Reconstruction of posterior cruciate ligament rupture and posterolateral instability with synthetic ligaments

JP Laboureau

Abstract. – *The posterior cruciate ligament (PCL) has two main bundles which play different roles. Other structures, and in particular the posterolateral corner (PLC), are necessary for posterior stability. Only complete reconstruction can provide improved results. Two facts should be borne in mind: 1) The PCL has a high potential for healing; 2) The inevitable process of revascularisation and recollagenisation weakens autografts and allografts, which are submitted to elongation by gravity and permanent traction by the hamstrings. This explains our mediocre results in the past, and the necessity for a new technical approach with the concept of "internal fixation" using specific synthetic ligaments.*

A specific guide makes the procedure easier, whether it be open or arthroscopic. A two-bundle reconstruction for chronic cases, with placement and tensioning, must recreate the non-isometric function of each bundle. Precise femoral insertion of each bundle must be determined by preoperative X-ray. In acute injuries, we use only one bundle as a synthetic scaffold; the procedure is carried out arthroscopically.

A prospective study in 1992 was carried out to evaluate the two-bundle PCL and posterolateral reconstructions using LARS® ligaments. The details of this study and the results are discussed. It was concluded that the use of synthetic ligaments appears to be a good solution in PCL reconstruction, allowing the reconstruction to resist mechanical stresses during the postoperative period.

Keywords: *knee, ligaments, posterior cruciate ligament, posterolateral instability, synthetic ligaments, LARS®, acute PCL injury, chronic PCL injury.*

Introduction

THE PRINCIPLE OF INTERNAL LIGAMENT FIXATION

If we base the results of posterior cruciate ligament (PCL) reconstruction using autografts or allografts on accurate radiolaximetry, the mechanical efficiency is poor. Objective good mechanical results [2, 4, 6, 10, 13] hardly attain 50% in the best of cases. Autogenous transplants require a postoperative period of rest, due to long periods of weaknessess related to collagen transformation and revascularisation. From the start, PCL reconstructions must resist gravity and permanent hamstring action. Scapinelli [22] has demonstrated the richness of PCL vascularisation. The PCL can heal and this has recently been confirmed by MRI studies which show continuous but elongated ligaments [23, 24]. This healing potential, always better in acute cases, makes the PCL itself the best transplant and all the more so since it is the only one to have mechanoreceptors for proprioception. And proprioception is the key to a good knee. The principle is therefore to obtain, by adequate internal fixation, proper healing with no elongation. The use of appropriate synthetic ligaments allows the knee to be firmly recentred and for the healing process to take place with the ligament at its initial length.

A reconstruction with one bundle is sufficient for acute injuries (less than 3 weeks). We have long considered that an anatomical and physiological two-bundle reconstruction is mandatory in chronic cases [15, 16]. Each bundle is recruited differently during motion and this must be reproduced. Moreover, we know the importance of posterolateral structures in the control of posterior and rotational stability. These structures work in synergy with the PCL and are involved in at least 50% of cases. Neglecting them means certain failure in any cruciate ligament surgery [18]. Their treatment is part of that of the PCL itself.

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Technique for PCL reconstruction

LARS® (LIGAMENT ADVANCED REINFORCEMENT SYSTEM)

We use the LARS® (Ligament Advanced Reinforcement System). This new generation of polyester ligaments is designed to fulfil the requirements for better resistance to fatigue in flexion and torsion, and better fibroblastic ingrowth. A ligament comprises (*fig 1*) one intra-articular part 40 mm long, made only of longitudinal, parallel and totally independent fibres, and two intra-bony parts composed of the same fibres strongly united by a warp-knitted process. Because of this strong connection in the bony tunnels, all the fibres will work together in the intra-articular part, and will share the forces once all of them have been recruited. The resistance of the ligament depends on the number of fibres: PC 60: 2500 N, PC 80: 3700 N, PC 100: 4700 N. Maximum strain before rupture is 9.8%. Mechanical trials on residual resistance to traction after 22 million cycles combining traction-flexion-torsion showed 40%

