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MEMOIRE

Acute ruptures of the anterior cruciate ligament. Reconstruction by suture on a synthetic reinforcement.

Results after five years experience.

J.P. Laboreau*, A. Cazenave (Dijon)
* Centre Orthopédique et traumatologique, 44 bd H. Bazin, F 21300 Chenove

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SUMMARY

225 patients with acute rupture of the anterior cruciate ligament were operated upon with a knitted polyester synthetic ligament (Ligastic®) reinforced by a suture of the anterior cruciate ligament remnant. Five technical points must respected during the implantation of the ligament : isometry, direction of the femoral and tibial tunnels, absence of abrasion of the ligament in the notch, tensionning of the synthetic ligament equal to the natural cruciate ligament, careful suture of the remnants of the ruptured anterior cruciate around the synthetic ligament replacement.

The functional results, according to the rating system of ARPEGE, demonstrated 8.6 on the stability scale, 8.1 for pain, 8.7 for mobility; 87 per cent of the competitors were able to return to their sport at the same level. There were no cases of acute synovitis. The patients were separated into three groups for evaluation : Group I - More than three years follow-up. Group II - More than two years follow-up. Group III - Less than two years follow-up. An anterior drawer test of less than 5 mm was observed in 85 per cent of Group I, 88 per cent of Groupe II, and 87 per cent of Group III. A negative jerk test was noted in 92 per cent of Group I, 95 per cent of Group II and 95 per cent of Group III. These differences were not statistically significant. On follow-up, a Lachman test of less than 5 mm was found respectively in 37 per cent, 70 per cent and 79 per cent; this difference was statistically significant. The relatively mediocre results of the Lachman test in Group I led us to follow a more precise isometric method.

Postoperative cases were reexamined and demonstrated that the artificial ligament had become covered with an oriented fibrous tissue. The long-term outlook also depended on a successful restoration of proprioception in the repaired remnant of the anterior cruciate.

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INTRODUCTION

Inspired by the idea that reconstructive ACL surgery should be functional, that is as simple as possible, and impairing the patient's activity as short time as possible, we adopted a technique using sutures on a ligament reinforcement in 1985, for repair in acute ruptures. In strict meaning this is not a ligamentary prosthesis.

MATERIAL and METHODS

I – The Ligament Reinforcement

The ligament used (LIGASTIC 60 NEF™) is a knitted polyester ligament (9) (Fig.1).

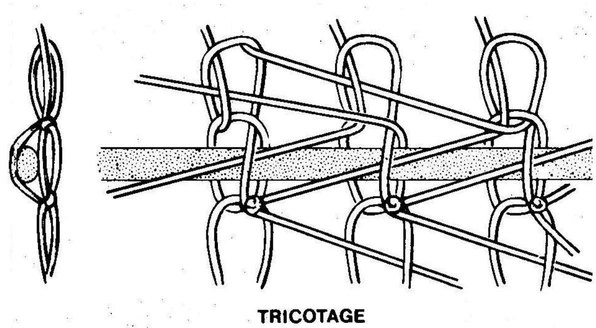

Fig. 1 – The fibres are straight and arranged longitudinally, not altered in "waves" due to the warp and weft of the weaving procedure.

Its structure is original as its longitudinal fibres are entirely oriented in the original ligament direction. This particular character eliminates all plastic elongation, normally associated with the use of woven ligaments (Fig.2). These longitudinal fibres, not deformed by any oscillating load, are united in permanent extension by solid knitting. This construction allows an important porosity (of about 400 microns), and solidity, necessary conditions for intra-osseous integration and intraarticular formation of synovial and connective tissue.

The resistance of the ligament is about 3500 N. Its capacity of elongation is less than the natural anterior cruciate ligament. The elongation is i.e. only 7% at a traction of 1730 N, which is the average traction force needed to create an ACL rupture in a young human according to Noyes (14).

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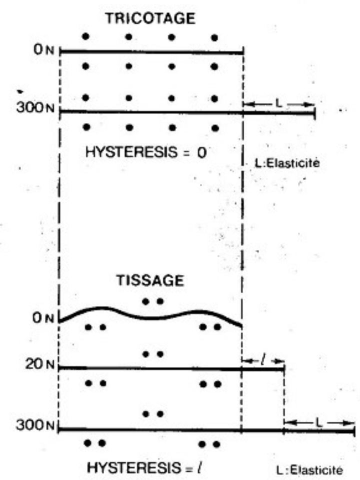

Fig. 2 – The fibre orientation united by a knitted structure eliminates the majority of the plastic deformation.

