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Isolated partial rupture of the anterior cruciate ligament

Long-term follow-up of 56 cases

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Abstract The majority of previous studies on partial ruptures of the anterior cruciate ligament (ACL) include a relatively large proportion of knees with associated intra-articular injury or collateral ligament tear that contributes to an increase in the symptoms of instability and further deterioration of knee function. In the present study only patients with isolated, partial ruptures of the ACL were evaluated. Fifty-six patients with one injured knee were examined after a median of 5.3 (range 2.0–12.7) years using the IKDC evaluation form, Lysholm knee function score and Tegner activity score. Of the 56 knees, 6 underwent autologous reconstruction due to early progression to complete rupture. Of 34 knees evaluated for laxity, 25 had a negative Lachman test and 7 a positive (+) Lachman. In 2 knees a Lachman ++ result and a positive pivot shift were found. With instrumented laxity testing 24 knees had 2 mm or less difference in laxity compared with the contralateral uninjured knee. The largest side-to-side difference in knee laxity was 4.5 mm. Lysholm score was median 86 (range 52–100) points, and 62% had good or excellent knee function. A significant decline in activity was seen. Only 10 patients (30%) resumed their preinjury activities. We find that the majority of patients with an isolated, partial rupture of the ACL have an acceptable knee function and a stable knee after a median 5 years follow-up. There is, however, a marked reduction in activity.

Key words Anterior cruciate ligament · Isolated partial rupture · Knee laxity

Introduction

Short- and long-term follow-up studies of partial ruptures of the anterior cruciate ligament (ACL) show that the prognosis for knee function is better than that associated with complete tears [5, 7, 11, 12, 15, 17, 19]. Other studies report that the long-term prognosis of partial ACL ruptures is poor in many cases, and that this might be due to a wrong initial diagnosis or progression to complete rupture [1, 5, 6, 9, 14]. Most of the previous studies on partial ACL ruptures, however, include a relatively large proportion of patients with associated intra-articular injury or collateral ligament tear, which contributes to aggravation of instability and of knee function [1, 3, 6, 7, 9, 15, 19]. In order to describe the long-term consequences of the isolated partial ACL tear, we performed a clinical follow-up study with evaluation of knee laxity, function and change in activity level.

Patients and methods

A follow-up study was designed to evaluate the long-term consequences of conservative treatment of an acute, isolated, partial rupture of the ACL. The criteron for the diagnosis was a macroscopically incomplete tear involving up to 75% of the ligament with the remaining fibres sustaining tension on probe testing [13]. The criteria to enter the follow-up study were: (a) a partial tear diagnosed within 4 weeks after the injury, (b) no associated intra- or extra-ar-

ticular lesions at time of diagnosis, (c) age between 17 and 48 years and (d) a minimum of 2 years' follow-up.

Sixty-seven patients met these criteria. Five patients sustained a new knee injury during the follow-up period: two a rupture of the medial collateral ligament (MCL), one a tear of the medial meniscus, one a MCL rupture in combination with a medial meniscus tear and one a rupture of the lateral collateral ligament. None of these patients showed evidence of retearing of the ACL as confirmed by arthroscopy. As these new lesions influenced knee function and stability, they were excluded from the follow-up study. Five patients were lost due to emigration, and one did not want to participate, leaving 56 patients for a clinical evaluation. The following data were noted during the review of patient records: age, sex, time from injury to diagnosis, activity at injury time and presence of haemarthrosis.

