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Revision ACL reconstruction using autogenous patellar tendon graft

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Abstract This retrospective study examined revision anterior cruciate ligament reconstruction using a bone-tendon-bone autograft of the patellar ligament. We followed up 44 patients (mean age 27.9 years) for an average of 41.2 months. Clinical examination with the Lachmann and pivot shift tests showed clearly improved stability; KT-1000 arthrometer measurements had a mean difference of 3.5 mm in side-to-side comparison. The evaluated knee scores were significantly improved ($P<0.01$); the median Lysholm score was 85 and the median Tegner activity score 5.0 at follow-up. In the IKDC ranking system 75.0% of knees were rated normal or nearly normal (grades A and B). According to a modified Fairbank scale, progression of radiographic signs of osteoarthritis was noted in 36.4%. There was a significant difference ($P<0.05$) in progression of radiographic signs of osteoarthritis between patients with major (grades III, IV) versus minor (grades I, II) lesions of the articular cartilage surface and between knees with versus without extensive synovitis due to previous synthetic graft reconstruction ($P<0.05$). Revision anterior cruciate ligament reconstruction using an autogenous patellar tendon graft shows good results with improved knee function compared to the prerevision status and is in line with various operative techniques described in the literature. Progression of osteoarthritis must be expected in patients with major lesions of the articular cartilage surface and knees with long-term extensive synovitis due to previous anterior cruciate ligament reconstruction using synthetic grafts.

Keywords Revision ACL reconstruction · Patellar tendon autograft · Osteoarthritis

Introduction

Rupture of the anterior cruciate ligament (ACL) normally leads to instability, with the increased risk of recurrent injuries and onset of osteoarthritis [17, 19, 25]. After primary ACL reconstruction using an autogenous patellar tendon graft restoration of stability and return to activity can generally be expected with good or excellent short- and long-term results [9, 12, 29, 30]. The development of recurrent instability and graft failure has been reported in as many as 8% of these patients [36]. In these cases revision ACL reconstruction is a possible option for further treatment. The indication for operative treatment is controversial because a successful outcome cannot be guaranteed in patients in whom the effects of long-term chronic anterior instability lead to damage of further knee structures and osteoarthritis with deterioration in final outcome [38]. The goal of revision ACL reconstruction must therefore be improvement in the prerevision status and a benefit compared to a nonoperative treatment. A key to achieve this goal is selection of the graft used for revision surgery, as there is a variety of options [7].

Considering these requirements the present retrospective study evaluated the results of autogenous patellar tendon graft in revision ACL reconstruction.

Patients and methods

All patients operated on between January 1988 and December 1994 with at least one previous reconstruction of the ACL and a minimum follow-up of 2 years were included. Indication for reconstruction surgery was clinical instability, which was defined as repeated episodes of giving-way or distorsion of the knee [7, 21].

Clinical stability of the knee was evaluated with the Lachmann [33] and pivot-shift tests [6] preoperatively and at follow-up. The Lysholm score [16], Tegner activity score [32], and IKDC ranking scale [1] were applied, and weight-bearing radiographs of the injured knee were taken in 10° knee flexion. The radiographs were rated according to a modified Fairbank scale [3, 17] to detect progression of osteoarthritis. At follow-up examination knee laxity measurements were also made with the KT-1000 arthrometer (MedMetric, San Diego, Calif., USA) using the maximum manual test in 25° of knee flexion with side-to-side difference [2]. All operations were performed by one surgeon, and clinical examination and evaluation of the radiographs by different examiners not knowing the results of each other's assessments.

All statistical analyses were conducted on SPSS for Windows software. The χ^2 test was used to determine significant differences for nonparametric score variables rated preoperatively and at follow-up. The level of significance was $P<0.05$.