However, the main quality of the actual ligament is its resistance to elongation by time, shown by different fatigue tests performed by the National Test Laboratory (LNE). The elongation found after 11 million traction cycles of 300 N at a frequency of 7 Hz was only 0.1mm. The remaining elongation was 1.5mm after 10 million cycles of combined traction, torsion and flexion, resembling natural physiology, which could be neglected in the clinical situation. At a sudden traction of 1730 N, corresponding to a trauma where the ACL normally should have ruptured, the remaining elongation after rest was 0.5%, which is not detectable as regards the intraarticular length of the ACL (Fig.3).

This lack in elasticity of the reinforcement, implies a precise surgical technique to avoid repeated micro-trauma in flexion-extension.

Five rules are fundamental, and should be followed:

- respect of the isometric situation
- adequate orientation of the bone tunnels
- avoidance of friction
- a solid mechanical and biological anchorage
- avoidance of tension

Another principle should be added: to conserve the proprioception as much as possible. This requirement is mandatory and performed by conserving the ligament ends if they are vital and by using a limited ventral incision. Those two seem too often to be forgotten using certain autografts, needing a wide opening.

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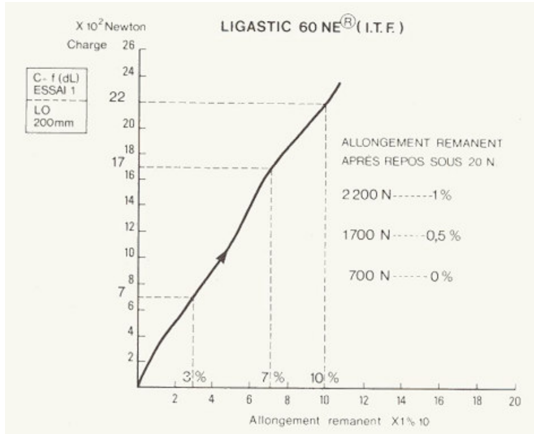

Fig.3- Mechanical characteristics of the ligament (Research Laboratory I.F.T.)

II- Surgical technique

1- Incision

The classical medial arthrotomy measures 5-7cm. It allows a verification of the possible associated intraarticular injuries, most often already described by an arthroscopy. The tibial insertion is made at the level of pes anserinus.

2- Drilling of the bone tunnels (Fig.4)

With the knee in extension, the ligament should be oriented in a straight line with the proximal portion 15-20° posterior and lateral from the vertical line. The lateral inclination from the tibial plateau should be 50-60°, and the femoral tunnel should touch the inner cortex of the posterior metaphyse before ending up at the posterolateral cortex. These tunnel orientations will minimise the friction by avoiding angulation of the ligament at the entrance of the tunnels. This will also minimise the risk of enlargement of the tunnel entrance.

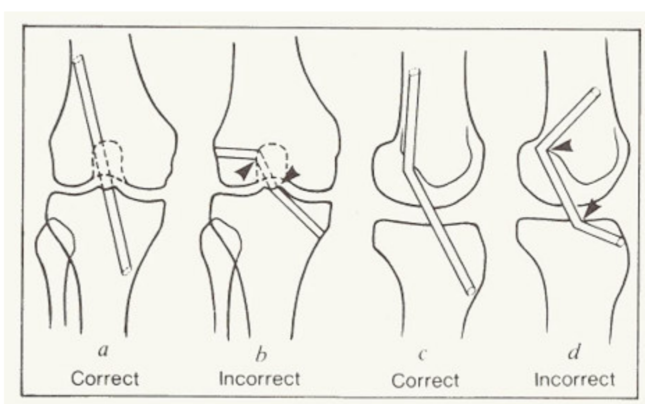

Fig 4- The direction of the bone tunnels should avoid an angulation of the ligament, compared to its intraarticular orientation.

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This necessity to obtain a straight ligament in extension is not respected by drilling the tibial and femoral tunnel at one time in the axis proposed by Odensten and Gillquist (15), which leads to a ligament position shown in Fig. 4 d.

a – *Drilling of the tibial tunnel.* The tibial visor is fixed by its point, slightly posterior to the centre of its tibial insertion, easily localised in acute ruptures. The visor handle should be parallel to the tibia, to obtain the required tunnel inclination. The drilling is performed directly with a 5.5mm or 5mm drill.

b – *Drilling of the femoral tunnel*. The important point, described by numerous authors such as Daniel et al. (5) and Abbink (1), is evidently to identify the femoral isometric point. To start with, our technique was not precise enough, and based on the estimation of the centre of the ligament rest. Our anatomical, radiological and clinical studies have shown that this isometric point corresponds to the centre of a circle with one third of its circumference common with the posterior border of the lateral condyle. Based on per- and postoperative studies, Saraglia et al. (17) described an equal result. We identified the point F on a preoperative profile x-ray without enlargement, with both condyles superimposed, using a transparent guide with concentric circles fitting the posterior border of the condyle. The distance FP between this point and the posterior border of the condyle was measured on a parallel line in the bottom of the intercondylar notch seen on the x-ray as the Blumensatt line.

