Anterior cruciate ligament repair with and without augmentation

A prospective 7-year study of 51 patients

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A prospective comparison was made of the 7-year results of repair of the acutely ruptured anterior cruciate ligament with and without augmentation using the longitudinal patellar retinaculum. The knee stability was evaluated by clinical tests and by a specially constructed testing device. In the repair group, 6/22 had unchanged activity and intensity levels compared with 24/29 in the augmentation group. Lysholm's functional score was higher in the augmentation group. All the clinical tests and all the objective measurements except Lachman's test showed better stability in the augmentation group.

Since Palmer (1938) and O'Donoghue (1950) presented their surgical techniques, repair without augmentation has been commonly used as the treatment of acute anterior cruciate ligament ruptures. At the end of 1970s, several studies had indicated unsatisfactory long-term results in 30–50 percent of the cases (Feagin and Curl 1976, Lysholm et al. 1982, Odensten et al. 1984). These disappointing results stimulated the use of some form of augmentation or primary reconstruction as an acute procedure (Althoff et al. 1979, Clancy et al. 1982, Larson 1983, 1985, Odensten et al. 1985, Gollehon et al. 1985, Aho et al. 1986, Noyes et al. 1987, Jonsson et al. 1989).

We have compared the long-term results of repair with and without augmentation of the acutely ruptured anterior ligament in terms of knee stability and function. The medial or lateral longitudinal retinaculum was used as the augmentation.

Materials and methods

Sixty-three patients operated on for an acute complete rupture of the anterior cruciate ligament between 1977 and 1981 were included in the study. The diagnosis was established by a clinical examination, by arthroscopy or arthrotomy, and by stability testing under anesthesia. The criteria for surgery was instability in the patients with great demands on knee function. The patients scheduled for surgery on Mondays and Thursdays were repaired without augmentation and the patients scheduled for surgery on Tuesdays and Fridays were repaired with augmentation. There were no differences in the skill of the surgeons between the two groups. The operations were performed 5 (1–30) days after the injury.

Twenty-eight patients, 23 men and 5 women with a mean age of 27 (17–43) years, were repaired without augmentation; and 35 patients, 31 men and 4 women with a mean age of 29 (18–50) years, were repaired and augmented. Twenty-four patients in the repair group and 25 patients in the augmentation group had a rupture of the medial collateral ligament and/or meniscal lesion. Two patients, 1 in each group, had undergone an earlier meniscectomy, and 2 patients in the augmentation group had substantial articular cartilage injuries. One patient in the augmentation group had a lateral collateral ligament rupture. Most of the patients had sustained their injuries in sports activities (soccer 28, down-hill skiing 10, European handball 7, ice hockey 2, other activities 16).

In both groups the ligament was sutured for interstitial ruptures or reinserted if avulsed from bone as described by Palmer (1938). In the augmentation group the ligament was also augmented with the longitudinal patellar retinaculum.

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Surgical technique

The medial or lateral retinaculum was used as a strip, at least 10 mm broad, starting at the superior margin of the patella and down to its attachment at the tibia. A channel from the medial aspect of the tibia, just proximal to the tibial attachment of the strip, was drilled slightly anterior and medial to the tibial attachment of the anterior ligament. The opening in the joint was made with a semilunar osteotome (Figure 1).

Another channel was drilled through the lateral femoral condyle just posterior to the femoral attachment. The strip was pulled through the channel in the tibia, through the joint covering the repaired ligament, and then through the channel in the femur. The sutures from the strip and the repaired ligament were tightened separately over a button after conditioning, i.e., prestretching the sutures by repeated flexion-extension movements of the knee (Althoff et al. 1979, Jonsson et al. 1989). All the associated injuries were treated surgically.

Both groups were immobilized postoperatively in a plaster cast for 6 weeks with the knee in 20°–30° of flexion. Weight bearing with pain as the limiting factor was allowed. Rehabilitation programs were then carried out.

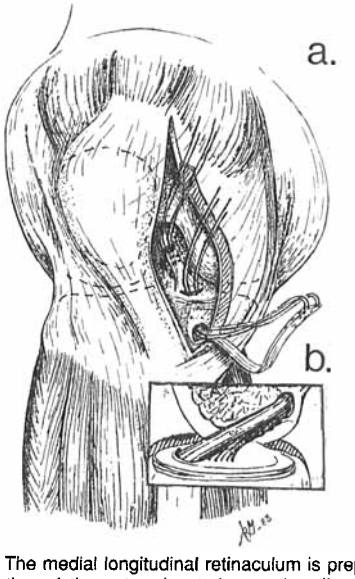

Figure 1. The medial longitudinal retinaculum is prepared for augmentation of the sutured anterior cruciate ligament (a), covering its anteromedial part (b).

