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Osteoarthritis after anterior cruciate ligament reconstruction using a patellar tendon autograft

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Abstract We studied 58 knees that underwent anterior cruciate ligament (ACL) reconstruction using a patella tendon autograft. The mean age at reconstruction was 30.4 (18–58) years, and the average follow-up was 11.2 (8.6–13.8) years. The presence of osteoarthritis was assessed radiographically using Kellgren and Lawrence's classification. Osteoarthritis was detected in the medial compartment in 25 cases and in the lateral compartment in 14 cases. Significant independent predictors of osteoarthritis were: accompanying meniscal injury [odds ratio (OR) 9.19), $p < 0.001$], an interval of more than 6 months from injury to reconstruction (OR 4.77, $p = 0.021$), and age more than 25 years at reconstruction (OR 3.37, $p = 0.034$). However, no statistically significant correlation was found between the development of osteoarthritis and clinical outcome or radiological stability.

Résumé Nous avons étudié 58 genoux qui ont subi reconstruction du ligament croisé antérieur par une autogreffe du tendon rotulien. L'âge moyen à la reconstruction était de 30,4 (18–58) ans, et le suivi moyen était de 11,2 (8,6–13,8) ans. La présence d'arthrose a été contrôlée radiographiquement en utilisant la classification de Kellgren et Lawrence. L'arthrose a été détectée dans le compartiment médial dans 25 cas, et dans le compartiment latéral dans 14 cas. Les éléments indépendants prédictifs de l'arthrose étaient: la lésion méniscale associée, un intervalle de plus de 6 mois entre le traumatisme et la reconstruction, et l'âge supérieur à 25 ans à la reconstruction. Cependant, aucune corrélation statistiquement significative n'a été trouvée entre le développement de l'arthrose et le résultat clinique ou la stabilité radiologique.

Introduction

The clinical outcome of anterior cruciate ligament (ACL) reconstruction is good [4, 8]; however, until now, the incidence and the risk factors that contribute to the development of degenerative osteoarthritis after ACL reconstruction have remained controversial because few long-term follow-up studies have been done.

Therefore, the aim of this retrospective study was to evaluate clinical outcome in patients with a reconstructed ACL and to evaluate the development of osteoarthritis and identify its risk factors.

Materials and methods

Eighty consecutive patients who underwent arthroscopically-assisted ACL reconstruction between 1991 and 1996 composed the study group. Ten patients were excluded because they had later received another form of ligamentous surgery, and 12 patients were lost to follow-up. The study group thus consisted of 58 patients, 55 male and three female. The average follow-up time was 11.2 years (range 8.6–13.8 years), and the average age at the time of reconstruction was 30.4 years (range 18–58 years). Twenty-nine injuries occurred during pivoting contact sports, 22 during pivoting noncontact sports, three during daily activity, and four following a traffic accident. The time interval from injury to reconstruction averaged 31.1 months (range 0.5–180 months). Twenty patients underwent medial meniscectomy, seven had lateral meniscectomy, and six had combined medial and lateral meniscectomy.

Routine diagnostic arthroscopy was done to verify ACL rupture and to address associated meniscal or chondral injuries. After meniscal and chondral injuries had been treated, a 10-mm, middle-third patellar autograft was harvested with 25-mm bone plugs at either end. A single-incision arthroscope-assisted reconstruction technique was used in all patients. ACL remnants were resected, and a tibial tunnel was created using a drill guide within the footprint of the ACL. A femoral tunnel was created through

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Table 1 Kellgren and Lawrence classification

Grade	Definition
I	Minute osteophyte
II	Definite osteophyte
III	Moderate diminution of joint space
IV	Joint space impaired with subchondral sclerosis

the tibial tunnel, and the patellar tendon autograft was passed through the tibial tunnel using an Ethibond pull-through suture. Bone blocks were positioned in the tunnel and secured. The autograft was placed with its cortical edge oriented posteriorly within the femoral tunnel, and a metal interference screw was placed anteriorly to minimize graft soft tissue injury. After femoral fixation, the affected knee was cycled several times to assess graft fixation and isometry, and a metal interference screw was inserted alongside the tibial bone block with the knee in complete extension while applying tension to the sutures on the tibial plug.

Postoperatively, all patients wore a hinged knee brace locked in extension, except during intermittent active exercise four times per day. No motion limits were set for patients with partial or total meniscectomy or with chondral injuries. At 24 h postoperatively, legs were placed in a hinged brace allowing 30–90° flexion of motion, and patients were placed on a rehabilitation regimen that included quadriceps muscle strengthening and straight leg raising exercises. Patients were allowed partial weight-bearing until eight weeks postoperatively. Knee braces were fully removed on the eighth postoperative week, when full weightbearing was allowed. At three months postoperatively, patients were allowed low-impact sports.