The drilling of the femoral tunnel was made with an isometric visor (4). The hook part of the visor was introduced in the notch by the medial arthrotomy, sliding backwards along the lateral side of the notch and hooked on the posterior cortex. An incision on the external side of the lateral metaphysis through the fascia lata was made.

The tube part of the visor was attached to the handle, and the FP distance measured and used to regulate the sliding part, which then was firmly fixed (Fig. 5). A drill guide then introduced into the tube would automatically end up at point F.

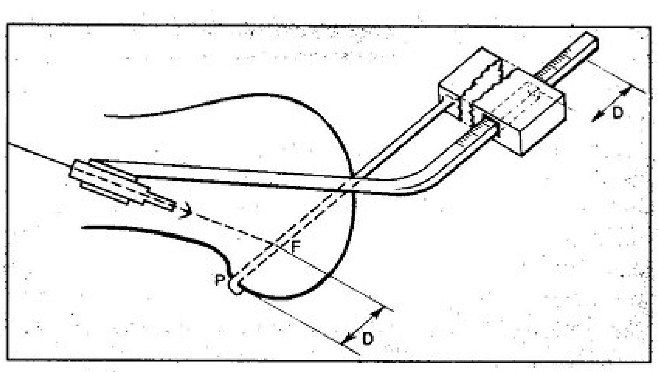

Fig.5- Adjusting the visor for the distance FP, will assure the centre of the drill to end up in point F.

- the hook should be firmly attached to the posterior cortex of the condyle;
- the visor stem should be aligned with the axial line of the condyle and directed upwards and anteriorly parallel to the upper border of the notch;
- the top of the drill guide should rest on the posterior part of the lateral notch wall just above the arterial vessels who are a good landmark.

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3- *Passing the ligament*

Depending on the ACL rupture level, the reinforcement ligament is placed:

- from below and upwards if the rupture is close to the femoral insertion,
- from above downwards if the rupture is close to the tibial insertion,

The thread at the plastified ligament end are passed through the tunnels by metal slings.

4- Verification of the isometric situation and absence of friction:

By the use of the isometric visor and the tibial guide, an isometric positioning of the tunnels and ligament are practically assured. This point is of crucial importance, and could also be verified by controlling that the ends of the synthetic ligament are not moving in the tunnels when the knee is moved in flexion and extension. In case of an imperfect tunnel placement, the following measures should be taken:

- the ligaments removed;
- the bone tunnels entirely filled with cylindrical bone blocks, harvested from the area below the pes anserinus on tibia;
- new tunnels drilled in a good position.

The most common error is shown by the ligament gliding at 90° flexion, indicating a femoral bone tunnel in a too anterior position in the notch. If the ligament is "swallowed" by the tunnel in extension, the femoral tunnel is too posterior, or the tibial tunnel too anterior.

A friction problem indicates a too narrow notch. It is particularly important to verify that there is no contact between the notch bone and the anterior part of the ligament in full extension. Complete flexion and extension should be made without any efforts.

5- Suture of the ruptured cruciate ligament on the reinforcement (Fig.6):

The ligament rests are carefully attached with resorbable sutures all around the reinforcement ligament. The goal is threefold:

- to conserve the mechano-receptors,
- to stimulate the ingrowth of fibroblasts and collagen,
- to cover and isolate the synthetic reinforcement.

To facilitate the suturing, this is performed on the free ligament, before its definitive attachment in the bone tunnels.