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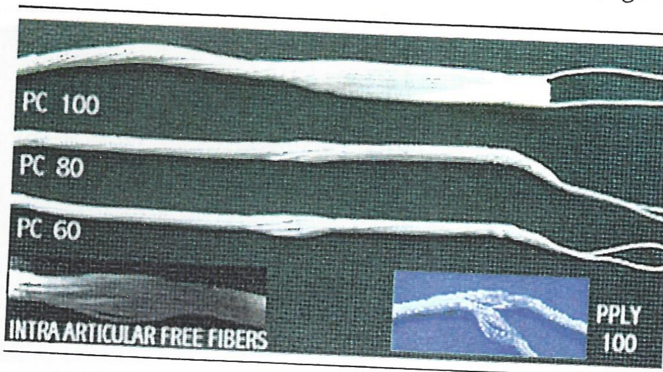
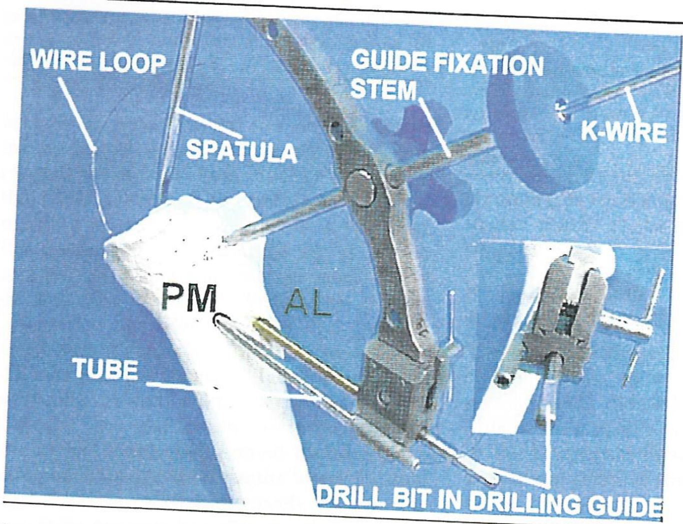
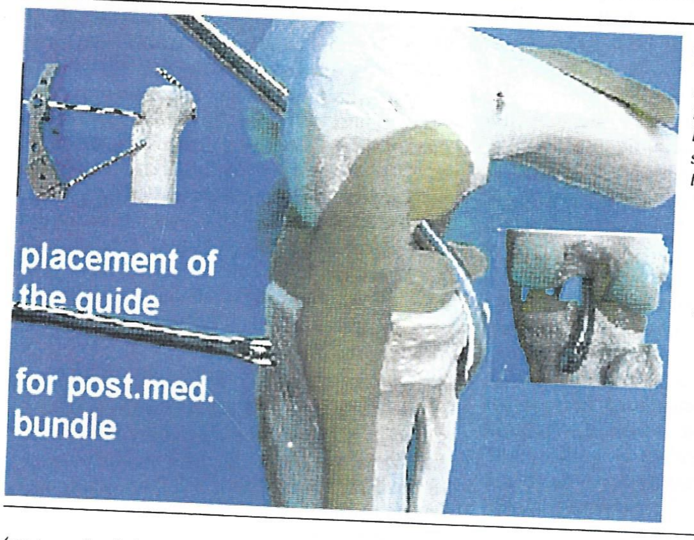


1 *The intra-articular part is made of longitudinal slack fibres, which provide suppleness and allow integration into the fibrous tissue. The fan-shaped PC 100 is particularly made for the anterior bundle and requires a slot-shaped femoral tunnel. PC 80 and 60 are cylindrical.*



2 *Fixation of the guide in place is secured with a K-wire. The stem must be parallel to the tibial plateau. The drill bit used for the first tunnel is replaced by a tube to pass the wire loop.*



3 *The knee is flexed at 90°. The spatula is blocked by the roof of the notch. This position together with the parallelism of the fixation stem ensures the proper placement of the spatula in depth.*

(average) of the initial resistance, with 6.3% elongation. In theory, these results give a life expectancy of more than 10 years. The PPLY 100 ligament is a special implant, shaped as a Y to allow for the reconstruction of two ligaments using a single tibial tunnel (7.5 mm). One branch of the Y can be used for the anterior bundle and the other for the posterolateral reconstruction, or for a combined posterolateral and lateral collateral ligament reconstruction.

The fixation of the synthetic ligaments is carried out using cannulated interference screws which have been especially designed not to damage the ligament. The diameter of the screw must always be at least 1 mm larger than the diameter of the tunnel. Staples complete the fixation outside the tunnels.

TIBIAL GUIDE

The tibial guide allows for the placement and drilling of the tibial tunnels, while ensuring complete safety of the posterior nerves and vessels, without any posterior approach (*fig 2, 3*).

The drilling guides drive the drill bits through a small anterior incision and at an angle of about 45°, until they reach the spatula placed behind the tibia. The drill bit is then replaced by a wire-passer tube with a curved end. A stainless steel wire loop is pushed through the tube, passes into the hollow stem of the spatula and exits out of the joint. This loop will be used to pull the ligament into the tibial tunnel(s).

TELESCOPIC TUBES

Telescopic tubes allow the passage of the drill bits through a micro-incision on the femoral side (especially when using an arthroscopic procedure), as well as the passage of the wire loops and the interference screw, without damaging the soft tissues.

Surgical procedure

For severe chronic or combined instabilities, or revisions, this technique should not be performed under arthroscopy unless the surgeon is very experienced. Precise well-performed open surgery will always be better than an uncertain and long arthroscopic procedure. The aim is to repair the PCL, not to use the scope. The two techniques will be described.

