Reconstruction of old anterior cruciate ligament injuries

No difference between the Kennedy LAD-method and traditional patellar tendon graft in a prospective randomized study of 40 patients with 4-year follow-up

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In a prospective randomized study we investigated 40 patients with functional instability due to old anterior cruciate ligament tears by using two different techniques for reconstruction of the ligament. 20 patients were randomized to reconstruction with use of a traditional medial bone-patellar tendon graft and 20 patients to a half-thickness patellar tendon graft augmented with the Kennedy Ligament Augmentation Device (LAD). At follow-up after 4 years, both groups were still improved concerning function scores and arthrometry. The use of the Kennedy LAD method, however, gave no more subjective or objective benefits than did the traditional method.

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The use of the medial third of the patellar tendon as an autolog substitute for reconstruction of an old anterior cruciate ligament injury was described by Brüchner (1966). The method was then widely used and further improved by others (Alm and Gillquist 1974, Eriksson 1976). Later it was stated that autolog tissue transplants after a few months have impaired strength, due to necrosis, but the strength is regained after a period of about a year (Clancy et al. 1981). Kennedy et al. (1980) developed an intraarticular ligament augmentation device (LAD), designed to give protection to the autogenous graft while it regained its strength.

We have earlier had good results with the Kennedy LAD technique in a 5-year follow-up (Dahlstedt et al. 1993) and similarly good results with patients who had a traditional patellar-tendon augmentation reconstruction because of an acute anterior cruciate ligament injury (Dahlstedt and Dalén 1991).

In this prospective randomized study we compared the Kennedy LAD augmentation technique to the traditional medial patellar tendon graft reconstruction (PT), without augmentation, to evaluate whether the more expensive LAD method has any advantage.

Patients and methods

Inclusion criteria were arthroscopically verified anterior cruciate ligament rupture present more than 6 months and major anterior instability symptoms. We excluded patients with anterior cruciate ligament injury in the contralateral knee, rupture of the posterior cruciate ligament, major varus/valgus instability or signs of arthrosis. 40 consecutive patients filling these criteria and consenting to participate were included in the study after careful information. Their ages ranged between 18–36 years at the time of surgery and they were randomized for one of the two techniques by instructions in a sealed envelope. There were 20 patients in each group, and the operations were performed during the period 1987 until April 1990 by LD and ND. The study was approved by the local medical ethics committee.

Patients

The LAD-group consisted of 7 women and 13 men. Their mean age at surgery was 25 (18–36) years, and their mean duration of symptoms 2.5 (0.5–9) years. In this group, 19 of the patients had a clearly positive pivot shift sign preoperatively, and in 1 patient this was difficult to provoke without anesthesia. The mean follow-up time was 4 (3–5) years. 8 patients had been operated on between the accident and the anterior cruciate ligament reconstruction: 6 medial meniscus operations, 2 lateral meniscus operations, 1 medial collateral ligament suture and 1 patient had an extra-articular reconstruction performed. At the time

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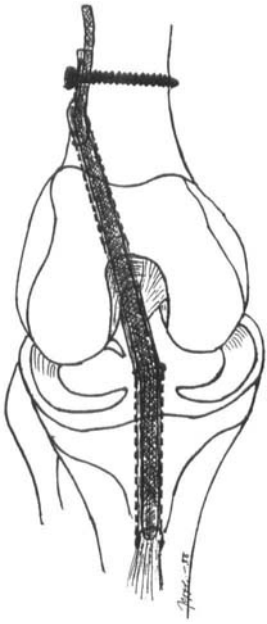

Figure 1. Kennedy LAD-technique, modified over-the-top procedure.

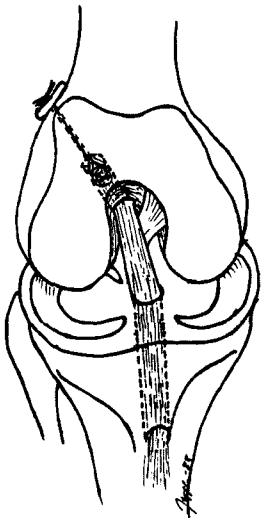

Figure 2. Reconstruction with the use of the medial third of the patellar tendon (PT).

of the index operation, another 3 medial meniscus operations were performed in this group.