The patients underwent a clinical examination which focussed on knee stability, symptoms (pain, swelling, giving way) and function. Their present knee status was assessed with the Lysholm & Gillquist knee score [10], the IKDC evaluation form, and a modified Tegner activity score [21]. In the original Tegner score European team handball at competitive level results in a score of 7. European team handball is one of the most knee-stressing sports, which is clearly reflected in the high incidence of knee injuries [20]. We therefore scored handball players equal to soccer players at all levels. Furthermore, the patients were asked about possible rest pain, defined as a deep aching sensation from the knee occurring at night. Pain was classified as "light" when occurring only occasionally, and "severe" if experienced daily. The contralateral healthy knee served as a control in every evaluation. The International Knee Documentation Committee (IKDC) knee ligament standard evaluation form qualifies knees into four groups of 8 categories (Table 1). The following definitions are used in the evaluation: A (normal), B (nearly normal), C (abnormal) and D (severely abnormal). *Activity level* is divided into four categories from activity of daily living (ADL) to cutting sports (Table 1). *Subjective assessment* is evaluated with regard to daily knee function and possible influence on the activity level. The patients are asked for *symptoms* of pain, swelling, and partial as well as complete giving way at the actual activity level. *Range of motion* is normal if the lack of extension is < 30° and the lack of flexion < 60°. *Ligament examination* was performed using the Lachman test, the drawer test and an instrumented test. The Lachman test was performed with the patient supine, the knee flexed at 30°, while the drawer test was done at 80° flexion. Instrumented laxity test was conducted with the Stryker Laxity Tester (Kalimanzoo, Mich., USA) at 30° knee flexion. Laxity measurements in millimeters were taken at 20 pounds (89 N). A side-to-side difference of 2 mm or less is considered „normal" in both tests, 3–5 mm mild laxity, 6–10 mm moderate laxity, and more than 10 mm severely abnormal. The pivot shift was graded into negative (0), glide (+), clunk (++) and gross (+++). *Compartmental crepitus* in at least one of the three compartments was graded as slight, moderate or severe. *Functional testing* was performed with the one-leg jump (OLJ). The best of three attempts with hands folded on the back was noted. A normal function requires a jump of > 90% of the opposite leg. In the present study radiographic evaluation was omitted.

Data were stored and analysed with the EPI-INFO database, version 5.0, and Medstat, version 3.0. Stryker laxity and one-leg jump measurements were compared with the contralateral healthy knee, and differences were analysed with Student's *t*-test. For comparison between groups the chi-square test was used. An alpha-level of 0.05 was accepted as significant.

Table 1 Categories associated with two commonly used evaluation methods

The IKDC evaluation	
	Patient's subjective assessment
	Symptoms (pain, swelling, giving way)
	Activity level (ADL, running, jumping or cutting sports)
	Functional test (one-leg jump)
	Range of motion
	Ligament examination
	Compartmental findings
	Radiographic findings
Activity score ESSKA consensus 1990	
Level 1:	Activities of daily living
Level 2:	Manual labor involving lifting. Straight running and sports that do not involve lower limb agility activities
Level 3:	Sports involving lower limb agility activities but not involving jumping, hard cutting or pivoting
Level 4:	Sports involving jumping, hard cutting or pivoting

Results

Overall results

Six patients (11%) underwent reconstruction of the ACL (four with the iliotibial band and two with the Slocum-Larsson procedure) within the first year due to early progression to complete rupture. This results in a rate of ACL insufficiency after a partial ACL tear of 11%. The remaining 50 patients (18 women and 32 men; median age 27 (range 17–48 years) were evaluated after median 5.3 (range 2.0–12.7) years. Thirty-four were able to participate in the clinical study, while 16 were interviewed.

Most injuries were sustained during sports activity (n = 42), most commonly soccer (n = 18) and skiing (n = 13). Initial haemarthrosis was present in 36 cases. Conservative treatment consisted of immobilization in a rigid plaster of Paris cast (n = 11) during the first part of the observation period. Another group was treated with early mobilization in a hinged cast for 6 weeks which allowed motion from 30° to 60° for 3 weeks, and from 0° to 90° for a further 3 weeks. Twenty-six patients did not receive any bandaging. All patients were instructed by a physiotherapist in exercises for joint mobility and quadriceps/hamstrings strengthening.

Knee function and activity score (n = 50)

Lysholm score was median 86 (range 52–100) points, with 31 (62%) having a good to excellent knee function at follow-up (Table 2). The Tegner score prior to injury was

Table 2 Changes in knee function measured by the Lysholm score (n = 50)

	Preinjury	Follow-up
Excellent (95–100)	46	12
Good (84–94)	4	19
Fair (65–83)	0	17
Poor (< 65)	0	2

Table 3 Knee stability and objective functional testing results (n = 34)