Examination

At the follow-up, the patients were evaluated by a questionnaire, including sports activities and intensity levels, a knee function score (Lysholm and Gillquist 1982), a clinical examination, and an objective stability test. The clinical examination included the Lachman and anterior drawer tests, graded 1+, 2+, and 3+ according to Hughston and Eilers (1973), and the pivot shift test, graded negative or positive.

An objective evaluation of the anterior tibial displacement relative to the femur was performed in a testing device that measured the anterior tibial displacement with the knee flexed to 90° and the tibia in the neutral position, 30° external rotation, and 15° internal rotation. Anterior tibial displacement was also evaluated at 20°–30° flexion (Lachman's test). The difference in the anterior tibial displacement between the injured and uninjured knees was measured. Three patients in the repair group were dropped from the objective evaluation because of technical failures.

In the repair group, 1 patient was reconstructed 4 years after the primary surgery because of severe giving-way symptoms. At the operation, a total atrophy of the ligament was noted, and the patient was excluded. At the time for follow-up, another patient was on the waiting list for a reconstruction of an insufficient anterior ligament and was included in the follow-up. One patient in the repair group was excluded because of psychosocial problems and another because of residua after poliomyelitis in the uninjured knee. Three patients were not available at the follow-up. The remaining 22 patients were followed up after 7.5 (5–10) years. In the augmentation group, 2 out of the 35 patients had sustained new injuries to the knee and were later reconstructed. Three patients had moved to other areas, and 1 patient could not be reached. The remaining 29 patients were followed up after 7 (5–10) years.

A comparison between independent groups and paired data was performed with the Student's *t*-test. For discrete data, the chi-square test with correction for continuity was used, while Fisher's exact test was employed for small samples. Only two-tailed tests were used, and $P < 0.05$ was considered significant.

Results

Six out of 22 patients in the repair group and 24 out of 29 patients in the augmentation group considered their activity and intensity levels as unchanged from their preinjury status. Twelve patients in the repair group and 1 in the augmentation group had discon-

Table 1. Objective measurement of the anterior tibial displacement under 150 N force. Repair without augmentation. Repair with augmentation. Three patients in the former group were unaccounted for objective evaluation

		Displacement (mm)						Difference (mm) injured-uninjured knee			
		injured knee			uninjured knee						
	n	mean	*SD*	range	mean	*SD*	range	mean	*SD*	range	*P*
Repair without augmentation											
Anterior drawer											
neutral	19	6.2	*1.7*	3.8–9.7	4.3	*1.1*	2.4–7.0	1.9	*1.6*	–0.3–4.9	< 0.001
30° ext. rot.	19	6.2	*1.8*	3.5–9.7	4.5	*1.3*	2.6–8.2	1.7	*1.8*	–0.8–4.9	< 0.001
15° int. rot.	19	5.0	*1.7*	1.8–8.1	3.7	*0.9*	2.3–5.8	1.3	*1.8*	–1.7–5.2	< 0.01
Lachman's test	19	4.8	*2.2*	2.1–10.6	3.9	*1.1*	2.4–6.1	0.9	*1.9*	–1.8–4.5	NS
Repair with augmentation											
Anterior drawer											
neutral pos.	29	4.7	*1.2*	1.9–7.3	4.3	*1.1*	2.4–7.0	0.4	*1.5*	–0.9–3.9	NS
30° ext. rot.	29	5.0	*1.3*	3.2–8.5	4.3	*1.0*	2.9–7.9	0.7	*1.7*	–1.4–3.5	< 0.05
15° int. rot.	29	4.3	*1.4*	1.8–8.1	3.7	*0.9*	0.9–5.8	0.6	*1.6*	–1.4–3.6	NS
Lachman's test	29	4.7	*1.8*	2.1–10.6	3.9	*1.1*	2.4–6.1	1.0	*1.6*	0.9–3.6	< 0.01

tinued participation in sports activities because of their knee disability. Two patients in the repair group and 1 in the augmentation group had reduced their sports activities because of impaired knee function. There were no differences in the long-term results between the two groups concerning "isolated" ruptures and those with associated injuries.