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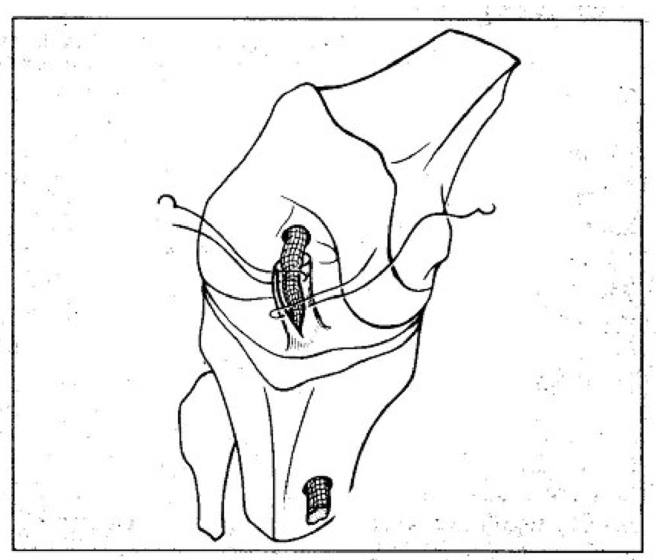

Fig.6 – The synthetic ligament in the centre of the tibial insertion of the ruptured ACL. The last is sutured around the synthetic ligament.

6- Treatment of associated lesions

Before the definitive fixation of the ligament complex, associated lesions should be treated, sometimes by a separated incision.

7- Tension

At 20° flexion the natural tension of the ACL does not exceed some hundred grams [being even zero over 20° flexion, as shown by Wesbecker, Benazet et al. (19)].

This fact should be respected. A tension is perfectly unnecessary and dangerous, as it implies a constant pressure on the cartilage inducing a mechanical degeneration of the cartilage. The pressure also implies friction at the entrance of the bone tunnels, producing micro-particles. Referring to Olson et al. (16) such free micro-particles can activate synovial cells inducing an enzymatic reaction contributing to a destructive influence on the cartilage. The reinforcement ligament should be tensioned by manual traction of the proximal end if the ACL rupture is located proximally, and distally if the ACL rupture is located distally. The tension applied should assure a completely straight intraarticular ligament, but no superior tension should be applied. The traction of the synthetic ligament approaches the ruptured ligament end to its original insertion.
The absence of traction may also allow the healing ACL to hopefully regain some of its proprioception.

8- Anchorage

This is performed by a double stapling of both the reinforcement ligament ends. An additional fixation by interference plugs or screws in the bone tunnels can be made. The pes anserinus tendons are reattached, covering the tibial staples.

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9-Closure

A lavage of the joint is performed and the incision layers closed by resorbable sutures over an aspiration drainage.

10-Postoperative treatment

Early mobilisation is allowed after 48 hours. The drainage is removed on day 4. Weight-bearing in a cast locked in extension is allowed. Dynamic quadriceps training against resistance should be included in the training. Unlimited active mobilisation is started, and the cast subsequently removed. After one month the range of motion should be at least 0°-90°. Proprioceptive training and muscular training is continued for 2 months, until the start of ordinary sports training at the end of 3 months postoperatively. Jogging on flat ground, bicycling and swimming are allowed after 60 days.

III- The series

All patients included had an acute ACL rupture and were between 18 and 40 years old. All had a certain sports activity and were operated as described above. Of 251 examined patients, 225 were operated. Of the 26 patients who were not immediately operated due to age or a low activity level, 7 demanded late surgery for impairing instability or meniscal lesions.
The results of this method were evaluated in the 225 patients operated, of which 65 had an isolated ACL rupture (mean age 26 years, range 17-46) and the rest associated lesions as described in Table I. There were 161 men and 64 women.

Measurements of the anterior drawer at 90° and 20° flexion were not performed due to pain and hemarthrosis. The mean time between the accident and surgery was 17 days (range 2-75 days).
Of the 195 patients seen at follow-up (14% lost) the activity level was, according to the CLAS system: Competition 103 (53%), Leisure sports 55 (28%), Some activity 37 (19%). No patients was classified as non active. The distribution in percentage was identical regarding the whole group of 225 patients operated.

The patients reviewed were divided into 3 groups, according to the follow-up time:
Group I: 48 (of 55) patients were seen at more than 3 years after surgery.
Group II: 100 (of 119) patients were seen after more than 2 years.
Group III: 95 (of 106) patients were seen at 2 years or less after surgery. A certain number of associated lesions were treated simultaneously (Table I).

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Table I – *Associated lesions treated*

- Méniscectomies int.	8
- Suture méniscale int.	33
- Méniscectomie ext.	1
- Suture méniscale ext.	6
- Suture ou réinsertion LLI	8
- Suture du PAPI	45
- Réparation simultanée LCP	5
- Réparation tendon poplité	4
- Réparation LLE	3

LLI: Medial Collateral Ligament
LLE: Lateral Collateral Ligament
PAPI: The postero-medial capsular angle
LCP: PCL

RESULTS

I- Anatomical results

The anterior drawer and Lachman was measured radiologically at the maximum amplitude with 300-400 N load, and subdivided into 3 groups: inferior to 5mm, between 5 and 10mm, and superior to 10mm. The search for a drawer in internal rotation showed the existence of three different results: Clearly negative, clearly positive and some results in-between, merely positive.

