THE JOURNAL OF BONE & JOINT SURGERY (Br)

Outcome after reconstruction of the anterior cruciate ligament in athletic patients

A COMPARISON OF EARLY *VERSUS* DELAYED SURGERY

A. A. S. Meighan, J. F. Keating, E. Will

From the Royal Infirmary of Edinburgh, Scotland

We randomised 31 patients with acute tears of the anterior cruciate ligament (ACL) to receive either early (within 2 weeks) or delayed (8 to 12 weeks) reconstruction using a quadruple hamstring graft in order to determine if there was any functional advantage to early reconstruction. Outcome measures included return of knee movement, muscle dynamometry, International Knee Documentation Committee (IKDC) scores and Tegner activity levels.

Two cases of symptomatic deep-venous thrombosis occurred in the early group. The mean range of movement was significantly greater at two weeks in the delayed group. Quadriceps muscle power was significantly better in the delayed group at 12 weeks ($p < 0.05$). These trends were evident at later time points, but were not statistically significant. One patient in each group had clinically significant knee stiffness at 52 weeks. IKDC scores and Tegner activity levels were not significantly different at 52 weeks. We conclude that there is no functional advantage to be gained by early reconstruction of the ACL.

J Bone Joint Surg [Br] 2003;85-B:521-4.
Received 7 August 2002; Accepted after revision 30 January 2003

Postoperative stiffness of the knee is a well-recognised complication of reconstruction of the anterior cruciate ligament (ACL).[1-3] In particular, early reconstruction after tears of the ACL has been associated with an increased incidence of stiffness and prolonged rehabilitation.[4] A delay in surgical reconstruction also has a potential morbidity, such as inability to return to employment or sporting activities, as well as an increased risk of meniscal damage from further injuries because of instability of the knee.[5] Currently, many surgeons prefer to treat injuries of the ACL with an initial period of rehabilitation followed by reconstruction two months or more after the injury.[4,6]

Table I. The inclusion criteria for entry into the study comparing the outcome after either early or delayed reconstruction of the ACL

Acute ACL tear seen within 10 days of injury
Athletically active
Less than 35 years of age
No associated injury to the medial collateral ligament
No previous ligament injury
No previous meniscal tear

Previous studies have suggested that the risk of joint stiffness is greatest if the surgery is carried out two to eight weeks after injury.[2] It has been proposed that early reconstruction, within a week of injury, will minimise the risk of stiffness. Immediate reconstruction in suitable patients may have other advantages, such as a reduction in the overall rehabilitation period and an earlier return to sporting and occupational activities.[7] On this basis many surgeons now carry out an immediate reconstruction of the ACL on athletic patients.[5,8] Although modern methods of reconstruction with minimally invasive techniques and accelerated rehabilitation appear to have reduced the risks associated with early reconstruction, there is limited evidence in the literature to support this approach. Our aim in this prospective, randomised study therefore was to compare the functional outcome of early and delayed reconstruction of the ACL in order to determine whether there was an advantage to early reconstruction.

Patients and Methods

We randomised 31 patients with acute tears of the ACL by selection of an envelope to either an early, within two weeks (group I), or delayed reconstruction, between 8 and 12 weeks (group II). The inclusion criteria are given in Table I. All patients were athletically active in a sport, which was considered likely to cause symptomatic instability in a knee which was ACL-deficient. The activity rating of Tegner and

A. A. S. Meighan, FRCS (Trauma & Orth), Knee Fellow
J. F. Keating, FRCS (Trauma & Orth), Consultant Orthopaedic Surgeon
E. Will, MCSP, Research Physiotherapist
Department of Orthopaedic Trauma, Royal Infirmary of Edinburgh, Lauriston Place, Edinburgh EH3 9YW, UK.