The mean knee function score for the repair group was 88 ± 7 and for the augmentation group 93 ± 6 points ($P < 0.01$). The mean stability score (maximum 30 points, part of Lysholm's score) was 25 ± 3 for the repair group and 28 ± 3 for the augmentation group ($P < 0.001$). In the subjective evaluation, 12/22 in the repair group and 25/29 in the augmentation group stated their knee function as excellent or good.

Fifteen patients had a positive anterior drawer graded 2+ or more in the repair group compared with 6 patients in the augmentation group ($P < 0.01$). Ten patients in the repair group and 5 patients in the augmentation group had a positive Lachman test (NS). Eight patients in the repair group had a positive pivot shift, while none existed in the augmentation group. In the repair group the mean stability score (maximum 30 points, part of Lysholm's score) for the patients with a positive pivot shift was 24 ± 2 points and for the patients with a negative pivot shift 27 ± 3 ($P< 0.05$). Two of the 8 patients with a positive pivot shift had discontinued with their sports activities and 5 had giving-way episodes during sports activities.

The differences between the injured and the uninjured knee as determined by the objective anterior tibial displacement at 90° flexion were smaller in the augmentation than in the repair group. In the group repaired without augmentation, there were differences between the injured and the uninjured knee except for the Lachman test (anterior tibial displacement in 20°–30° flexion; Table 1).

Discussion

Our unsatisfactory end results of acute repair alone agreed with other authors (Feagin and Curl 1976, Lysholm et al. 1982, Balkfors 1982, Odensten et al. 1984, Larsson 1985, Sandberg et al. 1987). Augmentation with the longitudinal patellar retinaculum gave superior long-term knee stability and function in accordance with Odensten et al. (1985), Aho et al. (1986), and Andersson et al. (1989). The reasons for failure possibly include severe damage to the cruciate ligament at the time of injury, compromised circulation resulting in atrophy of the ligament, too much stress on the repaired ligament during the early postoperative period, and secondary elongation of weak scar tissue. Therefore, augmentation or primary reconstruction is advocated in the surgical treatment of acute ACL ruptures (Althoff et al. 1979, Clancy et al. 1982, Larson 1983, 1985, Odensten et al. 1985, Gollehon et al. 1985, Aho et al. 1986, Jonsson et al. 1989). Other authors have reported good results of primary repair alone (Marshall et al. 1979, Strand et al. 1984, Higgins and Steadman 1987).

The clinical evaluation of abnormal knee laxity is often based only on the subjective opinion of the physician. An objective measurement as a complement to the clinical evaluation is of great value. (Markolf et al. 1978, Daniel et al. 1985, Aho et al. 1986). The objective evaluation showed less anterior tibial displacement relative to the femur in the augmentation group except in the Lachman test (Table 1), which also could be shown in the clinical evaluation.

An important finding in our study was that 8 patients in the repair group had a positive pivot shift compared with none in the augmentation group. Five of these patients had giving-way episodes. The pivot shift test is considered the best functional test to reproduce giving-way symptoms (Galway et al. 1972, Losee et al. 1978). A positive pivot shift indicates an insufficient anterior cruciate ligament and the patients' subjective experience of instability. Elimination of the pivot shift phenomenon is thus a notable indicator for successful treatment.

In this study a majority of the patients in the repair group had discontinued their sports activities or decreased the activity level, but a majority in the augmentation group could continue in their sports at the preinjury level. A change in activity level cannot, however, be measured in the functional score system used in this study. Therefore, a difference in the total score between the augmentation and the repair groups does not completely reflect the difference in the groups' activity or intensity levels. Tegner's (Tegner and Lysholm 1985) activity level score seems to be a valuable tool in the evaluation of end results of knee ligament injuries if combined with Lysholm's score. We have compared preinjury and postinjury levels.

The complexity of anterior cruciate injuries is not completely understood. The importance of revascularization of the ligament and its repair may be of great value for the survival of the ligament. The initial stability and the stability during the healing process can be improved by adding some form of augmentation, e.g., patellar, semitendinosus and gracilis tendons, and the iliotibial band. Augmentation with the longitudinal patellar retinaculum may thus support the healing process of the repaired ligament in several ways: viz., revascularization of the ligament by ingrowing vessels from the strip (Alm and Strömberg 1974), stimulation of synovial tissue proliferation over the repaired ligament (Lundborg and Rank 1978), additional stability during the healing period, and additional strength to the repaired and healed ligament.

The knee function expressed by the subjective evaluation of the patients, by the clinical tests, and by objective measurements correlate well in our study. For the acute rupture of the anterior cruciate ligament repair with augmentation was superior to repair alone.

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