INCOMPLETE RUPTURES OF THE ANTERIOR CRUCIATE LIGAMENT

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In a prospective study, 41 consecutive patients with a partial tear of the anterior cruciate ligament, diagnosed by arthroscopy, were reviewed after an average of 17 months, having been in plaster for six weeks after injury. Their average age was 29 years and review included clinical examination, measurement of anterior and posterior laxity with the Stryker knee laxity tester as well as evaluation of knee function and activity level.

Twenty-one patients had unstable knees at follow-up; the mean total anteroposterior laxity for these patients was 12.6 ± 3.9 mm compared with 7.1 ± 4.3 mm for the normal knee. Most patients had few symptoms, but there was a significant reduction in the mean level of activity in the unstable group.

Several studies have shown that partial rupture of the anterior cruciate ligament is common in an acutely injured knee with haemarthrosis. The incidence is reported to vary from 28% (Noyes et al. 1980) to 35% (Liljedahl, Lindvall and Wetterfors 1965; Johannsen and Fruensgaard 1988). While considerable interest has been focused on the treatment of total ruptures of the ligament (Liljedahl et al. 1965; Odensten, Lysholm and Gillquist 1984; Odensten et al. 1985; Noyes and McGinniss 1985; Tegner 1985), few studies have been concerned with partial or incomplete injuries (McDaniel 1976; Monaco, Noble and Bachman 1982; Farquharson-Roberts and Osborne 1983; Odensten, Lysholm and Gillquist 1985).

We have reviewed our short-term results in 41 patients with incomplete anterior cruciate rupture with reference to stability and knee function.

MATERIAL AND METHODS

Forty-one consecutive patients with acute partial rupture of the anterior cruciate ligament were reviewed after a mean follow-up of 17 months (range 12 to 22). The mean

Fig. 1

Paired values (injured knee and normal knee) of total anteroposterior laxity at 30 lbs (13.6 kg) for 20 patients with clinically stable knees and 21 with clinically unstable knees.

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age at follow-up was 29 years (range 12 to 72), 76% being aged 15 to 35 years. There were 26 men and 15 women, and 61% of the patients had sustained the injury in sports-related activities.

All patients had an arthroscopy and stability testing under anaesthesia within two weeks of the injury. The stability testing included valgus and varus stressing of

the extended and the semi-flexed knee, anterior and posterior drawer testing at 90°, the Lachman test (Torg, Conrad and Kalen 1976) and the MacIntosh pivot shift test (Galway and MacIntosh 1980). We used the American Medical Association (1976) grading to record instability.

Arthroscopy was performed with an Olympus 5 mm instrument using 30 and 70° telescopes. The anterior cruciate and other intra-articular structures were carefully probed; for subsynovial ruptures this was done after opening the synovium with a hook. The lesion of the anterior cruciate was classified as partial if there was subsynovial haemorrhage, disruption of the fibre bundles in some portion of the ligament, and a minimum of one-third of the fibres remaining intact to sustain tension when tested with the probe and to resist the drawer and Lachman tests. These tests were performed under vision through the arthroscope; all arthroscopic examinations were recorded on videotape.

Table I. Displacement in millimetres (mean $\pm$ s.d.) related to force on Stryker testing at follow-up in 21 patients with clinically unstable knees. In parentheses, for comparison, are the results in 20 patients with clinically stable knees

	Force applied		
	10 lb (4.5 kg)	20 lb (9 kg)	30 lb (13.6 kg)
Anterior displacement			
Injured knee	3.5 $\pm$ 1.8 (2.4 $\pm$ 1.3)	6.5 $\pm$ 2.6 (3.7 $\pm$ 1.7)	8.4 $\pm$ 3.1 (4.5 $\pm$ 1.7)
Normal knee	2.3 $\pm$ 1.6 (2.2 $\pm$ 1.0)	3.7 $\pm$ 1.7 (3.5 $\pm$ 1.2)	4.7 $\pm$ 2.0 (4.3 $\pm$ 1.8)
Posterior displacement			
Injured knee	2.3 $\pm$ 2.3 (1.2 $\pm$ 1.0)	3.3 $\pm$ 1.7 (2.2 $\pm$ 1.4)	4.2 $\pm$ 1.8 (2.8 $\pm$ 1.4)
Normal knee	1.6 $\pm$ 0.9 (1.4 $\pm$ 1.0)	2.3 $\pm$ 1.1 (2.1 $\pm$ 1.0)	3.1 $\pm$ 1.4 (2.7 $\pm$ 1.1)