1- Results by group

The results are shown group by group in Table II, III and IV. The good results were obtained mainly as regards the drawer in internal rotation: 92-95% were negative. The anterior drawer was inferior to 5mm in 84-88%. Concerning these two tests there was an important homogeneity between the groups.

Table II- *Anatomical results in group I (48/55 -Follow-up>3 years)*

	< 5 mm	5 - 10	> 10
TA*	84 %	12 %	4 %
Lachman	37 %	55 %	8 %

	0	+	++
Ressaut	92 %	6 %	2 %

*TA: Anterior drawer in flexion

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Table III- *Anatomical results in group II (100/119-Follow-up>2 years)*

	< 5 mm	*5 - 10*	*> 10*
TA*	**88 %**	**9 %**	**3 %**
Lachman	**70 %**	**28 %**	**2 %**
Ressaut	***0***	**+**	**++**
	92 %	**6 %**	**2 %**

*TA: Anterior drawer in flexion

Regarding the Lachman tests in group I , corresponding to our initial experience, less satisfying results were obtained as only 37% of the patients had a drawer inferior to 5mm, and 55% a drawer between 5 and 10mm. For group II and III with a shorter follow-up, the results of the Lachman test were slightly superior as 70% in group II and 79% in group III had an anterior drawer inferior to 5mm.

Table IV- *Anatomical results in group III (95/106 –Follow-up< or = 2 years)*

	< 5 mm	*5 - 10*	*> 10*
TA*	**87 %**	**10 %**	**3 %**
Lachman	**79 %**	**20 %**	**1 %**
Ressaut	***0***	**+**	**++**
	95 %	**5 %**	**0 %**

*TA: Anterior drawer in flexion

2- Evolution of the laxity by time

The evolution of these results were followed in each group by clinical examination at 6 months, 1 year, 2 years, 3 years and 4 years.

In group I with the maximum follow-up, 88% had an anterior drawer inferior to 5mm at 6 months, compared to 84% 4 years after surgery. The Lachman score changed from 40 to 37%, but the score for laxity in internal rotation was unchanged at 92% (Fig. 7).

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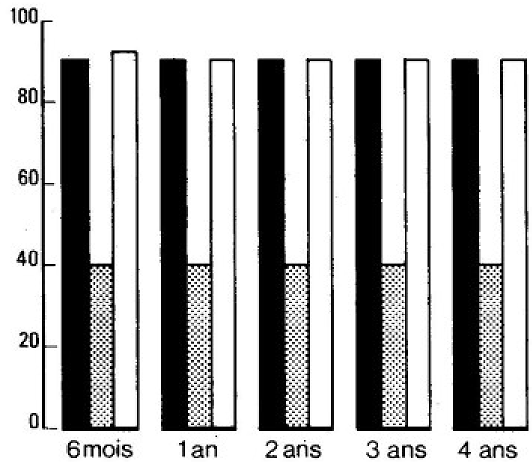
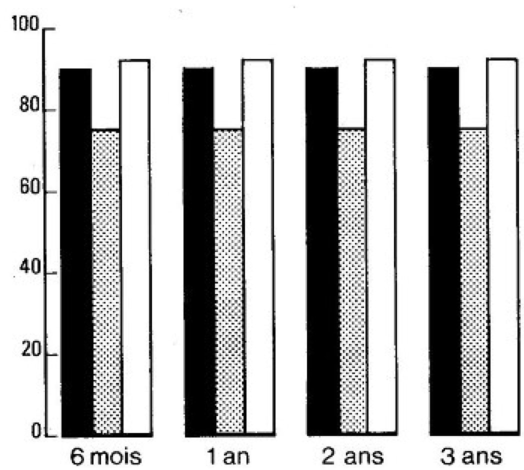


■ Anterior drawer ▩ Lachman □ Drawer in internal rotation

Fig. 7- Anatomical evolution in group I (45/55: Follow-up > 3 years).

In group II, 90% of the patients had an anterior drawer inferior to 5mm at 6 months, and 88% after 3 years. The Lachman was inferior to 5mm in 75% and 70% respectively and the drawer test in internal rotation was unchanged and negative in 92% *(Fig.8)*.



■ Anterior drawer ▩ Lachman □ Drawer in internal rotation

Fig. 8- Anatomical evolution in group II (100/119: Follow-up > 2 years).