OPEN TECHNIQUE

▪ Step 1 - Installation and approach

The patient is placed in a supine position. The thigh lies on a knee holder which is placed with the tourniquet as proximal as possible. The knee must be positioned in full extension and 100° to 110° of flexion. The incision is medial para-patellar from the tibial plateau up to the quadriceps tendon, passing laterally to the vastus medialis tendon. The patella must be retracted laterally.

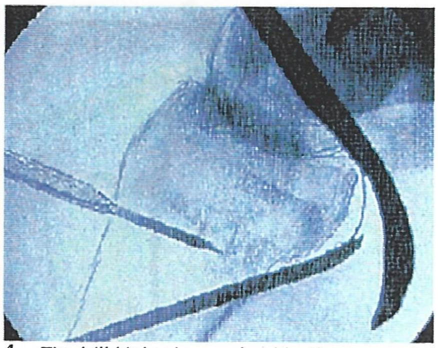
The first step consists of dissecting the adherences of the remaining PCL from the anterior cruciate ligament (ACL). Following the anterior aspect of the PCL, scissors cut all adherences and tibial attachments along the midline and for 2 or 3 cm on each side.

This step is most important in chronic cases and is the most difficult step to perform under arthroscopy. It ensures the re-attachment of the PCL and adjacent structures when the tibia is reduced forward, with a shortening effect.

▪ Step 2 - Drilling of tibial tunnel(s)

Tunnel for posteromedial bundle

The spatula of the guide is introduced through the notch, after removal of any osteophytes. The spatula passes on the medial side of the ACL, and is pushed



4 *The drill bit has been replaced by the curve-ended tube and the wire loop is pushed in. Note that the obliquity of the tunnel avoids the "killer angle" behind the tibia.*

backwards until its stem lies on the roof of the notch, the knee being flexed at 90°. The cannulated fixation stem must be parallel to the tibial plateau. The spatula is oriented medially to the midline, in such a way that the entry point of the drill bit is at the midpart of the medial metaphyseal aspect of the tibia *(fig 2, 3)*. When the proper orientation has been obtained, the guide is fixed with a cannulated fixation stem and a 2.5 mm K-wire. A small incision is made vertically, centred using the position of the drill bit. The soft tissues are retracted from the cortex. It should be noted that there is a cutaneous bridge between the lower incision and the para-patellar approach. This bridge has to be respected to preserve the branches of the saphenous nerve (sensibility and proprioception). The sharp 6-mm drill is fixed to the movable jaws of the guide and used to attack the cortex obliquely, until it bumps against the spatula. This first drill bit is replaced by the flat-ended drill bit, which is pushed and pulled back and forth to remove all the bony chips. The drill is then replaced by the wire passer tube and a simple wire loop is pushed through. The loop will appear at the other extremity of the spatula's cannulated stem *(fig 4)*. The guide is dismounted.

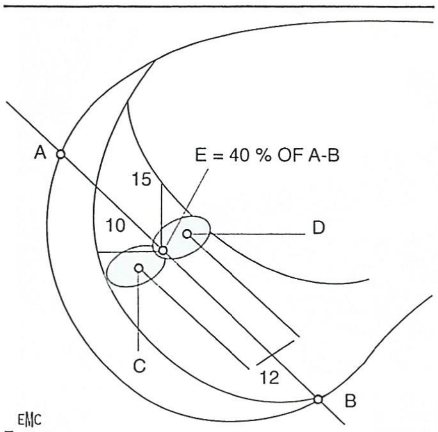
Tunnel for anterolateral bundle

A tube is placed in the first medial tunnel to protect the wire loop, and to ensure that the second tunnel will not cross the first one. The guide and the spatula are put back in place. The tube of the first tunnel lies on the groove of the medial face of the drill guide *(fig 3)*. The spatula is oriented laterally from the midline, and the guide is fixed in that position.

Depending on the size of the bone, the entrance of the second tunnel can be on the medial or lateral slope of the tibial tubercle.

If a type PC 100 ligament has been chosen for the anterior bundle, the 7.5 mm drill guide and corresponding drill bit and tube must be used.

Single tunnel: for a one-bundle reinforcement (acute or multiple



5 *Average measurements of PCL femoral attachments on 25 cadaver knees. E is the centre point and should be the centre of the tunnel for a one-bundle technique. D is the centre of the AL bundle. C is the centre of the PM bundle.*

reconstruction), the spatula is placed exactly in the middle of the posterior aspect of the tibia.

■ Step 3 - Correct positioning of femoral tunnels is fundamental

The centre of the anatomical PCL insertion corresponds to a point that can be geometrically defined for each knee *(fig 5)*. This point is at 40% on a line drawn parallel to the Blumensat line, passing by the most prominent point of the posterior condyle on an X-ray where the two condyles are superimposed. This point also corresponds to the so-called isometric point, as described by Ogata et al [20]. It can be determined on a preoperative X-ray and measured intra-operatively by any graduated device, or with the help of the image intensifier, which is highly recommended.