Patient no.	Sex	Age (years)	Lachman (0,+,++,+++)	Pivot (0,+,++,+++)	Laxity (injured/healthy in mm)	One-leg jump (% of healthy)	Lysholm (preoperative follow-up)	Tegner (preoperative follow-up)	IKDC overall (A,B,C,D)
1	M	25	0	0	6.0/5.5	102	100/ 90	7/6	B
2	F	31	+	0	5.5/4.5	81	100/ 95	4/4	B
3	M	32	0	0	6.5/5.0	98	100/ 76	7/4	B
4	M	31	0	++	7.0/6.5	81	85/ 85	9/5	C
5	M	39	++	+	9.5/5.0	117	100/ 70	6/2	C
6	M	42	0	0	7.5/5.0	87	100/ 81	6/4	C
7	F	40	+	+	9.5/5.5	105	100/100	4/3	B
8	M	21	0	0	6.0/5.0	100	100/ 95	7/7	A
9	F	23	++	+	7.0/3.5	110	100/ 95	9/7	B
10	M	29	0	0	8.0/6.0	109	100/ 81	9/3	C
11	M	37	0	++	4.0/2.5	89	100/ 88	9/6	C
12	F	48	0	+	4.0/3.5	102	100/ 95	6/6	B
13	M	17	0	+	6.5/4.5	81	100/ 90	7/5	B
14	M	17	0	0	5.5/3.5	95	100/100	9/9	C
15	M	43	0	0	2.5/1.5	105	100/ 97	6/6	B
16	F	45	+	0	4.0/2.5	95	100/ 90	7/6	B
17	F	18	0	0	4.5/4.0	92	100/ 85	9/9	B
18	M	26	0	0	5.5/3.5	85	100/ 95	5/3	B
19	F	33	+	+	6.5/3.5	80	100/ 82	6/3	C
20	F	25	0	+	7.0/5.5	96	100/ 81	9/5	C
21	M	24	0	0	6.0/4.5	120	100/ 80	9/7	B
22	M	42	+	+	9.0/5.0	83	100/ 89	8/8	B
23	M	27	+	+	6.5/4.0	82	100/ 80	8/6	C
24	M	33	0	0	5.5/3.5	75	100/ 86	7/5	B
25	M	45	+	+	6.5/4.0	95	100/ 90	8/6	C
26	M	30	0	+	5.0/5.0	91	100/ 90	7/5	B
27	F	18	0	+	6.5/4.0	89	100/ 90	8/6	C
28	F	36	0	0	6.5/4.0	63	100/ 80	6/6	C
29	F	34	0	0	4.5/5.5	65	100/ 52	3/3	C
30	M	33	0	0	5.0/3.5	[a]	100/ 86	8/6	D[a]
31	M	23	0	0	5.0/4.0	98	100/100	8/8	A
32	M	20	0	0	4.5/3.5	85	100/ 76	5/5	B
33	M	19	0	0	6.0/5.5	114	100/100	9/4	B
34	M	35	0	+	7.0/5.0	86	100/ 66	7/4	C

[a] The patient refused to perform one-leg jump

median 7 (range 3–9) points compared with median 5 (range 2–10) points at follow-up. One patient (2%) felt consistent rest pain from the knee which was not present before the injury. A further 26 (52%) stated that they occasionally experienced knee pain at rest.

Knee stability and objective functional testing (n = 34)

In 25 patients the Lachman test was negative, 7 had a light (+) laxity, and 2 had moderate (++) laxity, all with a firm end-point (Table 3). None showed severe (+++) laxity. Instrumented laxity assessment revealed that 24 knees (71%) had 2 mm or less side-to-side difference (Table 3). The remainder all had 4 mm or less laxity compared with the contralateral knee. Both patients with ++ Lachman score had more than 3 mm side-to-side difference in instrumented laxity testing (3.5 and 4.5 mm, respectively). Nineteen patients (56%) had a negative pivot shift, 13 a glide and 2 a clunk. None of the patients evidenced a gross pivot shift. Both patients with a “clunk” performed their one-leg jump (OLJ) at a level which was less than 90% of their contralateral healthy leg. OLJ on the injured side was mean 115 cm (SD 29.95 cm) compared with mean 123 cm (SD 27.66 cm) on the healthy side (NS). In terms of percentage of the healthy leg, OLJ was median 92% (range 63%–120%). Apart from one patient who did not perform the OLJ test, 15 patients (44%) scored at a level less than 90% of their healthy leg, while the remaining 18 (53%) had more than 90% (Table 3).

