

Primary suture of the anterior cruciate ligament

A 6-year follow-up of 74 cases

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Seventy-four consecutive patients were reviewed 6 (3-9) years after primary suture according to Palmer of a fresh rupture of the anterior cruciate ligament. Three fourths had excellent or good function as evaluated by the Lysholm score. The pivot shift test was trace-positive in one fifth and 2+ or 3+ in one quarter, and the Lachman test was 2+ or higher in one third. Tibial anterior instability was present in 23 knees. Radiographically, 15 knees had signs of arthrosis, 4 of which severe. Our 0.25 failure rate suggests that other procedures should be considered in the treatment of acute rupture of the anterior cruciate ligament.

Primary repair of anterior cruciate ligament ruptures has been advocated because knee stability is more easily restored acutely than by late reconstruction.

Although long-term follow-ups have shown decreasing stability and function over time (Feagin 1976, Lysholm et al. 1982, Odensten et al. 1984), two recent papers reporting good results after acute anterior cruciate ligament repair have renewed the interest in this approach (Sherman et al. 1988, Straub and Hunter 1988).

We present the long-term results after acute repair of the anterior cruciate ligament with emphasis on function, knee stability, muscle strength, and arthrosis.

Patients and methods

In 1977-1982, 84 patients had acute repair of a complete anterior ligament rupture at our hospital. Knees with incomplete tears of the anterior cruciate ligament, associated tears of the posterior cruciate ligament, bony avulsion, or intraarticular fractures were excluded from our study. This left 74 patients with a mean follow-up of 6 (3-9) years (Table 1). The mean age was

34 (12-65) years. There were 30 females and 44 males. Fifty-two of 74 patients were injured in sports, with skiing, and soccer being the most common activities. The patients were examined clinically and radiographically; muscle strength was measured with a Cybex II dynamometer, and stability was tested with a KT-1000 arthrometer.

Treatment

The patients were operated on within the first week after the injury. The anterior cruciate ligament tear was detected through testing under anesthesia and arthroscopy. The rupture was repaired according to the Palmer (1938) reinsertion technique or by the modified procedure (Marshall and Rubin 1977) using four U-sutures in the ligament stump pulled through two drill holes in the femur and tibia. Nonresorbable sutures were used. In 4 patients, a partial meniscectomy was done, whereas in 10 patients the meniscus was reattached, and in 25 it was excised. In 54 patients the medial or lateral ligament was repaired. Postoperative immobilization consisted of a long-leg cast for 6 weeks in 30° flexion, followed by active mobilization supervised by a physiotherapist. Return to contact sports was not permitted during the first year after the operation.

Postoperatively, there were three superficial and one deep infection, which all subsided after antibiotic treatment. One patient had a lung embolus and 1 had a deep venous thrombosis; both recovered.