A one-bundle reconstruction (acute cases or multiple ligament reconstruction in dislocated knees) must be centred at this point.

The tunnels of a two-bundle reconstruction must be located on each side of this point: anterior and proximal for the anterolateral bundle, posterior and distal for the posteromedial bundle. These points correspond to Ogata's findings and each bundle will have a limited "non-isometry". The drilling is performed from the inside out from the intra-articular aspect of the medial condyle.

■ Step 4 - Retightening of the PCL stump

In chronic cases, strong non-resorbable suture thread is passed in the distal part of the PCL remnants. These threads will be passed through the tibial tunnel(s) with the synthetic ligament(s) and fixed with it (them) under light tension.

■ Step 5 - Passage of the ligament and femoral fixation

Wire passer tubes are placed in the femoral tunnels. The wire loop and a blunt K-wire that will lead the interference screws are introduced from the outside in.

Each bundle is pulled through the corresponding tunnel from the inside out. The junction of the free fibres and the knitted portion must be adjusted 1 mm inside the tunnel.

Using the tibial wire loops, each bundle is then pulled through the corresponding tibial tunnel: the anterior femoral bundle in the lateral tibial tunnel, the posterior femoral bundle in the medial tibial tunnel.

The femoral fixation is immediately performed using interference screws (8 x 30 or 9 x 30) which are placed from the outside in with the help of the guiding K-wire. The telescopic tubes are used for open procedures if the femoral tunnels exit too far above the main incision and require a specific micro-incision. The lengths of the bigger tube and of the cannulated screwdriver are adapted to allow placement of the screw flush to the bone. If the screwdriver has been stopped by the tube, it is advisable to give another turn of the screw after removal of the bigger tube.

■ Step 6 - Tensioning and tibial fixation

The anterolateral bundle must be tightened in flexion. This tensioning must be performed manually, and must be limited to placing the ligament rectilinear and to correcting the tibial posterior displacement. This is achieved when the ACL is back to its normal tensioning and obliquity. The ligament is then blocked in this position, and it is essential to make sure that complete extension can be obtained.

Tibial fixation is performed with an interference screw (7 x 30 or 8 x 30). The screw must be placed at the upper face of the ligament and guided by a K-wire all the way up into the tunnel.

The posteromedial bundle must be tightened in extension; it is essential to make sure that complete flexion can be obtained.

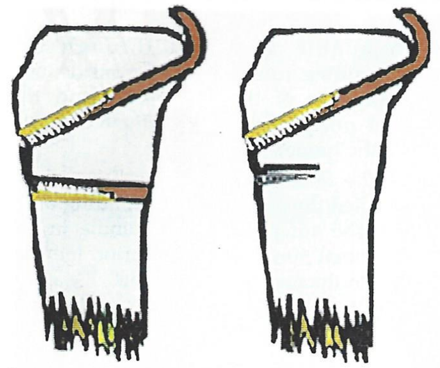
The threads corresponding to the PCL stump are lightly tensioned and fixed with the same interference screw.

Complete correction of the posterior sag and full motion must be controlled again, and the tensioning of each bundle readjusted if necessary. This step is fundamental and sufficient time must be taken until a perfect result is obtained.

As stress on the ligaments is high, it is mandatory, especially on the tibial side, to complete the primary fixation with at least one staple, or better still, with a second screw placed in a transversal lower tunnel *(fig 6)*.

Those parts of the ligament which are preserved outside the main tunnels will eventually allow a revision if needed, for retightening, new injury or other indications.

The operation is completed by careful lavage, and closure is performed with



6 *At the beginning, we encountered some loosening of tibial fixation. This fixation must be secured with a second screw in a lower tunnel, or at least with a staple. This also makes it easier to find the external part of the ligament in case of revision.*

resorbable sutures layer by layer on vacuum drainage. No splint is required.

ARTHROSCOPIC PROCEDURE

This is a minimally-invasive "internal fixation".

This procedure is recommended in mild, isolated posterior laxities and mainly in acute injuries where a one-bundle internal fixation is enough. The technical principles are the same as for the open procedure.

Do not use a pump in acute cases.

If there is an important liquid leak, which is rare, the scope must be abandoned and a mini-arthrotomy carried out instead.