Correspondence should be sent to Mr J. F. Keating.

doi:10.1302/0301-620X.85B4.13743 $2.00

Table II. The change in Tegner activity rating of patients before injury and at the 52-week follow-up after reconstruction of the ACL

Tegner activity level	Before injury (number of patients)	At 52 weeks (number of patients)
2	0	1
5	0	3
6	2	7
7	16	10
8	2	2
9	9	6
10	2	2

Table III. Range of knee movement (degrees) for the early (group I) and late (group II) groups, 12 weeks after reconstruction of the ACL

Follow-up (weeks)	Group I	Group II
2	11 to 76*	8 to 93*
6	4 to 112	2 to 121
12	2 to 123	2 to 128
24	0 to 131	-1 to 131
52	-2 to 131	-2 to 131

* significant, $p < 0.05$

Lysholm[9] is given in Table II. There were 28 men and three women with a mean age of 21 years (15 to 35). Most ruptures had occurred while playing football (18 patients), rugby (6 patients) and basketball (4 patients).

All the patients were seen at a specialist soft-tissue knee injury clinic between October 1996 and May 2000. The diagnosis was made on the basis of an acute haemarthrosis associated with clinical signs of laxity of the ACL. Patients with associated medial collateral ligament (MCL) sprains were excluded. Group I (13 patients) had an early reconstruction carried out within two weeks. Group II (18 patients) had preoperative physiotherapy to restore knee movement and underwent reconstruction between eight and 12 weeks after injury.

We confirmed the diagnosis at the time of surgery and the ACL was reconstructed with a quadruple hamstring graft inserted by an arthroscopically-assisted, single-incision technique. On the femoral side an Endobutton secured the graft and on the tibial side a soft-tissue interference screw. The patients in both groups underwent an identical postoperative programme of accelerated rehabilitation. This concentrated particularly on the management of the soft-tissue swelling, the recovery of full extension of the knee and muscle control, and on proprioception exercises.

All patients were followed up for one year and none was lost to follow-up. Clinical assessments were made before operation and after surgery at two, six, 12, 24, and 52 weeks. Any postoperative complications were recorded. A research physiotherapist (EW), blinded to the randomisation, carried out isokinetic muscle testing of the quadriceps and hamstring muscles with a dynamometer (Biodex system 2; Biodex Medical Systems, Shirley, New York) at 12, 24 and 52 weeks after operation. The range of knee movement was measured with a long-arm goniometer. There was an active warm-up period before each test, followed by measurements of flexion and extension at 180°/second. The physiotherapist repeated the tests ten times using standardised commands. The values obtained in the injured limb were compared with those of the uninjured side, which was considered to be normal for that patient. We expressed the results for the injured knee as a percentage loss when compared with the normal side. The IKDC score assessed functional outcome.[10,11]

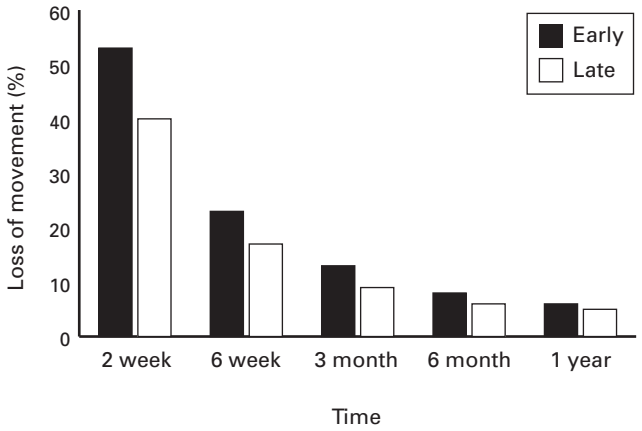

Fig. 1

Percentage loss of movement for early and late ACL-reconstructed knees compared with the uninjured side. The range of knee movement was better at all time points for those patients who underwent a delayed reconstruction of the ACL.

Statistical analysis. A comparison of means was carried out by Student's *t*-test. For non-parametric data we used the Mann-Whitney U test for unpaired data and the Wilcoxon test for paired comparisons.