From January 1988 to December 1994 we performed a total of 92 revision ACL reconstruction surgeries. This led to 47 patients fulfilling the study criteria (autogenous patellar tendon graft, minimum follow-up of 24 months); of these, 44 (93.6%) attended follow-up examination and were included in the study (33 men, 11 women; mean age 27.9±5.3 years). The mean follow-up was 41.2±11.1 months; the length of time from first injury to revision surgery averaged 43.8±34.8 months and that from last ACL reconstruction to revision surgery 41.3±33.6 months. In 40 patients there was one and in four patients two previous ACL reconstruction surgeries (Table 1). In only 7 patients (15.9%) was the primary ACL reconstruction performed at our clinic. Reasons for graft failure included accidental rupture due to adequate trauma in five knees and elongation of the transplant probably because of noncompliance in the rehabilitation program in two. The other 37 patients (84.1%) with 41 previous surgeries came from outside for revision surgery to our clinic. In our opinion, graft failure in these cases was caused by the previous reconstruction procedure because nearly all patients were treated with primary ACL suture or synthetic grafts, which are regarded as insufficient for stabilization. In additional to ACL reconstruction, partial meniscus resection was performed during previous surgical treatment in 21 patients (19 medial, 2 lateral).

During revision ACL reconstruction in our clinic arthroscopic evaluation of the knee was performed first. The condition of cartilage surface was assessed and cartilage lesions were classified from grade I to IV (Table 2); grades I and II were rated as minor lesions and grades III and IV as major lesions. In 38 patients (86.4%) associated injuries of other knee structures were detected and required surgical treatment (Table 3). In 19 patients (43.2%) with meniscal tears partial meniscus resection was performed 17 times (13 medial, 4 lateral) and meniscus suturing repair twice. Considering previous meniscus surgeries a total of 30 patients (68.2%) had had partial meniscus resection (24 medial, 2 lateral, 4 medial and lateral), but none of them had had a complete meniscectomy.

Table 1 Previous ACL reconstructions

Operation	Total	At outside clinic
Primary ACL suture	30	30
Patellar tendon graft	4	0
Semitendinosus tendon graft	4	1
Allograft	10	10

Table 2 Condition of cartilage surface

Grade		*n*
I	Cartilage softening, no visible lesion	6
II	Superficial lesion, roughness of the surface	7
III	Deep lesion, subchondral bone covered by cartilage surface	9
IV	Complete lesion, reaching subchondral bone surface	3
	No changes	19

Table 3 Additional perioperative injuries

	n
Medial meniscus lesion	15
Lateral meniscus lesion	4
Medial collateral ligament lesion	2
Synovitis	6

The reconstruction procedure was performed in an arthroscopically assisted transtibial technique (Arthrex) using a bone-tendon-bone (BTB) autograft by harvesting the central one-third of the patellar tendon. Interference screws were used for femoral and tibial fixation of the transplant in isometric position. We prefered a two-phase procedure in six cases with extensive synovitis due to use of synthetic grafts (Goretex, carbon) for previous ACL reconstruction. The first step was a complete, arthroscopically assisted synovectomy, and the second was the ACL reconstruction, with a delay of 6–8 weeks [22, 24]. In four cases with previous BTB autografts we harvested the contralateral patellar tendon graft as reported by Rubinstein et al. [27], with no major complications.

Results

In the postoperative course there was one superficial wound infection that was successfully treated with antibiotics and local care. Two knees had a persisting lack of extension (>10°) due to cyclop syndrome and required arthroscopic revision surgery after 6 and 8 months. In both cases extended ambulant physiotherapy for 4 and 6 months was necessary to reestablish full extension as seen at follow-up. In both patients primary ACL reconstruction was carried out with synthetic grafts (carbon), and we had to perform a two-phase procedure because of extensive synovitis. This led to a reoperation rate of 4.5% and total complication rate of 6.8%.