■ *Portal for the spatula*

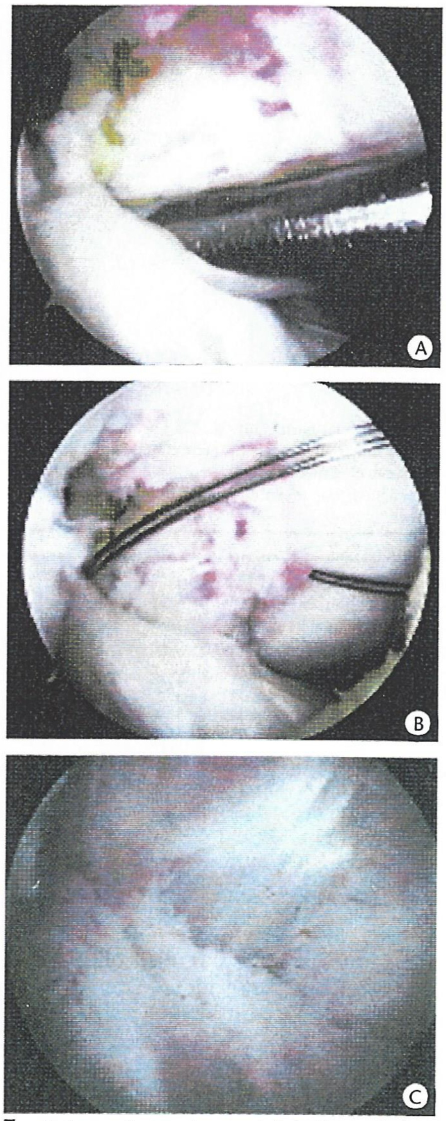
Entry for the spatula of the guide is medial para-patellar, 1 or 2 cm above the lower extremity of the patella. The wire loop will exit from the same place. The spatula goes along the medial edge of the ACL *(fig 7)* and must be placed behind the tibia on the midline.

■ *Femoral tunnel*

With a one-bundle reconstruction, the femoral tunnel must be located at the "isometric" point described above (point E) *(fig 8)*. The use of the fluoroscope is highly recommended. This point is marked by a K-wire which is introduced into the notch through the skin at the lateral edge of the patellar tendon, at joint-line level. The K-wire is directed obliquely through the medial condyle to exit through the skin of the lower and anteromedial aspect of the thigh. A micro-incision allows for the passage of the telescopic tubes guided by the K-wire. The cannulated drill bit is introduced through the bigger tube and the tunnel is drilled from outside in.

■ *Passage of the ligament*

A wire loop is passed from outside in over the cannulated drill and will be caught by a small arthroscopic forceps. This forceps is introduced through the same medial portal from which the tibial wire loop is exiting. With the help of these 2 wire loops *(fig 7)*, the ligament (PC 80) is passed first through the femur, then through the tibia. The scope controls the correct position of the free fibres in the joint *(fig 7)*.

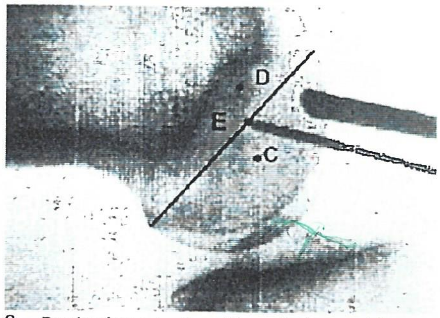


7 *Arthroscopic procedure: spatula in the notch along the medial border of the ACl (A); wire loops exiting from behind the tibia and from the medial condyle underneath the PCL attachments in an acute case (B); free fibres of a PC 80 in place (C).*

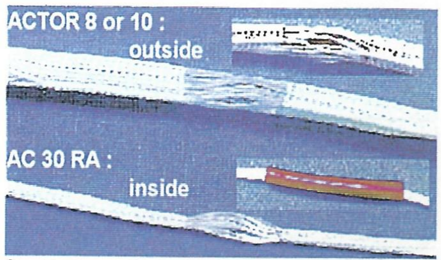
■ *Tensioning and fixation*

Tensioning and fixation are performed as for the open procedure. As it is supposed to be isometric, the single bundle can be tightened in flexion.

It is easier to control the aspect of the ACL, which must appear completely retightened. However, it is essential to make sure that full extension is still easily obtained and to adjust the tension accordingly.



8 *Precise determination of tunnel placement is mandatory. The 2 mm K-wire is inserted from inside out into the medial condyle and will guide the cannulated drill bit through the telescopic tubes outside it.*



9 *Ligaments for combined autogenous reconstruction: ACTOR 10 is a tubular reinforcement; the transplant is placed inside the tube. AC 30 RA is used as a "hot dog" inside the transplant or adjacent to it. The placement and fixation are the same.*

AUTOGENOUS OPTION

For all the previously given reasons (vascularisation, proprioception, real ligamentous structure), the PCL itself seems to us the best material. However, in some chronic cases, the PCL is totally absent (revisions), of poor quality, or has been removed by a previous aggressive shaver.