Of the 41 patients with a partial rupture, nearly all had a haemarthrosis. In 28 of them, no anteroposterior knee instability could be detected under anaesthesia; the other 13 had slight anterior instability to the Lachman test. None had a positive pivot shift. Associated lesions were common, with 14 partial ruptures of the medial collateral ligament, one partial rupture of the lateral collateral ligament and one case with partial rupture of both posterior cruciate and medial collateral ligaments.

Total ligament ruptures were seen in four knees, three of the medial collateral and one of the lateral collateral ligament. These were sutured. Two bucket-handle tears of the medial meniscus were sutured by an arthroscopic technique (Johannsen et al. 1988). One case of patellar dislocation was also treated by operation.

After arthroscopy the limb was placed in plaster for six weeks; after this, supervised exercises and rehabilita-

tion were started, emphasising strength training of the hamstrings.

At follow-up assessments were made of knee function and activity, and stability testing was repeated as outlined earlier. Anteroposterior laxity was also determined with the Stryker knee laxity tester (Stryker, Kalamazoo, USA).

The knee function score (Lysholm and Gillquist 1982) emphasises symptoms of instability, locking, pain and swelling during various activities. The maximum score is 100 points; more than 82 is rated good or excellent. The activity scale of Tegner and Lysholm (1985) grades activities of daily life and sports on an 11 point scale, according to the trouble they cause patients with an anterior cruciate injury. Grade 10 is equivalent to playing soccer at an international level; grade 0 represents patients on sick leave or receiving a disability pension for their knee problem.

The Stryker knee laxity tester measures anterior and posterior knee laxity. The patient sits, and the thigh and distal lower leg are restrained by straps at 20° of knee flexion. A displacement gauge then records movement of the anterior tibia in relation to the patella and, hence, the femur. Anteroposterior force is applied by a calibrated spring-loaded handle, and records of anterior and posterior laxity are made for 10, 20 and 30 lb applied force. The sensitivity and reliability of this device have been evaluated by Boniface, Fu and Ilkhanipour (1986).

RESULTS

Static anterior knee instability was found in 21 of the 41 patients at follow-up, and moderate to severe clinical instability was present in 18 of these, all of whom had a markedly positive Lachman test and a positive anterior drawer sign at 90°. In addition, 14 patients had a positive pivot shift test. Three patients had only slight instability: they had a positive Lachman test, a mild or absent anterior drawer sign and no pivot shift.

In general, the objective measurements of anteroposterior laxity tests with the Stryker apparatus were in good agreement with the results of clinical examination (Fig. 1). The paired difference in total anteroposterior laxity (injured knee minus normal knee), for the 18 patients with moderate to severe instability, ranged from 4 to 12 mm; for the three patients with slight clinical instability, a paired difference of 2 mm was found. The increase in anteroposterior laxity was mainly due to increased anterior movement (Table I).

Only two patients had collateral ligament instability at follow-up: one had moderately increased varus laxity, and one slightly increased valgus laxity. Both had an associated moderate increase in anterior laxity.

We found no clear relationship between primary anterior instability and instability at follow-up. At the original arthroscopy, there was slight anterior knee

instability in 13 patients; at follow-up nine were unstable, and four stable. Twelve patients with no detectable instability at the initial examination under anaesthesia showed instability at follow-up. Nor could we find any correlation between the apparent severity of injury to the anterior cruciate as judged at arthroscopy and later anterior instability. Instability and knee scores at follow-up, were no worse in patients treated for

combined ligament lesions than for patients with isolated anterior cruciate injuries.