The results of clinical examination on Lachmann and pivot-shift tests were clearly improved; at follow-up 35 patients (79.5%) had a negative or slightly positive Lachmann test (Fig. 1) and 37 (84.0%) a negative pivot-shift test (Fig. 2). Stability, as measured by side-to-side difference on maximum manual test in 25° of knee flexion with the KT-1000 arthrometer, averaged 3.5±1.0 mm (Fig. 3). In no case had the other knee sustained previous injuries. We noted a significant improvement ($P<0.01$) in

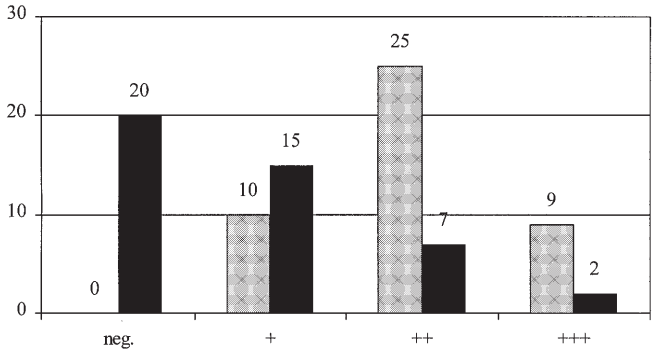

Fig. 1 Results on the Lachmann test, preoperatively (*gray bars*) and at follow-up (*black bars*). + 3–5 mm, ++ 5–10 mm, +++ >10 mm

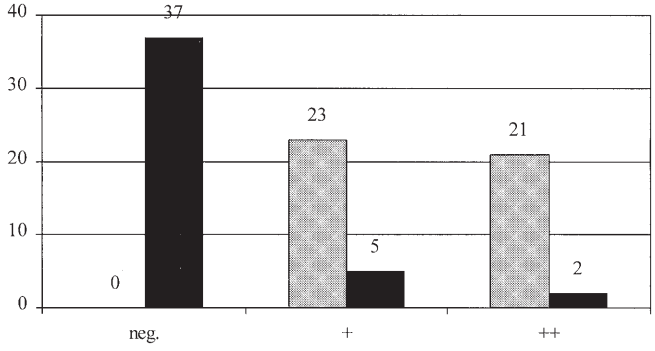

Fig. 2 Results on the pivot-shift test, preoperatively (*gray bars*) and at follow-up (*black bars*)

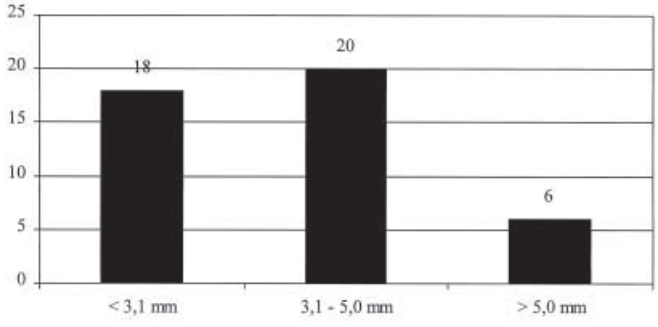

Fig. 3 KT-1000 arthrometer measurement in side-to-side difference

the Lysholm score from a preoperative median of 54 (20–73) to a median of 85 (52–100) at follow-up. The Tegner activity score rose from a preoperative median 4.0 (1–7) to 5.0 (2–7) at follow-up ($P<0.05$), but the activity level of a median 7.0 (3–9) before the first injury of the ACL could not be reached. All together 16 patients (36.4%) did not reach their preinjury activity level, but only 4 (9.1%) were unable to return; 10 elected not to return to the preinjury level. Also the IKDC ranking scale showed a clear improvement (Table 4); 33 knees (75.0%)

Table 4 IKDC scores preoperatively and at follow-up

Grade	Preoperative	Follow-up
A	0	12
B	9	21
C	25	7
D	10	4

Table 5 Radiographic progression of osteoarthritis according to modified Fairbank scale preoperatively and at follow-up

Grade		Preoperative	Follow-up
0	No changes	18	10
1	Flattening of femoral condyles	20	21
2	Osteophytes	5	11
3	Narrowing of joint space	1	2
4	Osteoarthritis	0	0

were rated normal or nearly normal (grades A, B). Progression of osteoarthritis was evaluated according to a modified Fairbank scale (Table 5) by comparison of the preoperative and follow-up radiographs. In 16 knees (36.4%) progressive osteoarthritis was noted; in these cases the deterioration was about one grade.