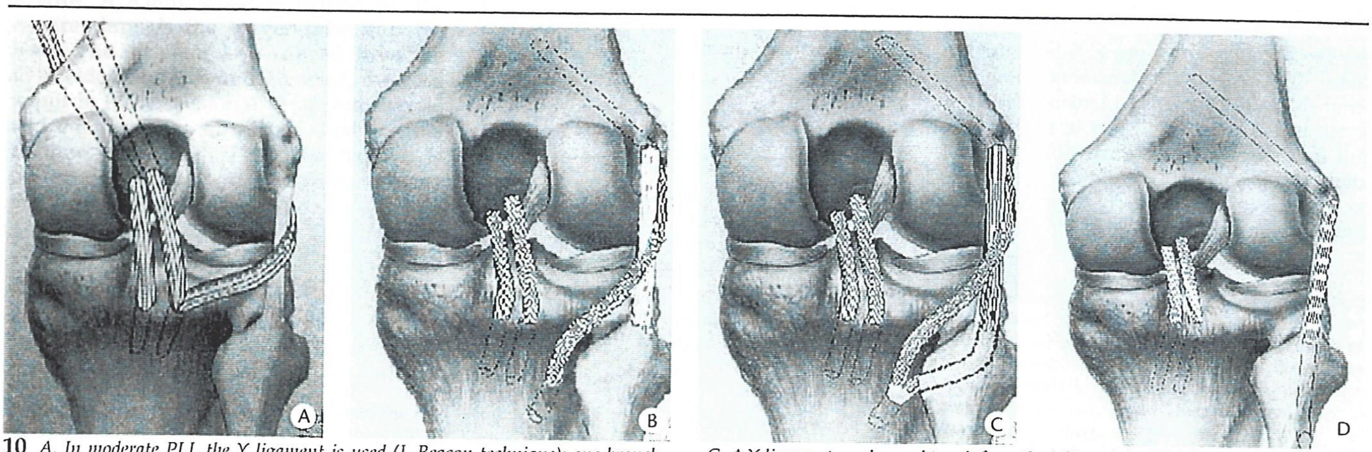
In these cases, the PCL must be reconstructed with an autogenous transplant reinforced with a synthetic ligament, as no fibroblastic ingrowth can otherwise be expected.

When using autogenous transplants, we prefer the quadriceps tendon or gracilis semi tendinosus which seem less damaging for the extensor apparatus than the patellar tendon. The extensor apparatus should be a main concern in PCL deficiency.

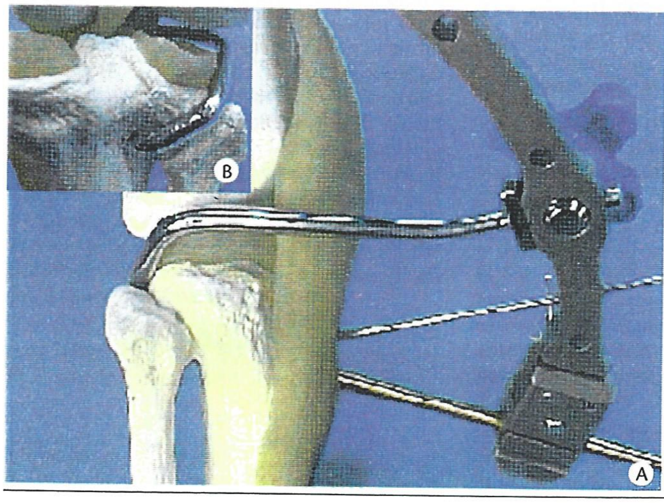
Specific LARS® ligaments are used for autogenous reinforcement, to prevent postoperative elongation *(fig 9)*. The tibial guide comprises drilling guides for 8 to 12 mm drill bits.

For the passage of the wire loop, the wire passer tube must be centred using the 6 mm drill guide. The autogenous transplant and the synthetic scaffold are fixed together in the femoral tunnel with an interference screw.

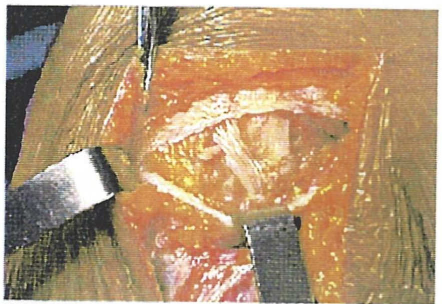
On the tibial side, the autogenous transplant must be tightened, while the synthetic ligament must not. The synthetic reinforcement must not prevent the autogenous transplant from doing its work,



10 *A. In moderate PLI, the Y ligament is used (J. Beacon technique): one branch makes the AL bundle, the other makes the PLC reconstruction.*
B. In severe PLI, using a separate PC 80 is more efficient as the tunnel is more lateral and lower.
C. A Y ligament can be used to reinforce the LCL and the PCL (Y. Forster technique).
D. Isolated reconstruction of the LCL with a PC 60.