Table 4 Changes in activity level according to the IKDC evaluation (n = 34)

	Preinjury	Follow-up			
		C	J	R	A
Cutting (C)	27	8	5	10	4
Jumping (J)	4	0	0	2	2
Running (R)	3	0	0	2	1
ADL (A)	0	0	0	0	0
Total	34	8	5	14	7

Table 5 IKDC ratings (n = 34)

	A (normal)	B (nearly normal)	C (abnormal)	D (severely abnormal)
Subjective	7	19	8	0
Symptoms	6	22	6	0
Range of motion	29	5	0	0
Ligament	15	15	4	0
Compartment	14	14	6	0
Function	19	12	2	1
Overall	2	17	14	1

IKDC evaluation (n = 34)

Twenty-seven patients had been engaged in cutting sports prior to injury compared with 8 at follow-up ($P < 0.00005$) (Table 4). Of 26 patients who stopped an activity, 17 stated that their knee status was the reason for the stop, while 9 attributed the change to other reasons, most commonly social considerations.

The results of the six categories in the IKDC score showed normal or nearly normal knee function for most patients (Table 5): 26 (76%) scored A (normal) or B (nearly normal) in subjective assessment, while 28 (82%) scored A or B with regard to symptoms. In general, range of movement was not affected, all 34 scoring A or B. The ligament score was A in 15 (44%) and B in 15 (44%). Fourteen patients (41%) exhibited no compartmental crepitus, while 20 (59%) had this to a slight or moderate degree (B or C). Thirty-one (91%) scored A or B in the functional evaluation. In the overall IKDC evaluation 19 (56%) were A or B, 14 were C (41%), and 1 (3%) was D (Table 5).

Discussion

We find that the majority of patients with an isolated, partial rupture of the ACL have an acceptable knee function and a stable knee after median 5 years. There is, however, a marked reduction in activity. Our ligament failure rate of 11% after median 5 years is lower than in most previous studies that report on partial ACL tears with or without associated injury to other stabilizing knee structures. None of the knees exhibited severe laxity (IKDC: 6 mm or more side-to-side difference with manual or instrumented testing), but 2 knees had a clunk (++) on pivot shift testing. A possible bias may exist in our material as 16 patients were evaluated by questionnaire only. The Lysholm knee function score symptoms of instability can lead to a deduction of up to 25 of the maximum 100 points. Five patients evaluated by questionnaire obtained 75 points or less in the Lysholm score. If these and the two knees with moderate laxity are included, the rate of ACL-insufficient knees is 23%.

One problem with evaluation of knee function, symptoms and activity is that different scores influence each

Table 6 Results of earlier investigations

	n	Isolated partial tear	Follow-up (years)	Lysholm	Activity rate of return	ACL-insufficient[a] (%)
McDaniel 1976 [11]	9	6	1.3 (0.3–3)	No functional or activity score		17
Odensten et al. 1985 [15]	21	6	5.8 (5.4–8)	95 (84–100)	Not evaluated	14
Kannus and Jarvinen 1987[a] [7]	44	14	8.0 (± 2.3)	90 (17–100)	Not evaluated	78
Sandberg and Balkfors 1987 [17]	29	29	3.0 (1–5)	94 (mean)	100%	62
Noyes et al. 1989 [14]	32	15	5.0 (2–9.2)	Other score	21%	38
Buckley et al. 1989 [1]	25	12	4.1 (0.7–11)	60% ex/good[b]	44%	60
Fruensgaard and Johannesen 1989 [6]	41	18	1.5 (1–1.9)	92 (69–100)[c] 84 (45–100)	50%	44
Sommerlath et al. 1992 [19]	21	0	12 (9–15)	93 (51–100)	32%	9
This study	56	56	5.3 (2–12.7)	86 (52–100)	30%	23

[a] ACL-insufficient knees are knees (a) needing reconstruction, (b) exhibiting 5 mm or more side-to-side difference in laxity assessed with Lachman or an instrumented test, or (c) giving way during daily activities

[b] Feagin and Blake score [4]

[c] Top line: knees stable at follow-up (n = 20), second line: knees unstable (n = 21; positive Lachman and positive pivot sign) at follow-up

other. The median Lysholm knee function score was 86 in our study, but if the knee is not challenged by demanding activity such as cutting and pivoting sports, the score may appear too high, and not reflect the actual function of the knee or the patient's satisfaction. Thus, a marked drop in activity level may mask a decrease in knee function due to ligament failure [6, 12, 15]. Although one-third of the patients in the present study ascribed their reduction in activity to other reasons than their knee status, the proportion of patients changing from a preinjury activity level involving cutting sports to activities mainly including straight running at follow-up was large. In the only previous study dealing solely with isolated partial ACL tears, Sandberg and Balkfors [17] found that all patients returned to previous activity levels after median 3 years despite 62% having a Lachman of ++ or more (Table 6). In 19 patients (66%) the activity involved cutting and pivoting sports (soccer, handball, skiing and badminton). The Lysholm score was a mean of 94. It seems that knee stability may be preserved in the majority of knees with isolated partial ACL tear if cutting or pivoting sports are abandoned, whereas if knee-stressing activities are resumed, there is a relatively high risk of progressive cruciate ligament failure.