Weightbearing anteroposterior, lateral radiographs of the ACL in reconstructed and contralateral knees were taken preoperatively and at the last follow-up, and osteoarthritis

Fig. 2 Antero-posterior radiographs taken 12 years after reconstruction showing evidence of grade II osteoarthritis on the medial and patello-femoral compartments of the reconstructed knee (right). This male patient had two risk factors, namely, an older age at the time of reconstruction (33 years old) and an extended time from injury to reconstruction (12 years)

levels were assessed using Kellgren and Lawrence's classification [10]. Patients with more than grade II arthritis who showed clear osteophytes were defined as having osteoarthritis (Table 1).

Lysholm knee scores, Lachmann and pivot shift test results, and return to preinjury activity levels were evaluated, and anterior knee laxity and persistent anterior subluxation of the tibia were assessed radiographically using the Telos device (20 lb) [5].

For statistical analysis, continuous variables in the arthritis and the nonarthritis group were analysed by the Mann-Whitney *U*-test, and risk factors were evaluated using Pearson's chi-square test and Fisher's exact test. Statistical analysis was performed using the SPSS program, and the confidence level was set at 95%.

Fig. 1 Antero-posterior radiographs taken 10 years after reconstruction showing no evidence of degenerative osteoarthritis in either knee. At the time of reconstruction, the patient was 20 years old and had no risk factors such as accompanying meniscal injury or an extended time between injury and reconstruction

Fig. 3 Antero-posterior radiographs taken 13.7 years after reconstruction showing evidence of grade III osteoarthritis on the medial compartment of the reconstructed knee (right). This patient had three risk factors: an older age at the time of reconstruction (30 years old), a long time from injury to reconstruction (7 years), and an accompanying medial meniscus injury

Table 2 Factors for the development of osteoarthritis (OA) after anterior cruciate ligament reconstruction

Variables	Total(58) mean $\pm$ SD	Cases of OA/total	Odds ratio (95% CI)	P-value
Age at reconstruction	30.4 $\pm$ 9.7		3.365	0.034
$\leq$ 25 years		6/23		
$>$ 25 years		19/35		
Time from injury to reconstruction	31.1 $\pm$ 38.5		4.767	0.021
$\leq$ 6 months		3/16		
$>$ 6 months		22/42		
Accompanied meniscal injury			9.188	<0.001
Yes		20/33		
No		5/25		
Lysholm knee score (points)	90.0 $\pm$ 9.9		1.349	0.578
$>$ 90		13/33		
$\leq$ 90		12/25		
Lachmann test			0.630	0.610
Normal or grade I		23/52		
Grade II or III		2/6		
Pivot shift test			0.417	0.449
Normal or grade I		24/54		
Grade II or III		1/4		
Anterior laxity	3.2 $\pm$ 1.6		1.231	0.777
$\leq$ 5 mm		14/35		
$>$ 5 mm		11/23		
Persistent anterior subluxation	1.3 $\pm$ 3.8		1.210	0.776
$\leq$ 3 mm		17/41		
$>$ 3 mm		9/17		
Return to preinjury activity			1.381	0.671
Complete		4/8		
Incomplete		21/50		

Results

Degenerative osteoarthritis was found in 25 knees, and in 24, more advanced osteoarthritis was seen in the knee joint that underwent ACL reconstruction. The remaining cases showed similar levels of osteoarthritis on both sides (Fig. 1). With regard to the severity of osteoarthritis, two cases were of grade II presurgically, as determined by Kellgren and Lawrence's classification, and at the final follow-up 20 cases were grade II (Fig. 2) and five cases grade III (Fig. 3). In all 25 cases osteoarthritis was found in the medial compartment of the knee joint, and 14 cases also had lateral compartment osteoarthritis.