11 *The PLI jig is fixed onto the PCL guide and hooked behind the tibia through the lateral approach (as shown in (B)). After drilling of the tunnel, a wire loop is passed and exits through the lateral incision.*



12 *The PC 80 in place reproducing the path of the popliteus tendon, but superficial to the LCL.*

but is there to limit the elongation. Therefore, at the end of the operation, 1 to 2 mm of laxity with a firm end point must be obtained. This is the necessary condition for obtaining a new ligamentous structure with collagenic and vascularisation ingrowth.

Technique for postero-lateral reconstruction

Cases requiring posterolateral reconstruction are quite frequent and must be diagnosed and treated simultaneously.

In acute cases, what can be sutured must be sutured and reinforced with a PC 60 or PC 80, reproducing the path of the popliteus tendon to avoid the external hyper-rotation of the tibial plateau and to resist the action of the biceps. Proper healing in a good position can then be expected.

In chronic cases, if the patient is not involved in strenuous sports activities and the posterolateral laxity is moderate, a reconstruction using the PPLY 100 ligament is performed. As described by J. Beacon [1], one branch of the Y reconstructs the anterior bundle of the PCL, and the other branch reconstructs the path of the popliteus tendon (*fig 10A*). If there is a major posterolateral laxity in a patient practising high level sports, a more mechanically-efficient, separate reconstruction of the posterolateral structures, using a PC 80, must be performed (*fig 10B*). A specific procedure must be added for lateral collateral ligament injuries (*fig 10C, D*).

SURGICAL PROCEDURE

A selective approach crosses the lateral collateral ligament (LCL) about 2 cm above the fibular head, goes through the iliotibial band, and the lateral edge of the lateral gastrocnemius is seen. The dissection passes in front of it and leads to the tibial popliteal surface. The LCL is exposed.

Tibial tunnel

The PCL guide features a specific device (PLI jig) for positioning this tunnel, which is drilled from anteromedial to posterolateral (*fig 11*).

The 6 mm tibial tunnel exits posteriorly 4 cm below the tibial plateau and 1 cm medial to the fibular head (*fig 10B*). A wire loop is introduced into the tunnel from the front and is conducted through the lateral incision.

Femoral tunnel

It enters the lateral condyle just in front of and below the LCL attachment (on the knee at 90° of flexion) and exits over the medial condyle. A tube is pushed in and a micro-incision allows its passage through the skin. A second wire loop and a 2 mm blunt K-wire are passed through the tube from medial to lateral.

Passage of the ligament

The ligament used can be PC 60, PC 80 or one branch of the PPLY. With the help of the wire loops, the femoral extremity is passed and the free fibres are adjusted at the entrance of the femoral tunnel. The synthetic ligament crosses over the LCL and the tibial extremity, and is passed through the tunnel, making sure that the free fibres are not twisted (*fig 12*).

Fixation and tension adjustment

The telescopic tubes are inserted on the proximal extremity of the femoral 2 mm

K-wire. A 8 mm screw is driven by the K-wire through the bigger tube into the bone. The ligament is tensioned from the tibial side. After this initial tension, the knee is put in full extension, then in full flexion, and the possibility of normal tibial external rotation is verified. The tibial fixation is performed in the position which ensures these three requirements.

Simultaneous reconstruction of PCL and ACL

The PCL reconstruction must always be performed first. The tensioning of the PCL cannot be adjusted on the ACL. Therefore, any hyper-correction of the posterior tibial displacement must be carefully avoided. Before fixation of the PCL tibial side, it must be ensured that the posterior border of the condyle is not in front of the posterior edge of the tibial plateau when the knee is at 90° of flexion. The use of a fluoroscope or intraoperative X-ray with the two condyles superimposed is very useful. A line is drawn from the posterior edge of the condyle parallel to the posterior cortex of the tibia. If the tibial plateau is in front of this line, the tensioning of the PCL must be released. This line must be adjusted so it is flush with the posterior border of the tibial plateau. Then the fixation is achieved.

The ACL reconstruction can be performed only when the knee has been recentred by PCL and/or posterolateral reconstruction.

Postoperative care

The LARS® technique allows full and immediate mobilisation and weight-bearing.

Days 1 - 2:

- Passive motion with C. P. M.
- Active motion according to the patient's pain.
- Isometric contractions of the quadriceps.

Days 2 - 3:

- Weight-bearing with crutches.
- Quadriceps exercises. Mobilisation.
- Removal of the drainage.

Physical therapy is then carried out every day. Active dynamic contractions of the quadriceps with resistance and in open chain must be prohibited. Isokinetic rehabilitation in closed chain follows isometric contractions. Proprioception rehabilitation may start after 2-3 weeks. As soon as proprioception is satisfactory, sports activities can be resumed but must be progressive. Full sports activities are generally authorised after 2-3 months for all synthetic reconstructions and after about 7 months when combined autogenous-synthetic transplants have been used. The use of synthetic ligaments avoids the use of a brace.