Table 1. Patients' data

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	1	25	43	0	0	1	1	99	1	1	7	7	0	0	2	0,8	0,7
2	2	30	84	2	0	1	1	94	1	2	3	2	1	0	3	0,9	0,8
3	1	40	82	2	0	3	1	91	2	1	6	6	1	2	3	1,0	1,3
4	2	24	40	2	0	1	1	99	1	1	7	7	1	2	3	0,9	0,8
5	2	40	46	2	0	4	1	99	1	1	7	4	2	3	4	0,6	0,6
6	1	17	44	0	0	4	1	100	1	1	5	5	2	3	3	1,1	1,1
7	1	35	44	0	0	4	1	100	1	1	5	5	0	0	3	0,5	0,4
8	1	12	58	2	0	1	1	100	1	1	9	9	2	0	5	1,2	1,1
9	1	42	42	0	0	4	1	99	1	1	4	3	0	0	1	0,9	1,0
10	2	21	84	2	0	1	1	85	2	2	7	5	3	3	5	0,7	0,8
11	1	25	36	1	2	1	2	99	1	2	9	7	2	1	3	0,9	1,2
12	1	16	39	2	1	1	2	89	2	2	9	7	2	2	6	1,3	0,8
13	2	13	101	0	0	2	1	94	1	2	3	3	0	0	2	-	-
14	2	60	44	1	2	2	1	90	1	2	3	2	2	2	2	0,5	1,0
15	2	58	42	1	2	3	3	90	1	2	3	3	0	0	1	0,4	0,3
16	1	18	38	0	0	1	1	90	2	2	5	5	0	0	3	0,8	0,9
17	1	56	40	2	0	4	1	87	1	2	5	3	1	0	5	0,7	0,7
18	1	64	41	1	1	3	1	80	2	1	4	4	2	1	3	0,9	1,2
19	2	34	50	2	1	1	1	85	1	2	7	3	2	2	6	0,7	1,5
20	2	61	54	2	1	1	1	99	1	1	3	3	2	1	7	0,9	0,8
21	1	26	76	2	1	1	1	79	2	2	5	3	1	1	2	0,9	0,7
22	1	21	45	2	1	1	1	95	2	1	9	7	2	0	6	0,8	0,7
23	1	35	52	2	1	3	1	95	1	2	7	7	1	0	1	0,6	0,7
24	1	43	52	1	1	1	1	77	3	2	9	6	2	0	2	1,1	0,7
25	1	32	56	2	1	1	1	100	1	1	4	4	2	1	5	0,7	0,8
26	2	16	52	1	1	1	1	65	4	3	6	6	2	3	5	-	-
27	1	34	48	1	1	1	1	86	2	2	7	7	1	1	3	1,0	0,9
28	2	40	88	2	1	3	3	79	2	2	6	3	1	2	4	0,5	0,9
29	1	62	76	2	1	1	1	99	1	1	4	4	0	0	1	0,8	0,9
30	1	37	55	1	1	1	1	89	2	2	7	7	1	0	0	0,8	1,0
31	2	20	39	2	1	1	1	95	2	1	4	4	0	0	0	1,3	1,0
32	1	22	101	0	2	1	3	99	1	1	4	4	1	0	1	0,8	0,9
33	1	16	86	1	0	3	1	72	4	3	4	4	2	2	6	0,7	1,0
34	1	18	93	1	0	3	1	95	2	1	4	4	2	1	4	0,9	1,0
35	2	15	32	1	0	1	1	85	2	2	7	7	1	0	2	0,9	0,6
36	2	13	40	1	0	4	1	95	1	2	4	4	1	0	3	1,1	0,8
37	2	16	89	1	0	3	1	81	2	2	7	4	2	1	3	0,9	1,3
38	1	12	33	0	0	1	1	100	1	1	7	7	0	0	1	0,9	1,2
39	2	15	36	0	0	3	1	76	2	2	9	9	2	2	5	0,8	0,9
40	1	35	39	1	0	4	1	99	1	1	9	7	1	0	3	1,2	0,7
41	2	47	39	1	0	1	1	92	1	2	7	4	1	0	1	0,8	1,0
42	1	17	61	0	1	1	1	100	1	1	7	7	1	0	-	-	-
43	1	24	73	1	0	3	1	94	1	2	9	7	2	3	5	1,1	0,7
44	1	25	49	0	1	1	4	85	2	3	5	5	2	1	4	1,0	1,3
45	1	22	68	1	1	3	3	81	1	1	1	1	1	2	-	0,8	0,8
46	1	30	69	1	0	1	1	95	1	2	5	5	1	0	-	0,9	2,0
47	1	21	68	0	0	1	1	91	1	2	7	7	1	1	-	1,0	0,8
48	2	67	66	1	0	3	1	86	2	1	3	3	1	0	-	1,1	0,7
49	2	36	67	1	0	1	1	80	3	2	7	4	2	2	-	1,0	1,4
50	1	24	85	1	2	3	2	78	2	3	4	4	1	1	-	0,9	0,7
51	2	21	74	1	2	3	2	94	1	2	4	4	1	0	-	1,2	1,2
52	1	46	68	1	0	3	1	76	2	3	7	4	2	2	-	1,1	0,7
53	2	48	74	1	0	1	1	80	3	2	4	4	1	2	0	0,9	1,0
54	2	54	78	0	1	1	3	95	1	2	4	4	1	0	-	0,9	1,1
55	2	44	87	1	0	3	1	85	1	2	4	4	1	1	-	0,8	0,3
56	1	51	84	1	0	3	1	94	2	1	5	3	2	1	1	0,9	0,8
57	1	23	84	0	2	1	3	100	1	1	9	5	1	0	1	1,0	1,1
58	2	62	82	0	1	1	3	87	1	1	4	3	2	1	2	-	-
59	1	26	55	0	0	1	1	86	2	2	9	4	2	2	6	0,9	0,2
60	2	55	57	1	0	4	1	83	2	2	4	3	1	1	4	0,8	0,8
61	2	46	55	1	0	1	1	99	1	1	7	7	1	0	4	0,8	0,9
62	1	51	93	1	2	3	3	99	1	1	4	4	1	1	1	-	-
63	1	57	91	1	0	3	1	100	1	1	4	4	1	0	5	-	-
64	1	24	107	2	0	3	1	79	3	2	7	5	2	0	5	-	-
65	1	38	90	2	0	3	1	82	2	2	9	7	1	0	5	0,8	0,5
66	1	33	80	0	0	1	1	99	1	1	9	7	0	0	1	1,3	1,9
67	2	28	76	1	1	4	1	91	2	1	9	7	1	3	7	0,5	1,3
68	1	28	80	1	0	1	1	100	1	1	9	7	0	0	1	0,9	0,5
69	2	44	92	1	0	1	1	99	1	1	5	5	1	0	1	0,7	0,8
70	2	19	74	0	0	1	1	74	2	3	8	7	-	-	-	-	-
71	1	20	66	0	0	1	1	85	2	1	5	4	-	-	-	-	-
72	1	52	106	0	0	1	1	96	1	1	5	5	-	-	-	-	-
73	1	22	90	0	0	1	1	90	2	2	7	6	-	-	-	-	-
74	1	57	87	0	0	1	1	100	1	1	5	5	-	-	-	-	-

