstruction remains controversial in every currently proposed surgical technique. A graft must be accessible, rigidly fixed and strong enough to provide stability against posterior tibial translation.

The patellar tendon graft has traditionally been the graft of choice but etiologic studies have demonstrated a late incidence of patellofemoral arthritic changes. Some concern regarding histologic changes within the PT ligament has been recently reported by Bosch *et al.* (8). In this study, conducted on a sheep model, different fiber distribution within the neo-ligament was compared with normal PCL. Moreover, tunnel passage of the bone-tendon-bone block may be difficult. Given donor site morbidity associated with the use of PT autografts in ACL reconstruction, it may be beneficial to use alternate graft sources for optimal long-term outcome.

Hamstring tendon must be doubled in order to obtain a strong enough graft. Tripled hamstring graft outcomes have recently been presented by Yasuda *et al.* (50), during the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine(ISAKOS) meeting in 1999. The results were comparable to those reported in the literature for PT grafts. This is an important preliminary observation that may lead to further controlled trials comparing PT and hamstring grafts in isolated PCL tears.

Autologous bone-quadriceps tendon graft has been strongly advocated by different authors. The advantage seems to be related to minor morbidity in comparison with the PT graft and excellent mechanical features (19). Moreover, while the bone plug offers good fixation on the tibial side, the femoral side is easily suitable for the double bundle technique. However we use this technique in cases of failure, or when PT or hamstring tendons are unavailable. We must consider that the graft itself is bulky and this technique requires a large bone plug, which is interesting in revision surgery. Potential disadvantages include anterior knee pain, patellar fracture and rupture of the remaining quadriceps tendon.

Allograft, which is extremely popular in the United States, is an option in revision surgery or when avoiding damage to the contralateral extensor mechanism or hamstring tendons in combined ACL and PCL reconstruction. Because of its high tensile strength and passage facility, the Achilles tendon allograft is commonly preferred. Disadvantages include expense, the possibility of disease transmission, histocompatibility mismatch with immune response and the possibility of late failure. In 1994 Noyes and Barber (36) reported their experience with the use of allograft with and without ligament augmentation device (LAD). They concluded that the use of LAD provided no benefit. Use of artificial ligament has been also advocated in knee dislocation because it is straightforward, timesaving, versatile and with less morbidity compared to other treatment modalities such as autograft and allograft (M. Ku, personal communication, PCL Study Group, CapeTown 1999)

Several points must be taken into consideration during surgical reconstruction. First, the PCL is anatomically composed of two major bands : anterolateral, which tightens in flexion, and posteromedial, which tightens in extension. Femoral attachment of the PCL has been shown to present with an average width of thirty-two millimetres. Thus, unlike the anterior cruciate ligament, the PCL does not have an isometric area large enough to accept a normally sized graft. That is why the bulk of the PCL is anisometric. Galloway *et al.* (20), demonstrated that joint stability after reconstruction depends strictly on the location of the femoral attachment : the most ideal position using a single graft is distal and anterior within the anatomic footprint. The graft hole is placed high within the notch with an anterior to posterior inclination, avoiding proximal-distal femoral placement which would result in high graft stress and failure, or restricted knee motion. Finally, we are still unaware of the role of the menisco-femoral ligaments anteriorly (ligament of Humphrey) and posteriorly (ligament of Wrisberg). Although the size of these ligaments is highly variable, they average approximately 20% of the size of the PCL. The menisco-femoral ligaments are not always present :it has been shown that the Humphrey is present alone in 38% of knees, the Wrisberg alone in 39% and both are present in 20%. These ligaments serve as a secondary restraint to posterior tibial translation. Their presence may obscure examination and make diagnosis more difficult.

Surgical reconstruction of the PCL can be categorised as arthroscopic, arthroscopically-assisted or open. With respect to the tibial portion of the procedure, this can be further categorised via the tibial tunnel or inlay on the posterior aspect of the tibia at the tibial anatomical attachment site.

A complete arthroscopic procedure was first introduced by Clancy *et al.* in 1982 (11) and then applied and modified by several authors. The success of the procedure depends on correct placement of the bone tunnels. The tibial tunnel must be drilled from anterior to posterior. Clancy *et al.* stressed the importance that the graft lies on the superomedial edge of the tunnel. It has become evident that the acute angle created can produce significant bending around the tibial tunnel exit point.

In order to reduce this stress and more accurately reproduce the anatomic landmarks of the PCL, an arthroscopically-assisted technique has been recently introduced. Benedetto *et al.* (4) and Thomann and Gaechter (47) have popularised this procedure in Europe, while Berg (5) has reported his experience in a small series of patients. The inlay technique first consists of an anterior arthroscopic step, followed by a second posterior open approach. The latter, in the author's opinion, should protect the graft against iatrogenic damage, permitting more accurate placement of tibial PCL insertion with a reduction in the "killer turn". This term, introduced by Marc Friedman in 1992 (5), commonly describes the sharp angle at the proximal tibial tunnel margin which may function as an abrasive ridge and cause ligament graft rupture. At this point, Sharpey's insertional fibres on the bone graft may be abnormally stressed (fig. 5).

