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Knee function following suture of fresh tear of the anterior cruciate ligament

A retrospective consecutive series of 60 patients treated with primary suture of knee ligament injuries is presented. All patients had an anterior ligament (ACL) tear. In 54 patients this injury was combined with a medial compartment tear. Four patients had isolated tears of the ACL.
At follow-up after 4 years, 11 patients complained of instability, and in eight of these an anterolateral rotatory instability was demonstrated by the Slocum test. In contrast, only five of 49 patients with subjectively stable knees had positive Slocum tests. Thirty of 47 patients with negative Slocum tests had excellent function, compared with four of 13 patients with positive tests.

Key words: anterior cruciate ligament; knee injuries; ligaments.

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Primary repair of the anterior cruciate ligament (ACL) is a disputed matter (Johnson 1982), and the reported results are contradictory (Feagin & Curl 1976, Balkfors 1982, Lysholm et al. 1982). The present study was undertaken to evaluate our results of primary suture of the ACL, and to compare the objective and functional results at a follow-up examination.

Patients and methods

During 1976–1980, all patients with diagnosed recent anterior cruciate ligament tears were operated on by primary suture. No patients with ACL tears diagnosed within 4 weeks were treated conservatively, and no primary reconstructions or augmentations were performed during this period. Patients with previous knee injuries, avulsions of the tibial spine or other fractures in the same knee, as well as patients with associated ruptures of the posterior cruciate ligament were excluded. Eight patients lived too far away for follow-up. After these exclusions, the remaining 60 patients represented a consecutive series consisting of 34 men and 26 women, with median age 44 (15–70) years (Table 1). Nearly half of the injuries were caused by skiing accidents.

In 25 patients, an anterior drawer sign was demonstrated without anaesthesia, while this was found by repeating the examination in general or epidural anaesthesia in 51 patients. In nine additional patients, unexpected ACL tears were diagnosed by arthroscopy or by exploring the ACL during repair of other ligament ruptures. The specific anterolateral rotatory instability (ALRI) tests and the Lachman test were not performed regularly in this period. Arthroscopy was performed in only five of the patients in this series.

All patients were operated on within 4 weeks from the injury (median 4 days); 41 within the first week, 14 during the second, and five after more than 2 weeks. In all but four patients the ACL tears were associated with ruptures of other ligaments, notably the medial collateral ligament (Table 2).

Operative technique

All operations were performed in a bloodless field. When an ACL tear was verified, the capsular incision was extended proximally through the vastus medialis

Table 1. Age and sex of 60 patients who had primary suture of anterior cruciate ligament ruptures

Age, years	♂	♀
15–20	8	1
21–30	9	6
31–40	2	3
41–50	7	5
51–60	1	9
61–70	7	2
	34	26

Table 2. Classification of injuries

Ligaments torn	No. of patients
ACL isolated	4
ACL + MCL	53
ACL+ LCL	2
ACL + MCL + LCL	1

Abbreviations:
ACL: anterior cruciate ligament.
MCL: Medial collateral ligaments including posteromedial corner.
LCL: Lateral collateral ligaments including arcuate complex.

tendon until the patella could be dislocated laterally. The ACL was repaired by a modification of the technique originally described by Palmer (1938), using varying depth, multiple loop (5–6) sutures pulled through drill holes, in the femur in 53 cases, in the tibia in two cases, and in five cases with midsubstance tears in both directions (Figure 1). No guide instrument was used, but great care was taken to hit the original ligament insertions. The anteromedial and posterolateral components of the ACL were repaired simultaneously with one set of sutures, aiming at a correct orientation of the fibres. In ten patients the ACL tears were partial. In nine of these cases instability could be demonstrated. The ruptured component of the ACL was repaired in a similar manner. Ethilon® or Ethibond® No. 0 was used as suture material. All associated ruptures of other ligaments and capsular structures were repaired. Sixteen medial and one lateral meniscus detached from the capsule were sutured. In three patients the medial meniscus was removed. One lateral meniscus was removed and one torn lateral meniscus sutured.

Aftercare

A plaster cast was applied from the ankle to the proximal thigh with the knee in 30–40° of flexion. Isometric quadriceps exercises were started immediately and continued until the cast was removed after 6 weeks, after which active mobilization of the knee was started, usually supervised by a physiotherapist. Contact sports were not recommended during the first postoperative year. The median convalescence period was 6 (4–12) months.