Results

Early postoperative outcome. The mean tourniquet time for group I was 67 minutes compared with 74 minutes for group II ($p = 0.3$). Meniscal tears were identified in three patients in group I and in four in group II. The presence of a meniscal tear was not associated with a poorer outcome during the period of study. The reconstruction failed in one patient in group II shortly after the 12-week assessment. He subsequently underwent a revision reconstruction and his data are not included beyond the 12-week assessment. In group I there was one superficial wound infection and two patients developed a symptomatic deep-vein thrombosis and required anticoagulation.

Range of movement. The range of flexion was reduced in group I for all measurements made in the first 12 weeks after surgery (Table III). This difference was significant at two weeks. The trend was evident throughout the period of follow-up, although the differences were most apparent during the first three months (Fig. 1). There was no signifi-

Table IV. Total work deficit, mean quadriceps power deficit and peak torque deficit of the quadriceps, expressed as a percentage of the uninjured side. The results at 12 weeks were significantly better in those patients who had undergone a delayed reconstruction ($p < 0.05$)

Follow-up (weeks)	Work		Power		Torque	
	Group I	Group II	Group I	Group II	Group I	Group II
12	36*	22*	36*	23*	35	24
24	16	9	13	7	19	11
52	11	4	10	4	13	4

*significant, $p < 0.05$

cant difference in the loss of extension of the knee between the two groups at any stage. At the final follow-up (52 weeks) the mean range of movement in both groups was the same. Clinically significant residual stiffness (fixed flexion deformity >5˚, flexion <120˚) was present in one patient in each group. The patient in group II subsequently underwent a successful arthrolysis.

Muscle function. The mean quadriceps power and total work were reduced in group I at all measurement intervals (Table IV). This trend continued for 52 weeks but the differences were only significant at 12 weeks ($p < 0.03$). Hamstring power, torque and total work were reduced at 12 weeks in group I. The difference was not significant. The results after 12 weeks for the hamstrings were similar in both groups.

Functional outcome. There were no differences in the IKDC scores at 52 weeks. There were two abnormal results in group I. One patient had a painful tibial fixation screw which impaired function at one year. This was subsequently removed. The other had troublesome knee stiffness (range of movement 10˚ to 122˚). He declined further surgical treatment. In group II there were three abnormal results. One patient had a significant reinjury and ruptured the ACL graft. Another complained of subjective instability although the graft was intact. The third had persistent knee stiffness (range of movement 5˚ to 120˚) and underwent an arthrolysis, which was successful in restoring movement.

The Tegner activity scores were reduced for the whole study group when compared with their preinjury levels (Table II; $p < 0.002$) with no differences between groups I and II.

Discussion

We have found no evidence to suggest that an early reconstruction is of benefit to athletic individuals with an acute rupture of the ACL. The movement returns more slowly and the recovery of muscle function is delayed after an early reconstruction. However, one year after surgery there was no difference between early and delayed reconstruction in terms of muscle function, range of movement and functional outcome. There was an increased rate of complications in the early group with one patient having stiffness of the knee and two having clinically significant deep-vein thromboses. There was no difference in the incidence of meniscal tears between the two groups.

This is the first randomised comparison of early and delayed reconstruction of the ACL using objective outcome assessments. The patients were carefully selected in order to exclude patients with associated sprains of the medial collateral ligament and previous problems in the knee. All patients underwent identical surgical treatment and accelerated postoperative rehabilitation and objective assessments were undertaken by a research assistant who was blinded to the randomisation. The main disadvantage of the study, the small sample size, is mainly due to the pattern of presentation. Restrictions in access to acute orthopaedic services and stringent inclusion criteria contributed to the difficulty of recruiting larger numbers of patients.

Other studies have investigated the risks of immediate or very early reconstruction of the ACL. Shelbourne and Foulk[12] found a delayed return of quadriceps strength in patients who elected to have an early reconstruction and a slower progress to sport-specific rehabilitation exercises. An increased incidence of arthrofibrosis was also reported if the reconstruction was carried out within one week of injury.[4] They therefore recommended that surgery be delayed by at least three weeks, and suggested introducing an accelerated postoperative rehabilitation programme to reduce knee stiffness. Several authors have found similar results, with an increase in arthrofibrosis and a decrease in quadriceps strength after an acute reconstruction.[2,13] These studies were retrospective, included a variety of ligament injuries and surgical techniques, and had restrictive postoperative rehabilitation regimes. Accelerated protocols of knee rehabilitation with early knee movement after reconstruction of the ACL are now common and not associated with an increase in complications or morbidity.[1] This has led to the widespread practice of early reconstruction on the basis that it may shorten rehabilitation and allow an earlier return to the preinjury level of muscle function and sporting activity, as well as an economic advantage.[7]