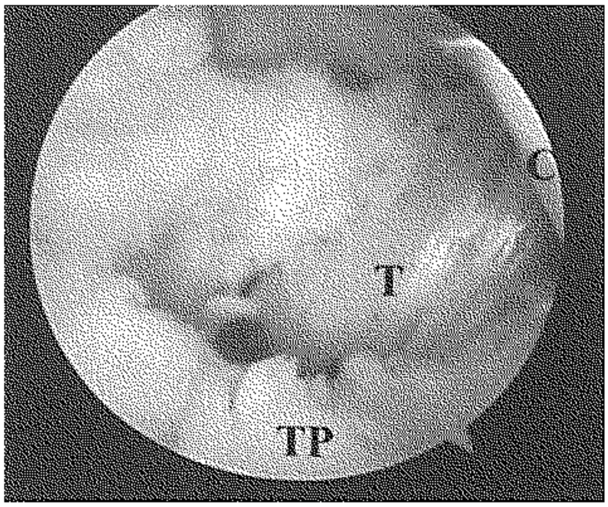

Fig. 5. — Posteromedial arthroscopic view of a patellar tendon graft after a full arthroscopic reconstruction. Note the emergence of the graft from the tibial tunnel, where it produces the so-called "killer turn" (C : femoral condyle, T : patellar tendon, TP : tibial plateau).

In a recent study by Bergfeld *et al.* (7), it has been shown that PCL reconstruction using the tibial inlay technique was more stable to posterior translation at all flexion angles than the tibial tunnel technique and the intact knee. In the tunnel technique examined macroscopically after repetitive loading, the graft appeared thin and damaged just above the bone-tendon junction at the exit of the tibial tunnel ("killer curve"). Fretting as a cause of graft failure has been shown in ACL reconstruction with either autologous or synthetic grafts. This effect, which has raised concern regarding the full arthroscopic technique, has not yet been clearly validated either biomechanically *in vivo* or *in vitro*. The full implications of the "killer turn" with regard to vascular ingrowth and cellular population are still unknown. In order to avoid or reduce the "killer turn" a more vertical tunnel has been suggested (fig. 6).

Fig. 6. — Cadaveric specimen evidencing the "killer turn". The graft has been marked with a metallic wire.

In order to improve functional outcome and reproduce as accurately as possible PCL structure and biomechanics, a two-bundle reconstruction technique has been proposed recently. This technique originates from anatomical findings which have documented that the PCL acts as two separate bands or ligaments, anterolateral and posteromedial, supported by biomechanical studies of Morgan *et al.* (34) and Race and Amis (40, 41). The two separate grafts or split graft are passed through the tibial tunnel or fixed onto the back of the tibia, depending on the surgical technique. The two stripes are then passed through separate drill holes in the femur, fixing the anterolateral portion in flexion and the posteromedial in extension. The two-bundle procedure offers an attractive option which requires accurate orientation and graft placement in order to achieve successful results. Recently Harner (22) presented the results of his laboratory study in which single and double-bundle techniques were compared. The results support the idea that the two-bundle technique is superior to the single bundle technique for restoring physiological posterior translation from 0 to 120° of flexion. Moreover, further in vivo studies with longer follow-up are needed to evaluate the real outcome of these procedures. Fixation of the graft can be achieved with commonly used devices. The graft may be fixed utilizing an interference screw when adequate bone blocks or patellar tendon are used, while soft tissue grafts may require stapling or suture tying over a screw and washer.

Techniques based on retention (6) of the ligament have recently been proposed, and can successfully be applied in cases of ligamentous slackening in primary or revisional surgery.

As previously reported, great importance is addressed to the peripheral lesion in case of posterolateral injury. Surgical intervention in the acute situation usually involves primary repairs where possible with augmentation where needed. In cases of chronic posterolateral instability, tissues are added to provide a check rein to prevent varus and posterolateral rotations.

Regardless of the type of primary surgical reconstruction, the knee is placed in a brace post-operatively and locked in extension for at least five weeks. Full weight bearing is encouraged as soon as possible and continuous passive motion is begun approximately six days after surgery.

Quadriceps exercises, such as straight-leg raising and squat sets, are allowed early in the rehabilitation period, while emphasis is placed on avoiding posterior tibial translation. Thus, quadriceps exercises are started immediately with active knee extension and passive knee flexion exercises used to gain knee flexion, while hamstring exercises are avoided because of posterior translation stresses placed on the graft. Patients are usually allowed to return to their normal sporting activities at 7 to 9 months postoperatively.

RESULTS

Operative treatment has lead to a considerable variety of results.

Clancy *et al.* (11) in 1983 reported a series of 23 patients with excellent results following a complete arthroscopic procedure with PT graft. Excellent results were achieved in 100% of acute cases and greater than 80% of chronic cases.

Fanelli *et al.* (16) reported a series of 31 combined PCL reconstructions with a minimum follow-up of 36 months, showing more than 75 % of patients studied presented a side-to-side difference of less than 5 mm with the Telos® device at 90° of flexion.