In the PT-group, there were 4 women and 16 men, with a mean age of 23 (18–32) years at surgery. Their mean duration of symptoms was 3.5 (0.5–10) years. In this group, 18 patients had a clearly positive pivot shift sign preoperatively and in 2 of the patients it was difficult to provoke without anesthesia. Their mean follow-up time was 4 (3–5) years. 2 patients were operated on because of medial meniscus lesions between the accident and the anterior cruciate ligament reconstruction. Another 3 medial meniscus operations were performed in this group at index surgery.

All 40 patients had a clearly positive Lachman test prior to surgery. No patient was lost during the follow-up period.

Operative techniques

Bloodless field and peroperative antibiotics were always used. In both techniques, a medial, parapatellar incision was used and notchplasty was performed if the anterior notch diameter was less than 16 mm.

During the LAD operations, the autogenous transplant was harvested as a continuous strip from the quadriceps tendon, the prepatellar tissue and the central one third of the patellar tendon. The tendon portions of the graft were taken in half-thickness of the tendons. An 8 millimeter polypropylene braid (LAD) was sutured to the graft with non-resorbable sutures at the ends and resorbable ones in the intra-articular portion.

When performing the medial patellar tendon technique we harvested the transplant with an adequate piece of bone from the anteromedial part of the patella and as a full thickness graft from the medial third of the patellar tendon.

In both techniques, the tibial insertions of the grafts were left intact. Proximal to the insertion of the grafts on the tibial tubercle, a 7.9 millimeter tunnel was drilled in the direction of the anatomical anterior cruciate ligament insertion on the tibial eminence.

The LAD procedure included a modified over-the-top technique, letting the transplant perforate the posterior capsule and then pass through an extraarticular, posteriorly located, drill tunnel in the distal femur (Figure 1). The combined transplant was tensioned manually and fixed to the femur with a screw and washer with the knee in 20° flexion.

The PT femoral channel was prepared by drilling a K-wire from the femoral attachment site of the anterior cruciate ligament through the lateral femoral condyle with the knee in 120° flexion. A cavity, 20 mm deep and 7.9 mm wide, was drilled over the K-wire at the femoral attachment site. With help of non-resorbable sutures applied to the bony end of the transplant, the graft was pulled through the tibial tunnel into the joint and the bony end was countersunk in the preformed cavity at the femoral attachment site. The sutures were pulled tight via a small lateral incision and tied over a button lying on the cortical bone of the lateral femoral condyle with the knee in 20° of flexion (Figure 2).

Rehabilitation

Rehabilitation was the same for both groups. The operated knee was immobilized for 2 weeks in a knee-plaster in 20 degrees of flexion. From day 2, active rehabilitation, including crosstraining of the non-operated leg with use of one-leg cycling and strengthening exercises. Transcutaneous electrical stimulation together with isometric voluntary quadriceps contractions on the operated side was used. After plaster removal, a custom-made hinged brace allowing full range of motion was applied to the knee. Pool-training started after 2 weeks when the wound was healed. Full weightbearing was not allowed until 6 weeks after the operation. Strength training on the operated side started when movement was restored to nearly normal, usually after 8–10 weeks. Cycling outdoors was allowed after 3–4 months and light jogging after 5 months. Return to full sport activity was allowed 1 year after the operation. The rehabilitation was supervised by a physiotherapist.

Evaluation

Preoperative and yearly follow-up examinations were performed by LD. Subjective symptoms and activity levels were evaluated with Lysholm's functional score (Lysholm and Gillqvist 1982) and the Tegner activity score (Tegner and Lysholm 1985). The main factors for the total Lysholm score are pain, swelling and a feeling of instability.