Karlsson et al[5] found that reconstruction between two and 12 weeks after injury resulted in a higher activity level for competitive athletes. There was also a decrease in meniscal damage when compared with delayed surgery. Other authors have found no differences in function or strength tests relative to the timing of surgery.[5,7,8] These findings disagree with our results and those of Shelbourne et al,[4] in which recovery of muscle function was slower in the early reconstruction group.

We therefore conclude that there is no advantage in early reconstruction for isolated tears of the ACL and that this is associated with an increased rate of complications. Delayed surgery is associated with a more rapid return of movement and muscle function. In addition, a delay in surgical intervention allows the surgeon time to assess more carefully a patient's suitability for reconstruction of the ACL.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References

1. **Noyes FR, Mangine RE, Barber S**. Early knee motion after open and arthroscopic anterior cruciate ligament reconstruction. *Am J Sports Med* 1987;15:149-60.
2. **Mohtadi NGH, Webster-Bogaert S, Fowler PJ**. Limitation of motion following anterior cruciate ligament reconstruction: a case control study. *Am J Sports Med* 1991;19:620-4.
3. **Hughston JC**. Complications of anterior cruciate ligament surgery. *Orthop Clin North Am* 1985;16:237-40.
4. **Shelbourne K, Wilckens JH, Mollabashy A, DeCarlo M**. Arthrofibrosis in acute anterior cruciate ligament reconstruction: the effect of timing of reconstruction and rehabilitation. *Am J Sports Med* 1991;19:332-6.
5. **Karlsson J, Kartus J, Magnusson L, et al**. Subacute versus delayed reconstruction of the anterior cruciate ligament in the competitive athlete. *Knee Surg Sports Traumatol Arthrosc* 1999;7:146-51.
6. **Peterson W, Laperell H**. Combined injuries of the medial collateral ligament and the anterior cruciate ligament: early ACL reconstruction versus late ACL reconstruction. *Arch Orth Tr Surg* 1999;119:258-62.
7. **Berbig R, Rillman P**. Timing of the surgery of rupture of the anterior cruciate ligament: effects of acute or delayed surgery on arthrofibrosis rate and work disability. *Unfallchirurg* 2000;103:726-30.
8. **Jarvela T, Nyyssonen M, Kannus P, Paakala T, Jarvinen M**. Bone-patellar tendon-bone reconstruction of the anterior cruciate ligament: a long-term comparison of early and late repair. *Int Orthop* 1999;23:227-31.
9. **Tegner Y, Lysholm J**. Rating systems in the evaluation of knee ligament injuries. *Clin Orthop* 1985;198:43-9.
10. **Hefti F, Muller W, Jakob RP, Staubli HU**. Evaluation of knee ligament injuries with the IKDC form. *Knee Surg Sports Traumatol Arthrosc* 1993;1:226-34.
11. **Risberg MA, Holm I, Steen H, Beynnon BD**. Sensitivity to changes over time for the IKDC form, the Lysholm score, and the Cincinnati knee score: a prospective study of 120 ACL reconstructed patients with a 2-year follow-up. *Knee Surg Sports Traumatol Arthrosc* 1999;7:152-9.
12. **Shelbourne KD, Foulk DA**. Timing of surgery in acute anterior cruciate ligament tears on the return of quadriceps muscle strength after reconstruction using an autogenous patellar tendon grafts. *Am J Sports Med* 1995;23:686-9.
13. **Wasilewski SA, Covall DJ, Cohen S**. Effect of surgical timing on recovery and associated injuries after anterior cruciate ligament reconstruction. *Am J Sports Med* 1993;21:338-42.