Statistical evaluation showed significant relationship ($P<0.05$) for progressive osteoarthritis between knees with major cartilage lesions (grades III, IV) and minor (grades I, II) or no cartilage lesions. In 12 patients major cartilage lesions were observed (Table 2), 11 of which showed progression of osteoarthritis at follow-up (42.6± 7.6 months). Furthermore there was a significant difference ($P<0.05$) in progression of osteoarthritis between patients with previous reconstruction by using synthetic grafts (carbon, Goretex) and those without. Eight of ten patients treated with synthetic grafts showed progressive osteoarthritis at follow-up (40.0±6.9 months). In both groups (primary reconstruction with vs. without synthetic ligament) the mean follow-up was close to the total follow-up of 41.2 months. Also, there was no difference in the proportion of patients with partial meniscus resection in the group with progressive osteoarthritis (11/16, 68.8%) and the proportion among those with no progression of osteoarthritis (19/28, 67.9%) or the overall frequency (30/44, 68.2%). Furthermore, there was a tendency for progressive osteoarthritis in knees with partial meniscus resection, but this association did not reach the level of statistical significance.

Discussion

This study demonstrates that a BTB autograft of the patellar ligament is very effective in revision ACL reconstruction. The operative procedure in the arthroscopically assisted technique is standardized and reproducible. In view

of the fact that this was revision surgery, the overall complication rate was minimal [21, 35]. None of the patients sustained further injury of the operated knee during follow-up. In comparison to other studies this is a good result [20, 34, 35, 36], but one must also consider differences in patient data and time of follow-up, and therefore a direct comparison is not possible. Arthrofibrosis is a well known problem in revision ACL surgery [37] and was the reason for both of the reoperations in this study. Additionally, these two patients had extensive synovitis due to previous synthetic graft reconstruction. This finding supports several other studies reporting higher rates of arthrofibrosis in patients with acute or chronic synovitis [22, 24]. For this reason we prefer a two-phase procedure: the first step is total removal of the synovitis by thorough synovectomy, and the second is reconstruction of the ACL, after a delay of 6–8 weeks [24, 31]. As with Rubinstein et al. [27], we had no problems harvesting the contralateral patellar tendon in those cases with previous ipsilateral patellar tendon autograft, but we performed no ipsilateral reharvest as reported by Karns et al. [14].

The results of the clinical examination showed distinct benefit of revision ACL reconstruction. The Lachmann and pivot-shift test results were clearly improved [21]. The KT-1000 measurements confirmed stable conditions in most of the knees. The results are better than or equal to those reported in other studies [20, 31, 34], but the duration of follow-up differs, and a direct comparison is therefore not possible because there is the possibility that our results will deteriorate by time. Furthermore, the results are below the outcome of primary ACL reconstruction [9, 11, 12]. Regarding knee stability we saw no difference between our results and those of other studies [4, 26] evaluating operative techniques with different graft selection (semitendinosus or gracilis graft).