Key to data

- A Case
 B Sex, 1 male, 2 female
 C Age at surgery
 D Follow-up, months
 E Medial side
 0 No injury
 1 Collateral ligament, deep part
 2 Collateral superficial part
 F Lateral side
 0 No injury
 1 Collateral ligament
 G Medial meniscal treatment
 1 No injury
 2 Partial resection
 3 Menisectomy
 4 Suture
 H Lateral meniscal treatment
 1 No injury
 2 Partial resection
 3 Menisectomy
 4 Suture
 I Lysholm score
 J Instability.
 1 Never giving way
 2 Rarely during athletics or other severe exertion
 3 Frequently during athletics or other severe exertion (or incapable of participation)
 4 Occasionally in daily activities
 5 Every step
 K Pain
 1 None
 2 Inconstant and slight during severe exertion
 3 Marked during severe exertion.
 4 Marked on or after walking > 2 km
 5 Marked on or after walking < 2 km
 L Tegner score preoperatively
 M Tegner score postoperatively
 N Lachman test: 1 +, 2 ++, 3 +++
 O Pivot shift test, as above
 P KT 1000 at 20 pounds anterior drawer in millimeter difference compared with normal knee
 Q Cybex peak quadriceps torque injured side/normal side
 R Peak hamstring torque injured side/normal side

Grading of function and stability

Function was graded according to Lysholm et al. (1982) emphasizing instability, pain, and locking. Pre-injury and current level of activity was graded by the Tegner score (Tegner and Lysholm 1985). Physical examination included evaluation of stability by manual and arthrometer testing.

Anterior stability in 20° flexion was tested by the Lachman test (Torg et al. 1976) and graded as negative, slight (1+, < 5 mm), moderate (2+, 5–10 mm), or severe (3+, > 10 mm), as compared with the noninjured knee. Anterolateral rotational instability was evaluated by the McIntosh and Slocum tests (Slocum et al. 1976), and was graded as negative, trace positive (1+), moderate (2+), or severe (3+). A trace-positive anterolateral rotational instability was a subtle, but definite, abnormal catching of the lateral tibial condyle felt during palpation. A 3+ anterolateral rotational instability was a classic pivot shift phenomenon.