For group III with the shortest follow-up, the anterior drawer was inferior to 5mm in 90% of the patients 6 months after surgery, and 87% in the second year. The Lachman test was inferior to 5mm in 82% and 79% respectively, and the drawer in internal rotation was unchanged in 95% (Fig. 9). The results were remarkably constant; the results obtained one year after surgery did not seem to change, at least not within the period of this study.

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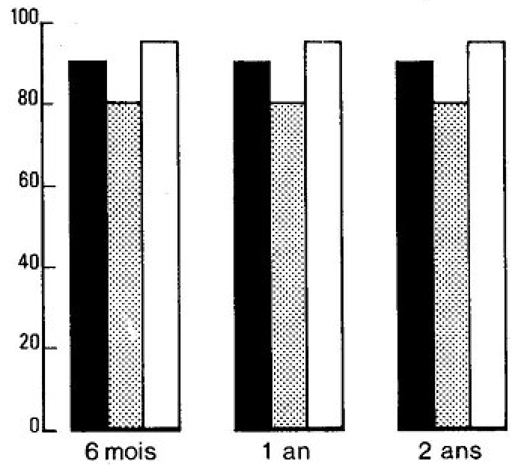

Fig. 9- Anatomical evolution in group III (95/106: Follow-up less than 2 years).

This series also confirmed the negative influence by meniscectomies in chronic knee laxities, often emphasized for example by Dejour et al. (6). This is also true for acute ACL ruptures, as none of the 8 patients who had a total meniscectomy had an anatomically satisfying result, especially as regards the Lachman test.

II- Functional results

The functional results were evaluated by use of the Arpège score. The scores obtained were: Stability 8.6 – pain 8.1 – mobility 8.7.
Thus, pain was the main factor decreasing the results.
According to the CLAS system (C=Competition, L=Leisure, A=Normal activity and S=Not active), 103 patients (53%) were classified as active in competition before the accident; 90 patients (46%) were found in the same group postoperatively, corresponding to 87% of the initial C group. The mean time before taking up the original sport was 4 months and 6 days.

Table V- *Degree of sports activities, due to the CLAS score*

	C	L	A	S
Pré-opératoire	53 %	28 %	19 %	0 %
Post-opératoire	46 %	32 %	19 %	3 %

On the contrary to these good results, 3 patients changed to the S group due to complications of the surgery. It is possible that this classification is temporary, as the patients were recently operated when examined.

The overall result was as follows: 88% good, 9% mean and 3% poor.

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The subjective results were: Very satisfied and satisfied 94%, (83% and 11%), not satisfied 4% and disappointed 2%. The factor of non-satisfaction was most often pain, limiting the time of sport activities.

One meniscectomy was performed secondary to the initial suture, 16 months after primary surgery. The importance of meniscal protection by an early repair of the ACL, has already been shown by Lynch and Henning (13), and the prognostic importance of the ACL repair does not need any further proof.

III- Complications

The complications found were the following:

- 6 thrombosis of which one severe pulmonary embolism despite systhemic anti-coagulant treatment
- 3 cases of severe stiffness in 2 women and one man, with a permanent extension defect of 20°. Two of these were later classed as "Non active". Two of the patients showed to be of a higher age (one 46 year old woman, and one 57 year old man), poorly motivated and where the surgical indication later was put to question. The third patient had a simultaneous ACL and PCL reconstruction, associated with a medial meniscectomy.

A mobilisation under general anaesthesia was necessary in 8 patients, and an arthrolysis was performed in one patient. In those 9 patients the final mobility was satisfying.
We had a suspicion of 6 secondary ruptures of the synthetic reinforcement, or enlargement of the entrance of the intraarticular bone tunnels, by a deterioration of the clinical results between the 6th month and the 2nd year, but the patients kept a good functional result and our suspicion could not be verified. In one case we could verify a secondary ligament rupture by arthroscopy, caused by a forced flexion. However, beside the ruptured synthetic ligament we found a reconstructed ACL of an excellent functional quality. The ruptured synthetic ligament could be removed without changing the functional result obtained by the healed ACL, with an anterior drawer of 6mm, a Lachman of 6mm and a negative drawer test in internal rotation.

Three algodystrophy syndromes were found in 2 women and one man.

One septic arthritis with staphylococci occurred 9 months after surgery, and 15 days after a dental abscess in a patient who had been back in sports for several months. The infection was treated by removal of the synthetic ligament and joint lavage, and healed without any remaining symptoms. Even in this case we found a healed ACL with a good functional status.