In a short term follow-up study Fruensgaard and Johannesen [6] showed that clinically stable knees performed better than knees exhibiting instability. Only half of the patients returned to their preinjury activity level. Sommerlath et al. [19] found that in 21 patients who all had major associated injuries, the knee function was equally good (Lysholm score median 93) after as long as median 12 (range 9–15) years' follow-up. Collateral ligaments were repaired, while four menisci were removed totally. All knees were stable, none of them demonstrating a pivot shift or needing ACL reconstruction. The associated lesions were, however, considered responsible for the high rate of cartilage degeneration, while the arthritic changes were subtle and asymptomatic [19]. Despite the absence of associated injuries, we found a high rate of rest pain (54%) and compartmental crepitus (59%). However, only 1 patient suffered persistent rest pain, the remainder having only occasional pain. Compartmental crepitus, in particular patellofemoral crepitus, as evaluated in the IKDC score might have been present before the ACL tear was diagnosed and may thus be reported at a too high rate without being actually associated with the ACL tear. Buckley et al. [1] found that 64% complained of activity-related pain after median 4 years in knees with partial tears of the ACL, but more than half of these knees exhibited associated injuries. Magnetic resonance imaging, which was not available during our observation period, detects a higher rate of subchondral lesions than conventional diagnostic arthroscopy. In cases of acute ACL tear, the prevalence of associated MRI-positive (arthroscopy-negative) subchondral lesions has been reported to be about 85% [2, 16].

It seems unclear whether it is the status of the ligament or the associated injuries which influence knee function and stability the most. The diversity in prognosis might be explained by the complex pathomechanical characteristics of the lesion as well as the diagnostic difficulties. The lack of initial sagittal instability and a weak symptomatology made the clinical diagnosis of a partial ACL rupture difficult before arthroscopic examination was introduced [17, 19]. Even during diagnostic arthroscopy a precise description of the lesion is difficult. Odensten et al. [15] found subsynovial partial and total ruptures of the ACL without haemarthrosis, and recommended splitting of the synovial sheet of the ligament. After introducing this technique, Scharlig and Segantini [18] noted a higher incidence of complete ruptures and a lower incidence of partial ruptures compared with earlier experience. The diagnosis is further complicated by biomechanical knowledge showing that ligaments may be stressed to ultimate failure in the absence of macroscopic disruption due to microscopic failure of collagen fibrils [8, 14]. The pathoanatomical complexity of the in vivo rupture might explain the diverging opinions on the prognostic importance of the extent of the rupture [2, 14]. Noyes et al. [14] noted that the amount of ligament tearing was a statistically significant factor predicting the development of complete ruptures. Some 50% of one-half tears progressed to a complete rupture compared with 86% of three-fourths tears. Buckley et al. [2, 14], however, found no correlation between percentage rupture and the prognosis. Sandberg and Balkfors [17] reported that tears localized to the posterolateral bundle resulted in knee instability more often than tears in the anteromedial bundle.

The term partial ACL tear is a tentative diagnosis based on a history of a twisting injury with subsequent haemarthrosis and a negative or slightly positive (+) Lachman test [3, 11–15, 17, 19]. If the patient desires to maintain a high level of activity or if an associated meniscus tear is suspected, arthroscopy should be performed within the first few weeks. Noyes et al. suggested that ACL tears initially diagnosed as partial should be followed up every half year for the first 5 years in order to classify the knees into ACL-functional knees (knees remaining stable) and ACL-insufficient knees (knees progressing to complete failure) [14]. In this way treatment can be guided towards the functional outcome rather than the initial macroscopic characteristics of the tear.

The prognosis for an isolated partial tear of the ACL seems good in the majority of cases. The desired level of activity may influence the prognosis to the same degree as the amount or localization of the tear. The results of previous studies in general show that cutting or pivoting sports can be resumed after a partial tear of the ACL at the expense of knee stability; alternatively, the prognosis for knee function is good to excellent if knee-stressing activities are abandoned.

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