Instrumental testing of anterior-posterior instability was carried out with a KT-1000 Medmetric arthrometer (Daniel et al. 1985).

Muscular strength was measured with a Cybex II dynamometer at 60°. Maximum quadriceps torque and hamstring torque were compared with the normal knee, and a hamstring/quadriceps ratio for both knees was calculated.

Radiographic evaluation was done with AP projections in the standing position. The degree of arthrosis was scored according to Ahlbäck (1968).

The statistical analysis was carried out using the chi-square test.

Results

Eleven knees were reoperated on because of meniscal injuries. Function was excellent in 31 cases, good in 26, fair in 16, and poor in 1. The main complaints were instability and pain, with 26 patients reporting episodes of instability during strenuous activities and 7 during moderate sport activities and work. Thirty-three patients noted some discomfort after strenuous sport activities, and 7 had pain regardless of activities.

Thirty of the 74 patients had reduced their activity level (0.41), and the group as a whole had reduced their Tegner score from 6 to 5.

The Lachman test and pivot shift were 2+ or more in 26 and 18 knees, respectively. The patients with a positive pivot shift reported the highest level of pain ($P < 0.001$) and effusion ($P < 0.01$). There was a strong correlation between a positive pivot shift and a low Lysholm score ($P < 0.005$).

The KT-1000 measurements were carried out in 57 patients, 23 patients of whom had more than 3-mm anterior tibial translation compared with the noninjured knee. There was a good correlation between KT-1000 and the Lachman results.

In the Cybex test carried out on 53 patients, there was an 11 percent average quadriceps peak torque reduction and a 14 percent hamstring reduction. Twenty-six of the patients had less than 90 percent of peak torque of the noninjured quadriceps, and 30 had less than 90 percent of peak torque of hamstrings. There was no correlation between the feeling of giving way as expressed in the Lysholm score and quadriceps peak torque.

Radiographically, four knees had developed stage 2–3 arthrosis, and 11 had reduced intraarticular space medially or laterally of more than 3 mm; according to Ahlback, these are all at high risk of developing arthrosis.

Discussion

Although most authors consider that the Palmer technique gives poor long-term results, few studies have actually considered this issue. Feagin and Curl (1976) found 30 of 32 patients to have symptoms of instability after 5 years. Odensten et al. (1984) reported 19/38 objectively unstable knees as evaluated by the pivot shift test after 5 years. Strand et al. (1984) found a failure rate of 30 percent in highly active patients, whereas Sandberg (1987) found 23/81 patients with a positive pivot shift after 3 years. In a recent report, Sherman et al. (1988) found an overall objective success rate of approximately 50 percent. Three fourth of our patients had good function at 5–6 years. This may be explained by the higher age and lower activity level compared with other reports. The overall reduced activity level was mainly due to the 12 soccer players who changed to lower level recreation soccer or to less knee-demanding activities.

Like Odensten et al. (1984), we found poor function in patients with a positive pivot shift. These patients experienced giving way, pain, and effusion. They are candidates for reconstruction if unwilling to reduce their activity level or if a brace cannot prevent subluxation. Whether the rather large group of patients with a trace-positive pivot shift will proceed to severe anterolateral rotational instability remains to be seen.

Radiographic changes due to anterior cruciate ligament deficiency are common (Noyes et al. 1983, Kannus and Järvinen 1987). According to Noyes (1983), an anterior cruciate deficient knee will develop arthro-

sis in 10–15 years. After 5 years, 4 of our patients had developed severe arthrosis; all of them had a positive pivot shift. In the 11 knees with radiographic changes suggesting development of arthrosis, no correlation

was found with meniscal injury or pivot shift.

With failures in one fourth of our repairs, we conclude that the Palmer procedure is not reliable, and we have therefore started an augmentation study.

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