No acute synovitis occurred in this series. Three cases of chronic synovitis were found in connection with the ligament being in mechanical conflict with the anterior part of the intercondylar notch. This friction verified by arthroscopy was responsible for a liberation of particles into the joint, implying a synovitis and damage to the cartilage. One of these patients was operated with a widened notch to avoid all friction, and treated by a continuous lavage for 5 days, which resulted in a complete healing.

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IV-Arthroscopic and histological controls

We performed 17 postoperative intraarticular controls (13 arthroscopies, 4 arthrotomies). The arthroscope allowed a verification of the ligamentary structure, which was totally covered by fibrous tissue that isolated the synthetic reinforcement, except in the cases where a friction occurred against the notch at the lateral femoral condyle (where we also found the chronic synovitis). Superficial biopsies showed the existence of a dense capsule of connective tissue, with oriented fibres and a few macrophages.

The arthrotomies performed in three cases with true secondary ligament ruptures, allowed a more complete anatomical and pathological examination. In all three cases, the ligament was ruptured centrally, without moving the fixation of the ligament ends. Particularly the intra-osseous ligament fixation showed to be extremely resistant, not allowing a simple extraction after removal of the staples. The removal of the ligament could only be performed with the help of a small drill, penetrating the bone surrounding the ligament ends.

Longitudinal and transverse histological samples could be made, that showed a strong 1-2mm connective tissue capsule surrounding the whole synthetic ligament. In addition there was also a dense fibroblastic tissue, reaching the middle part of the ligament, with oriented fibres between the ligament strands and also in-between the ligament fibres (Fig. 10 and 11). The absence of inflammatory reactions and the few number of macrophages were also a witness of the excellent tolerance of the implant. This deep cellular ingrowth, here found in human knees, has earlier been shown after 12 weeks in rabbit by Amis, Kempson et al. (2), who concluded that polyester was superior to other materials as for example carbon fibres, in this aspect.

It was not possible to characterise the collagen tissue, and we could not draw the conclusion that the actual connective tissue had a mechanical value, but it covered and isolated the synthetic ligament.

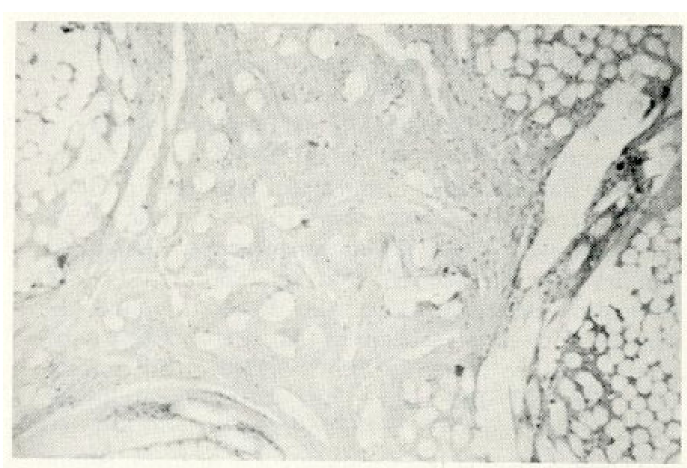

Fig. 10- The central part of the reconstructed ligament. Four ligament strands are visible, each appearing in the corners of the sample. The space in-between the strands is filled with connective tissue with some isolated polyester fibres (x100).

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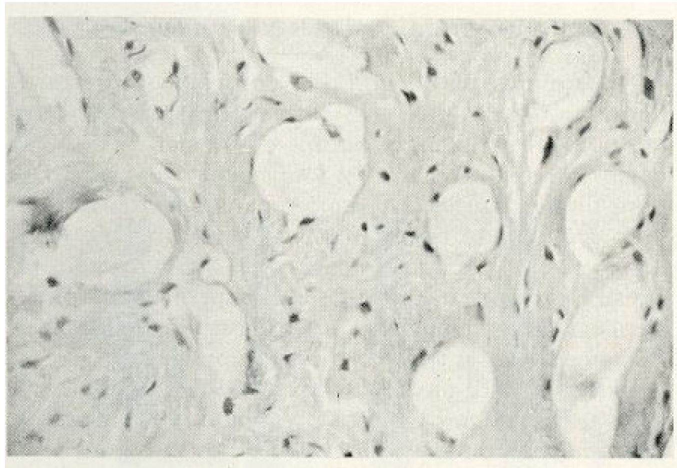

Fig.11-Fibres spread inside a ligament strand. Numerous fibroblasts (x400).