Lipscomb *et al.* (29) reported the results of 25 isolated PCL reconstructions with hamstring grafts, showing optimistic subjective reporting, but unsatisfactory overall results.

Kim *et al.* (27) presented a series of 37 patients who underwent PCL reconstruction with complete arthroscopic and single-incision technique, showing an average score of 89.3 using the Hospital for Special Surgery scoring system.

Yasuda *et al.* (50) recently presented the results of PCL reconstruction using a hamstring graft. Twenty-four isolated PCL and 15 combined PCL and posterolateral corner deficient knees were reconstructed using a composite polyester/tripled hamstring graft stapled proximally and distally. Those with combined PCL/PLC also had a biceps tenodesis. International Knee Documentation Committee (IKDC) evaluation was normal or nearly normal in 80% of the isolated and 53% of the combined cases.

Noyes and Barber-Wenstin(36), reporting the results of allograft reconstruction with or without an augmentation device, underlined the importance of early reconstruction for acute ruptures in active patients.

Until now, results of the inlay PCL reconstruction technique have been reported as abstracts or as preliminary results (5). The outcomes appear to be extremely satisfactory, allowing recovery of physiological anterior-posterior translation. Cooper (12) reported a series of 22 patients (6 revisions, 4 isolated and 12 combined) reviewed at least one year postoperatively ; at follow-up, there was an average side-to-side difference of 4.7 mm (results not corrected for magnification).

Our experience with the full arthroscopic technique is extremely satisfactory (32). Our results, published in 1997, showed greater than 75 % of the patients studied, with an average follow-up of 26 months, were graded between A and B using the IKDC evaluation form. However we must stress the results reported present only mid-term follow-up. Further long-term studies will determine the true outcome of these techniques.

Full (complete) arthroscopic technique may also be safely performed in cases of simultaneous ACL/PCL reconstruction (33). In our experience, the tunnel technique results in less morbidity, reduced surgical time and decreased postoperative complications, such as arthrofibrosis or infection.

Surgical treatment may also lead to different intra- and post-operative complications. Neurovascular injuries are typically related with the full-arthroscopic technique due to the presence of the popliteal artery and nerve immediately behind the posterior horn of the lateral meniscus. Arterial or nerve injury can occur during tibial tunnel preparation because guide wire penetration during placement or inadvert guide wire advancement during reaming. The use of a posterior medial access decreases the risk of these complications.

Persistent posterior sag may be caused by insufficient mechanical strength of PCL substitute, improper graft placement or tensioning and/or poor graft fixation.

Avascular necrosis of the medial femoral condyle has been reported by Athanasian *et al.* (2), and may be related to vascular damage created by improper femoral tunnel position (too close to the articular surface), which may disturb the intraosseous blood supply. Loss of motion and anterior knee pain may also be experienced by some patients but are usually managed with intensive postoperative rehabilitation.

CONCLUSION

The most important factor influencing treatment of a PCL rupture is a correct diagnosis. The distinction between isolated and combined injuries is crucial, as is the grading of lesion.

PCL reconstruction, either arthroscopic or inlay, is still an experience-related procedure that must be performed by an experienced arthroscopist. Regardless of the type of technique, good results may be achieved with surgical treatment, however further studies with longer follow-up are necessary to confirm these preliminary results.

It is important to remember that good results with these new techniques have been obtained only in the laboratory and are still awaiting necessary *in vivo* confirmation.

The natural history of the PCL-deficient knee continues to be under debate, and the treatment of PCL injuries continues to evolve. Renewed emphasis on this problem may lead to new solutions.

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SAMENVATTING

F. MARGHERITINI, P. F. MARIANI, P. P. MARIANI. Huidige concepten in de diagnose en behandeling van achterste kruisbandletsels.

Over de laatste decennia heeft de achterste kruisband (AKB) de aandacht gevraagd van de orthopeden van de ganse wereld. Zelfs met nieuwe en blijkbaar effectieve chirurgische technieken, blijft de nauwkeurige evaluatie een uitdaging. Dit ondanks nieuw en gevoelige klinische tests, MRI en stress radiografieën. Het doel van dit artikel is om te voorzien in een actuele oppuntstelling voor de diagnose en behandeling van AKB-letsels.

RÉSUMÉ

F. MARGHERITINI, P. F. MARIANI, P. P. MARIANI. Conception actuelle du diagnostic et du traitement des lésions du ligament croisé postérieur.

Au cours des dix dernières années, le ligament croisé postérieur a retenu l'attention des chirurgiens orthopédiques du monde entier. Il reste très difficile d'évaluer avec précision une lésion du croisé postérieur, malgré le recours à des tests cliniques toujours plus sensibles, à des radiographies dynamiques et à la résonance magnétique nucléaire. Les techniques chirurgicales ont obtenu de bons résultats. Le but de ce travail est de faire une revue actuelle du diagnostic et du traitement des lésions du ligament croisé postérieur.