Results

Using the International Knee Documentation Committee (IKDC) evaluation system, modified by the international PCL study group, global results for 72 patients with a follow-up of more than 2 years were: 38 group A (53%), 21 group B (29%), 10 group C, 3 group D. Seventy-eight percent had excellent or good results on the posterior drawer test. There was a slight increase in the posterior drawer between 1 month and 18 months postoperatively (average 1.5 mm), but no significant change was noted between 18 months and the final review. This suggests that mechanical results stabilised around 18 months postoperatively.

The same IKDC quotations were applied separately on the 33 acute and 39 chronic cases. Ninety-four percent were A and B in acute, with 63% A and B in chronic.

Of the 37 patients who presented a posterolateral instability (PLI), 32 had a simultaneous reconstruction.

Objective results were assessed using the Rotational Laxiometer, developed by J Beacon [1], and evaluated by RM Bleday, G Fanelli et al [3]. This instrument seems to be the most accurate for the moment; it allows reproducible measurements of external rotation for different angles of flexion. These measurements must always be comparative.

Of the 32 initially-operated patients, 27 had an excellent mechanical result, and 23 were in IKDC group A.

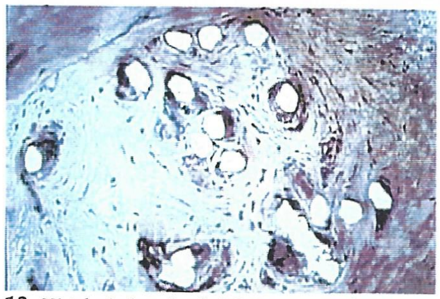
The 5 patients who were not simultaneously operated for their posterolateral instability were partial or total failures and were found in groups C or D. Four of them had to undergo a revision 1 to 2 years after the initial procedure. Two misdiagnosed PLI were later found in the patients of groups C and D and will have to be revised. Fifteen patients had a combined PCL and ACL, without any other associated ligament injury. The two ligaments were simultaneously treated: 9 were found in group A and 3 in group B.

Discussion

The results suggest the following comments.

The results in acute cases are much better than for chronic cases.

The fact of the injury being acute or chronic made more difference than the level of injury, and the presence of an ACL or posterolateral complex (PLC) injury, especially if acute, had practically no effect on the results if they were treated initially. The posterolateral structures and the PCL protect each other, as demonstrated by Markolf et al [18]. Neglecting posterolateral or other ligament reconstruction will sooner or later lead to failure of PCL reconstruction [9, 11, 19]. Classical techniques are not simple and efficient enough to be easily combined with PCL reconstruction in the same surgical operation [25].



13 *Histological study of a PC 80, 4 years after surgery for a new trauma. The synthetic fibres of the LARS® are completely surrounded and penetrated by fibrous tissue even in between the microfilaments, forming a fibre with production of new collagen. There is no significant inflammatory reaction.*

Among the different combinations of injuries, a lesion of the lateral collateral ligament, fortunately quite rare, appears to indicate a poor prognosis. The worst situation was found in chronic injuries with combined PCL, PLC and LCL injuries on varus knees. In our opinion, it is now mandatory in these chronic associations to perform an osteotomy at the same time as ligament reconstruction. Obviously, multiple injuries should always be treated acutely and thoroughly. It is in these cases that degenerative changes and secondary restraints appear quickly and result in situations which are difficult to repair.

Synthetic ligaments break sooner or later, even though they have been improved since our last published review [15, 16].

However, we did not find any degradation with time of the results in acute series or in previous synthetic series operated between 1987 and 1991. The PCL is extra-articular, well-vascularised, and able to produce strong fibrous healing [17]; this potential explains the durable result. It is therefore sufficient to correct the posterior laxity for a certain period of time. The study of the evolution of the posterior drawer by radio laximetry during the postoperative period suggests that this healing takes about 1 to 1.5 years to complete. This interpretation has been confirmed by histological findings on the few ligaments which were removed and by arthroscopic controls. The artificial ligaments were always totally surrounded by thick fibrous tissues and were even invaded in the deep core by fibroblasts and new collagen *(fig 13)*.

Conclusion

Considering the risk of severe degenerative changes in non-operated PCL injuries [7, 8, 12], *and given the results that we are now able to obtain, it seems logical to operate these injuries. We suggest that PCL injuries in young and active patients be operated acutely. For these patients, the results appear to be even better than for ACL, for which surgery is widely accepted. The frequency of combined PLI, and the importance of not neglecting it, should lead us to systematically search for such lesions.*

The concept of early "internal fixation" using synthetic ligaments, which have proven their excellent tolerance and efficacy, is now the procedure of first choice for many knee surgeons.

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