Pivot shift tests were performed as described by Galway et al. (1972), Losee et al. (1978), Noyes et al. (1980) and graded as 0 (absent), 1 (difficult to provoke, glide) and 2 (clearly positive). A pivot shift that is difficult to provoke is recorded as negative, because we are unsure of its clinical significance.

Arthrometric measurements were performed with the KT-1000 (Med-Metrics Corp. San Diego CA, U.S.A.) with the knee in 25° flexion, and a forward pull of 67 N and 89 N and also with the use of the Maximum Manual Displacement test, as described by Daniel et al. (1985). We consider the injured-uninjured difference at 89 N pull to be the principal measurement value.

Statistics

For arthrometric measurements, the Student *t*-test was used and mean values are given. For the nonparametric scores, the Mann-Whitney U-test and Wilcoxon rank sum test were used and median values are given. For number of patients, chi^2 was used. $P < 0.05$ was considered significant.

Results

There were no infections or wound problems. 18 patients in the LAD-group and 17 in the PT-group were satisfied with their operation at the last follow-up.

Both groups improved their Lysholm functional score. The improvement was unchanged at the last follow-up. Problems with swelling of the knee after exercise occurred in 4 LAD patients and 2 PT patients (Table 3). Pain scores improved in both groups but their activity score did not improve (Table 1).

The PT-group, by chance, showed less arthrometric injured-uninjured difference, than the LAD-group at preoperative arthrometric measurement. The KT-1000 measurements showed unchanged improvement in both groups during the follow-up period and at the last follow-up (Table 2 and Figure 3).

There were 2 patients in the LAD-group who, without trauma during the follow-up period, developed an anterior instability which increased so much as to be considered an insufficient graft or rupture. In the PT-group also 2 patients were considered to be failures. 1 patient had a rupture after trauma during soccer-play, and 1 never showed improvement after surgery. We have had no case with synovitis in either group.

In the LAD and the PT groups, 6 and 8 patients, respectively, had a second operation performed due to problems after index surgery (Table 3).

Table 1. Lysholm functional and Tegner activity scores of LAD- versus PT-operated patients. Median (range) values are given

	LAD			PT			
	Preop	Last follow-up	Diff.	Preop	Last follow-up	Diff.	Diff. between diff.
Lysholm total score (max =100 p)	66 (48–80)	94 (83–100)	28 *	70 (59–87)	94 (72–100)	24 *	4
Lysholm >96 p (number of patients)	0	9	9 *	0	7	7 *	2
Lysholm pain score (25 p =no pain)	18 (10–25)	25 (20–25)	7 *	20 (15–25)	25 (15–25)	5 *	2
Activity	6	6	0	6	5	–1	–1

* difference ($P < 0.05$) between preoperative and last assessment.
The differences between the differences in the groups were not significant.

Table 2. Arthrometric measurements, LAD versus PT operated patients. Mean values *SD* are given

	LAD			PT			
	Preop	Last follow-up	Diff.	Preop	Last follow-up	Diff.	Diff. between diff.
AD I	12.6 *2.7*	8.4 *1.7*	−4.2 *	11.2 *2.2*	8.2 *1.7*	−3 *	1.2
ADD I-U	6.0 *2.1*	1.4 *1.5*	−4.6 *	4.6 *2.2*	1.0 *2.0*	−3.6 *	1
MMD I-U	8.1 *3.2*	2.2 *2.6*	−5.9 *	6.9 *3.0*	0.6 *3.2*	−6.3 *	0.4
ADD I-U ≥ 3 mm (no. of patients)	19	6	−13 *	15	4	−11 *	2

AD I anterior displacement (mm) of injured knee at 89 N anterior pull.
ADD I-U anterior displacement difference (mm) between injured and uninjured knee at 89 N anterior pull.
MMD I-U maximal manual displacement difference (mm) between injured and uninjured knee, anterior pull.
* difference ($P < 0.05$) between preoperative and last assessment.
The differences between the differences in the groups were not significant.