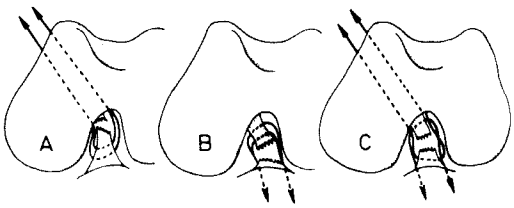

Figure 1. Repair of anterior cruciate ligament ruptures by multiple loop, varying depth sutures. Five to six sutures are used in each direction.
A: Ruptures at or near femoral insertion.
B: Ruptures at or near tibial insertion.
C: Midsubstance ruptures.

Follow-up

A follow-up examination was performed by four of the authors during 1982. Every patient was examined by two physicians. The median observation time was 48 (15–75) months.

The functional result was graded as excellent when the injured knee did not restrict the patient's activities, including strenuous work and sports. In cases rated as good, there was some but not incapacitating functional loss, permitting the patient to participate in light recreational sports. Daily activities were not affected and the patients continued in their previous occupation. In cases classified as fair, there was a significant functional loss, which however did not affect light daily activities. In cases rated as poor, there was unacceptable impairment of function, affecting activities of daily living.

Medial-lateral and antero-posterior stability was tested as described by Hughston et al. (1976); the results were recorded as the difference from the normal knee and graded as 0, 1+, 2+ or 3+ instability. Antero-posterior stability in the semi-flexed knee (20°) was evaluated by the Lachman test (Torg et al. 1976), and the instability was graded as above. Anterolateral rotatory instability (ALRI) was assessed by the Slocum test (Slocum et al. 1976), and graded as positive (instability) or negative. The results were analyzed statistically by the Fisher exact probability test (Fisher 1934).

Results

There were three superficial wound infections and four thromboembolic complications not affecting the late results.

At follow-up, 28 out of 60 patients had no symptoms from the knee. Fourteen patients had slight or moderate pain, considered to be of patellofemoral origin in most cases. Nineteen patients considered the injured knee to be weaker than the other, and eight patients had intermittent hydrops.

Eleven patients had symptoms of instability (giving way). The functional result was graded

Table 3. Number of patients with antero-posterior and medial-lateral instability at follow-up

Test	0	1+	2+
Anterior drawer			
In neutral rotation	40	16	4
In external rotation	41	15	4
In internal rotation	55	5	0
Posterior drawer	60	0	0
Valgus stress			
Extended	58	2	0
In 20° flexion	28	26	6
Varus stress			
Extended	59	1	0
In 20° flexion	55	5	0

The instability was graded as the difference compared to the uninjured knee. 0 = No instability, 1+ < 5 mm, 2= 5–10 mm (Hughston et al. 1976).

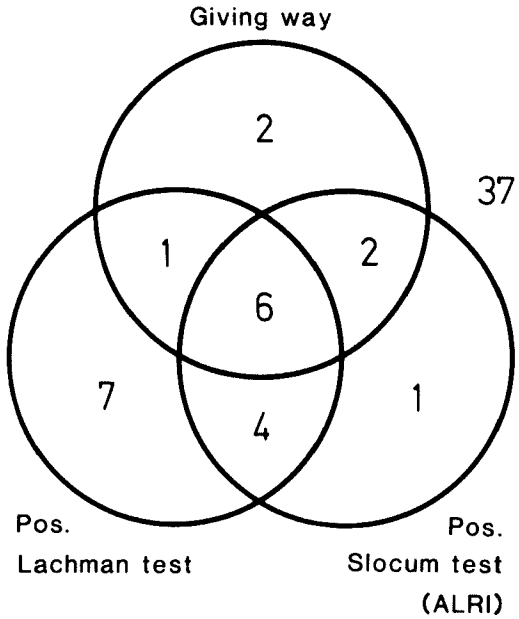

Figure 2. Relation between subjective instability (giving-way), Slocum and Lachman tests at follow-up.

as excellent in 34, good in 22, fair in one, and poor in three patients.

The results of the clinical testing of medial-lateral and anterior-posterior stability are given in Table 3. Anterolateral rotatory instability demonstrated by a positive Slocum test was found in 13 patients. Of the five patients with total midsubstance tears, four were stable. None of the ten patients with partial ACL tears had ALRI. No difference was found between patients operated on before or after 7 days from injury. One of the three total ACL tears repaired after more than 3 weeks resulted in ALRI. Lachman tests were negative in 43 patients. Of the 17 positive tests, 12 were 1+ only. The range of motion is given in Table 3.