The mean Lysholm knee score for the patients without instability was 92 (range 69 to 100). Patients with instability had a mean score of 84 (range 45 to 100); this difference was not statistically significant. There was no obvious correlation between increasing anterior laxity and decreasing knee score (Fig. 2). Three patients with

Fig. 2

Lysholm knee score related to the paired difference (injured knee minus normal knee) in total anteroposterior laxity at 30 lbs (13.6 kg) in all 41 patients.

Fig. 3

Activity levels before and after injury in all 41 patients related to the paired difference (normal knee minus injured knee) in total anteroposterior knee laxity at 30 lb force.

very low knee scores had coincidental knee disorders: two had chondromalacia patellae with malalignment, and one had arthrosis. This explains, in part, the low scores. However, when the levels before and after injury were compared with laxity, there was a clear tendency for activity level to drop with increasing laxity – with only a few exceptions (Fig. 3). The mean activity level for the unstable patients had decreased from a mean level of 6.9 to 4.8, whereas the stable group had decreased only from 6.1 to 5.8. These decreases were almost exclusively caused by decreased participation in the more strenuous sports. Only one patient had changed his occupation (lorry driving) because of knee instability.

DISCUSSION

The principal role of the anterior cruciate ligament is to resist anterior displacement of the tibia on the femur and to help control internal tibial rotation (Butler, Noyes and Grood 1980; Cabaud 1983). Different functions have been described for different portions of the anterior cruciate ligament. Wang and Walker (1973) and Crowninshield, Pope and Johnson (1976) found that the anteromedial fibres were most tense in flexion and the posterolateral fibres most tense in extension. This could explain the occurrence of partial ruptures – the posterolateral fibres being most susceptible to hyperextension injury, while injuries occurring with the knee flexed would rupture the anteromedial fibres first.

Few studies of the course of partial anterior cruciate ruptures have been published: McDaniel (1976) found instability in only one of nine patients at a mean follow-up of 15 months. Monaco et al. (1982) reported a series of 19 patients and stated that no patient had had recurrent problems, but the length of the follow-up was not specified nor the methods of evaluation. Odensten et al. (1985) reported encouraging results in 21 patients at two-year follow-up and no exacerbation of symptoms six years after injury (Lysholm knee score 93 ± 6). Only three of their patients had an unstable knee with a positive pivot shift, although an additional three patients had a positive Lachman test.

In contrast to these reports, we commonly found static anterior instability at follow-up; 21 of our 41 patients had some degree of this. The increase in laxity in our patients with instability corresponds well with that found by other investigators in patients with verified total, chronic, anterior cruciate rupture (Markolf, Kochan and Amstutz 1984; Daniel et al. 1985). This indicates that the primarily partial tears had become total.

Kennedy et al. (1976) discussed the difficulty in assessing the strength of a visibly intact ligament. They found that the anterior cruciate ligament could be macroscopically intact at ultimate mechanical failure, whereas electron microscopy revealed widespread disruption of collagen fibrils. They suggested that this

microscopic failure may be a significant cause of later clinical instability or of secondary tears. This may explain why we were unable to predict, from macroscopic appearance at arthroscopy, which knees would later develop instability and which would become stable. It also provides the rationale for our policy of protecting knees with partial anterior cruciate rupture during the initial stages of healing.

Most of our patients rated their knee function at review as good or excellent (Fig. 2), but the reduction of activity seen in those with unstable knees, indicates that their instabilities were of some functional significance: they caused the patients to avoid more strenuous sports and thereby to mask the limitation of function (Fig. 3).

Although none of our patients had suffered any significant re-injury at the time of follow-up, long-term studies show that chronic anterior cruciate insufficiency ultimately leads to significant problems in a high proportion of cases (Odensten et al. 1984). Repeated episodes of subluxation may cause articular damage, meniscal lesions and stretching of the secondary restraints. These may result in progressive deterioration of the joint, especially in the athletically active individual (Noyes and McGinniss 1985). We therefore consider it important that these patients are kept under review so that, should they develop symptomatic instability, they can be advised on activity modification, muscle strengthening exercises, the use of prophylactic bracing and the possibilities of surgical treatment.

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