DISCUSSION

If we compare the results of our experience of acute ACL reconstruction, with the results reported in the literature exposed at the SOFCOT symposium on anterior knee laxity in 1981 (20) as regards sutures and autografts, the use of a synthetic reinforcement seem to bring a simplification and better results. The most important observation to us has been the need of a functional reparation of the ACL. It should be easy to perform, not induce further lesions, and impair the patient's physical activities for a minimum of time. Simple sutures have shown a too high failure frequency. Witvoët reported 70% anterior drawers and 35% positive dynamical tests after this technique (20). Autografts seem to be too heavy surgical procedures [Dejour (7), Laboureau (10, 11)]. Many authors report a long rehabilitation time. The best autogene implant to use is certainly and logically the ruptured ACL itself. This is why we find the use of an artificial ligament as tutor, under precise technical conditions, as a good solution that could be further developed.

The artificial ligaments are classically the subject of four main critics: acute and chronic synovitis, ruptures, elongation and the unknown long term results.

1- No acute synovitis was observed in this series. The studies on this subject have clearly shown that this complication without any doubt has been linked to the presence of synthetic fibres in fat and oligomeres, resulting in a physio-chemical influence at their passage. The actual ligament tissue is treated with numerous cleaning procedures, and controlled systematically by spectro-photometry, so eliminating these substances completely. Normally this acute type of synovitis should not occur with artificial ligaments sufficiently controlled. Several publications confirm this, as the ones by Deveyt (8) and Saragaglia et al. (17), and this complication, solely linked to the fabrication process, should not by our opinion put the method to question.
The few cases of chronic synovitis found, originated from technical errors, causing friction which produce free micro-particles. The disappearance of this synovitis after enlargement of the lateral notch plasty, demonstrates this clearly.

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2- A spontaneous ligament rupture was confirmed in only one case. Probably this occur more often, but should not exceed 1%, equivalent to the deterioration of the objective test results 6 months to 4 years postoperatively (4%). However, this slight decrease in the number of patients with a negative anterior drawer, is seen as an augmentation in the group of medium size drawers between 5 and 10mm, which is not sufficient to confirm a complete rupture under the actual examination conditions. The group with a initial postoperative drawer of over 10mm show an augmentation of only 1% between 6 months - 4 years after surgery. In one case an ovalisation of the tibial tunnel entrance was noticed by arthroscopy, probably linked to an initial placement too anteriorly. This mechanism is possibly more often responsible for the decrease in the objective test scores than the ligament rupture.

3- A secondary elongation seem neglectable, referring to the different mechanical tests performed on the actual ligament in laboratories. The stability of the clinical tests confirm these findings.

4- Even if the patients followed for the longest period of time, this period is only 4 years, and an important question is what happens to the patients at long term. This evolution depends on 2 factors:

- the mechanical quality of the connective tissue covering and infiltrating the ligament.
- the conservation of the proprioception, protecting the knee, as described by Barrak and Skinner (3). This protection could only be possible by saving the central part of the ruptured cruciate, and even better the distal end containing most of the mechano-receptors, as shown by Schutte, Abezies et al. (18). Several longitudinal mini-incisions could be used for this purpose, preserving the ligament border close to the patellar tendon, which is especially important. The ideal situation would be to insert the artificial ligament by arthroscopy. However, we have abandoned this technique, as we found the suturing of the ruptured ligament on the artificial band to be much too difficult. These two factors mentioned, the mechanical quality of the connective tissue and the proprioception are actually our main subjects for our further research.

5- Despite our efforts to obtain a good isometric balance, there was a significant difference between the drawer in flexion and the drawer in extension. Classical ACL reconstructions give in general an insufficient control of the anterior drawer in extension, observed by Dejour et al. (6, 7).

It seems practically impossible to us to obtain a perfect correction of these two laxities with a single strand reconstruction, controlling either the stability in flexion or the one in extension. Only a reconstruction with two strands could approach a satisfying mechanical solution. Different technical solutions have been proposed with two strand autografts, by us in 1980 (10) and by Zaricznyj in 1983 (21). An artificial ligament with two strands, combining straight and crossed fibres, has been made (Ligastic 72 HX), and used with good results. But the follow-up time is still to short. The indication of choice is not to our opinion acute ACL ruptures, where we find it necessary to save and to suture the ruptured ACL ligament. The procedure is also more difficult as there is a risk for conflict in the notch, and as two femoral bone tunnels have to be used. However, the results are encouraging and indicate a new future way in ACL reconstruction, as recently shown in the thesis of P. Deveyt (8) and M. Léon (12).

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