The relations between subjective instability (giving way), ALRI and Lachman tests are given in Figure 2. Eight of the 11 patients with subjective instability had ALRI, compared with five of the 49 patients with subjectively stable knees ($P = 0.001$).

Thirty of the 47 patients with sufficient ACL, as evaluated by the Slocum test, had an excellent functional result, compared with four of the 13 patients with insufficient ACL ($P < 0.05$). A slightly positive (1+) anterior drawer or Lachman test was not correlated to ALRI or functional outcome. Neither did a slight (1+) valgus instability in 20° flexion affect the functional outcome.

Of four patients with fair or poor results, two had ALRI. Three of them had a significant (2+) valgus instability in 20° flexion. All patients with fair or poor results were more than 40 years of age at injury, and the three patients with less than 90° of knee flexion were all more than 50 years of age. The distribution between excellent and good results, however, was not correlated to the age of the patients.

Table 4. Range of knee motion at follow-up examination

Range of movement	No. of patients
Normal	48
Loss of extension 5–10°	3
Flexion > 90° < 120°	6
Flexion < 90°	3

Discussion

Our policy in acute knee ligament injuries has been to repair all torn components to achieve maximal primary stability. The systematic repair of the ACL was part of this policy.

The subluxation-relocation test for anterolateral rotatory instability, described by Slocum et al. (1976), is a specific and sensitive test of ACL function. The diagnostic value of

ALRI tests has also been demonstrated in cadaver studies (Jacob et al. 1981). The negative Slocum tests in 47 out of 60 patients indicate a sufficient ACL function after 48 months.

There was a significant correlation between ALRI (positive Slocum test) and a less then excellent functional outcome, indicating the importance of the ACL for optimal knee function.

Our results are in accordance with those of Lysholm et al. (1982). On the other hand, Kennedy et al. (1974) and Balkfors (1982), comparing repaired and unrepaired ACL tears, did not find operative treatment to affect the functional results significantly. These authors did not, however, report the excellent and good results separately.

We regard the surgical technique in primary suture to be of utmost importance. In ruptures at or near the femoral end of the ligament we aimed at an exact reinsertion of the ACL at its original attachment far back on the lateral condyle. Even mop-end midsubstance tears appeared to be amenable to repair.

The importance of early repair has been emphasized by Liljedahl & Nordstrand (1969). No correlation between the results and delay of repair was revealed in our study. Thus, primary suture may be performed successfully even after 2 weeks.

All four patients with fair or poor results were more than 40 years.

In conclusion, primary suture of acute tears of the ACL eliminates instability and restores function in most cases, and thus is considered to be justified.

References

Balkfors, B. (1982) The course of knee-ligament injuries. *Acta Orthop. Scand.* Suppl. 198.

Feagin, J. A. Jr. & Curl, W. W. (1976) Isolated tear of the anterior cruciate ligament: 5-year follow-up study. *Am. J. Sports Med.* **4**, 95–100.

Fisher, R. A. (1934) *Statistical methods for research workers.* Oliver & Boyd, Edinburgh.

Hughston, J. C., Andrews, J. R., Cross, M. W. & Moschi, A. (1976) Classification of knee ligament instabilities. Part I and II. *J. Bone Joint Surg.* **58**-A, 159–179.

Jacob, R. P., Hassler, H. & Staeubli, H. U. (1981) Observations on rotatory instability of the lateral compartment of the knee. *Acta Orthop. Scand.* Suppl. 191.

Johnson, R. J. (1982) The anterior cruciate: A dilemma in sports medicine. *Int. J. Sports Med.* **3**, 71–79.

Kennedy, J. C., Weinberg, H. W. & Wilson, A. S. (1974) The anatomy and function of the anterior cruciate ligament. *J. Bone Joint Surg.* **56**-A, 223–235.

Liljedahl, S. O. & Nordstrand, A. (1969) Injuries to the ligaments of the knee. *Injury* **1**, 17–24.

Lysholm, J., Gillquist, J. & Liljedahl, S. O. (1982) Long-term results after early treatment of knee injuries. *Acta Orthop. Scand.* **53**, 109–118.

Palmer, I. (1938) On the injuries to the ligaments of the knee joint. *Acta Chir. Scand.* Suppl. 53.

Slocum, D. B., James, S. L., Larson, R. L. & Signer, K. M. (1976) Clinical test for anterolateral rotary instability of the knee. *Clin. Orthop.* **118**, 63–69.

Torg, J. S., Conrad, W. & Kalen, V. (1976) Clinical diagnosis of anterior cruciate ligament instability in the athlete. *Am. J. Sports Med.* **4**, 84–93.