Table 3. Problems in LAD- versus PT-operated patients

	Number of patients LAD	PT
Positive pivot shift	2	2
Extension deficit 3–5°	2	4
Moderate effusion	4	2
Second operation	6	8
Types/numbers		
diagnostic arthroscopy	5	3
mobilization under anesthesia	4	6
resection of medial meniscus	1	2
resection of lateral meniscus	0	1
op bursitis	1	0
tensioning of graft/LAD band	1	0

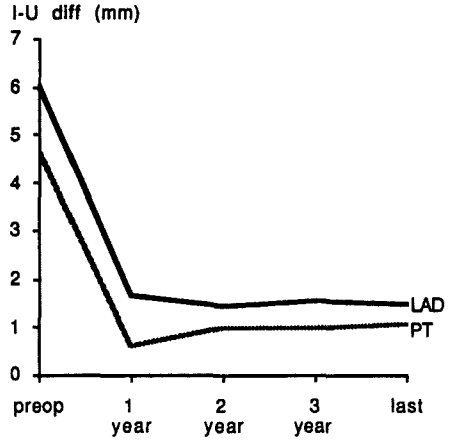

Figure 3. (I-U diff). Arthrometric injured-uninjured difference between LAD- and PT-operated knees preoperatively and during the follow-up period.

Discussion

Anterior knee pain is a well-known problem after anterior cruciate ligament reconstruction using autologous patellar tendon as a graft. This may be due to different mechanical properties after operation, such as malalignment in the patellar joint, tendon contractures with abnormal positioning of patella, weakening of the quadriceps muscle and extensor mechanism. It therefore seemed advisable to take only a half thickness of the central part of the extensor mechanism as in the LAD-technique instead of a full thickness of the medial part. Our results, however, showed no difference in pain score between the two techniques.

The 2 LAD patients considered as failures might imply that the grafts are too weak which was also found by Noyes et al. (1984). Hypothetically this could mean that the augmentation device can serve as a stress shield, leaving a weaker autolog transplant when the LAD eventually breaks because of wear. To investigate this, one would need a longer follow-up period than in the present study. In our study, we have had no problems in tensioning the graft enough to achieve adequate anterior stability, nor have we been able to demonstrate an increase in anterior laxity as a function of time in any of the groups, which has been reported in other studies (McPherson et al. 1985, Jonsson et al. 1992).

In our hands, both techniques produce good results with few, if any, complications. The patients are satisfied, they have a maintained anterior stability, they have regained, but not increased, their preoperative sport level and they have less pain. These results are the same as in two similar studies, one not randomized and both with a shorter follow-up (Moyen et al. 1992, Noyes and Barber 1992).

We have found two studies with results contrary to ours. One is an animal study (McPherson et al. 1985) with 2-year follow-up. They found the augmented

group to be mechanically stronger at follow-up, but this could not be statistically verified because of the smallness of the groups. The other study (Roth et al. 1985) is a retrospective, not randomized study between LAD-augmented and unaugmented knees. There was a 14 month difference in follow-up between the groups. In subjective questioning, physician's testing and radiographic examinations, the augmented group had better results, but objective testing with the KT-1000 arthrometer and Cybex isokinetic strength test showed no difference between the groups.

All our results in both groups improved except on the activity level. One possible explanation is that patients with chronic anterior cruciate ligament ruptures have adapted themselves to a lower degree of activity and they may also be unwilling to risk their knee stability after surgery, having experienced the discomfort and pain of "giving way".

Another explanation is that we operated mostly on recreational athletes. The Tegner activity score might be better at evaluating professional or elite athletes but was not sensitive enough for this group of patients.

With the results of the present study and after reviewing the literature, our conclusion is that the Kennedy LAD-method with use of a modified over-the-top technique is equal to but not better than the traditional patellar tendon technique. It reqiures an implantation of foreign material into the knee joint in the young individual and there is an uninvestigated risk of late failures.The Kennedy LAD method therefore cannot be recommended for routine use in the reconstruction of chronic anterior cruciate ligament ruptures.

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