All evaluated knee scores improved. The Lysholm score had a median of 85, which is close to some results of primary ACL reconstruction [11] and comparable to those in other studies on revision reconstruction [20, 31, 34]. In some studies a direct comparison is difficult because of different score systems. The Tegner activity score rose to a median of 5.0; of course the level of 7.0 before the first ACL injury could not be reached. Of the 16 patients (36.4%) who did not return to their preoperative activity level only 4 (9.1%) were unable to achieve; the others decided not to return, expressing a modification in behavior after relapsed ACL injuries. The IKDC ranking system is very extensive, incorporating multiple subjective and objective criteria. According to the IKDC score, only 9 knees (20.5%) were graded nearly normal (B) at preoperative examination; at this time the abnormal (C) and severely abnormal (D) results in the other 35 knees were causes of instability. At follow-up 33 knees (75.0%) were graded normal (A) or nearly normal (B), but at this time the minor results in the other 11 knees in the first line were caused of progressive signs of osteoarthritis. Our study showed a similar outcome as other operative techniques [4, 20, 34, 35] for the patellar tendon autograft, but it was below the long-term results of primary ACL reconstruction [11, 23].

Progression of osteoarthritis was controlled by evaluating the preoperative and follow-up radiographs according to a modified Fairbank scale. Signs of progressive osteoarthritis were noted in 16 knees (36.4%); in each of these cases deterioration was about one grade. Progression of osteoarthritis in knees with chronically insufficient ACL has been reported previously [10, 11, 17]. This is the reason why it is recommended to restore stability before further injuries occur that could lead to degenerative changes [11, 12]. Even after successful stabilization, however, progressive osteoarthritis has been reported in knees with partial or especially complete meniscus resection [3, 4, 15]. In our patients there was a tendency for progression of osteoarthritis in knees with partial meniscus resection, but this association did not achieve statistical significance. Probably with longer time of follow-up we will find statistical significance as already reported by several authors [3, 4, 15]. A significant statistical relationship was seen between osteoarthritis and patients with major articular cartilage lesions (III, IV). In this group of 12 knees 11 showed osteoarthritic progression, compared to 2 of 13 in the group with minor cartilage lesions (I, II) and 3 of 19 in knees without cartilage damage. This result supports the findings of Gillquist et al. [8] and a recent review of Getelman et al. [7] reporting a poorer outcome in knees with high-grade articular cartilage damage in regard to sports activity and strong physical work. Other studies have observed no such relationship [12, 18]. Furthermore, we saw a significant relationship between osteoarthritis and previous ACL reconstruction with synthetic grafts (Goretex, carbon). In this group of ten patients eight showed deterioration on the modified Fairbank scale. In each case we found extensive synovitis caused by particles of the artificial ligament. In six knees we had to perform a two-phase procedure. In neither group (primary reconstruction with and without synthetic ligament) did we see a statistically significant difference in the number of knees with partial meniscus resection or time of follow-up. It is therefore unlikely that one of these factors affected the difference in outcome of the two groups. We suspect that one reason for progressive osteoarthritis in this group is the potential danger of cartilage damage caused by long-term joint effusion [5].

Our results were superior to those reported in patients treated nonoperatively [13, 17, 28]. Persistent instability is seen in up to 92% of the latter, progressive osteoarthritis in all cases [28], and, most importantly, further knee injuries in up to 25% due to persistent instability [13, 17, 28]. Of course a direct comparison of these results is not possible because of different patient data and study design. Nevertheless there is a difference in final outcome, and in our opinion operative treatment in cases of revision

ACL injury must be recommended at least for those who still want to participate in competitive sports or do not accept a modification in behavior.

We conclude that revision ACL reconstruction using a BTB autograft regularly leads to good results with improvement in knee stability and knee score values. Our results are in line with those of other authors performing the same or other techniques; however, the results are not as good as those after primary ACL reconstruction. Progression of radiographic signs of osteoarthritis must be expected in patients with major articular cartilage lesions (grades III, IV) and those with extensive synovitis caused by previous ACL reconstruction using synthetic grafts. Regarding these results, performance of revision ACL reconstruction is one possible option of further treatment in knees with chronic anterior instability, and we recommend it especially for those patients who still wish to participate in competitive sports or do not want to accept modifications in behavior. In our opinion, the time of revision should be as early as possible to prevent further knee injuries that could lead to deterioration of the final outcome.

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