In 35 cases in which the age at the time of reconstruction was $>$ 25 years, osteoarthritis was found in 19 at the final follow-up. This rate was significantly higher than that of cases with an age $\leq$ 25 years at the time of reconstruction [odds ratio (OR) 3.37, $p=0.034$]. In 42 cases where time from injury to reconstruction was $>$ 6 months, osteoarthritis was detected in 22 cases. This frequency was higher than that in cases where the time from injury to reconstruction was $\leq$ 6 months (OR 4.77, $p=0.021$). In particular, in four of five cases with grade III osteoarthritis, reconstruction was performed more than 25 months after the injury. In

addition, in cases with accompanying meniscal injury (20 of 33 cases), the frequency of osteoarthritis was significantly higher than in those with no accompanying meniscal injury (five of 25 cases; OR 9.19, $p<0.001$). In 12 of 26 patients with medial meniscectomy, radiographs showed osteoarthritic changes in the medial compartment (OR 3.71, $p=0.03$), and three of 13 patients with lateral meniscectomy showed osteoarthritic changes in the lateral compartment (OR 1.20, $p>0.05$; Table 2).

At the final follow-up, Lysholm knee scores averaged 90.0 $\pm$ 9.9 points (58–100 points). In terms of activity levels, eight of 58 patients were able to perform competitive sports at a level equivalent to the preinjury level, and 41 patients were able to perform at reduced levels or were able to jog. Nine were unable to perform any athletic activity, including running, or they did not attempt these activities because of instability of the knee. However, neither the Lysholm knee score nor the activity level correlated with the development of osteoarthritis (Table 2).

At the final follow-up, 52 cases had a negative Lachmann test, five cases showed a mildly positive test, and one case had a moderately positive test. There were no cases with severe positive tests. In 52 cases the pivot shift test was negative, and in six cases it was mildly positive (Table 2).

There was no significant correlation between anterior instability of the knee or persistent anterior subluxation of the tibia and the development of osteoarthritis ($p>0.05$) (Table 2).

Discussion

In this study, the average follow-up after ACL reconstruction using a patellar tendon autograft was 11.2 years, and in 25 of 58 cases (43%) degenerative osteoarthritis developed, especially in the medial compartment. This incidence is much lower than the 72% reported by Jomha et al. [9] after a 7-year follow-up, but higher than the 11% reported by Shelbourne and Gray [14]. Such differences are considered to be due to the different methods used to evaluate osteoarthritis. Time from injury to reconstruction can also influence the results. In the present study, this interval averaged 2.7 years, whereas Jomha et al. [9] reported an average interval of 5.6 years.

The following have all been suggested as risk factors for the development of osteoarthritis: the patient's age at the time of reconstruction, accompanying meniscal injury, time from injury to reconstruction, anterior instability, and persistent anterior subluxation. However, the nature of these relationships has not been elucidated [1–3, 6, 7, 9, 11–15].

It has previously been reported that patients who have undergone meniscal resection associated with ACL injury might develop osteoarthritis more frequently after the reconstruction [6, 9, 11, 14, 15]. This finding was confirmed by our study. Of our patients with meniscal resection, 61% developed degenerative osteoarthritis, which concurs with the reports of Aglietti et al. [1] and Jomha et al. [9].

Jomha et al. [9] reported that in 53 patients who underwent early (within 12 weeks of injury) ACL reconstruction, degenerative changes were detected in 27% after seven years. In those who underwent reconstruction more than 12 weeks after the initial injury, degenerative changes were detected in 54%. Thus, it was suggested that early reconstruction can prevent or delay development of degenerative osteoarthritis. In our study, osteoarthritis developed in 52% of those who underwent reconstruction more than six months after the initial injury. In addition, four out of five cases of advanced degenerative osteoarthritis (grade III) were seen in patients who had their reconstruction more than two years after the initial injury. These findings indicate that a longer interval from injury to reconstruction increases both the risk of osteoarthritis development and its grade.

With regard to patient age and degenerative osteoarthritis development, it has been reported that the frequency of osteoarthritis is significantly higher in those over 25 years of age at the time of injury [7, 9]. In this study, 54% of those over 25 years at the time of operation developed osteoarthritis, which was significantly higher than the 26% among those below 25 years of age.

The relationship between the development of osteoarthritis after ACL reconstruction and anterior instability is still controversial. A number of authors have proposed that anterior instability induces degenerative osteoarthritis in the knee joint. However, recently, it has been reported that anterior instability is not related to the development of osteoarthritis after reconstruction since degenerative changes have been detected in patients without anterior instability during long-term follow-up [7]. Almekinders et al. [2] reported that an abnormal relationship between femur and tibia is the cause of degenerative change after ACL reconstruction; in other words, persistent anterior subluxation of the tibia contributes to such degenerative changes. In our study, anterior instability and persistent anterior subluxation of the tibia were not found to be significantly correlated with the development of degenerative osteoarthritis after ACL reconstruction.

After ACL reconstruction using a patellar ligament autograft, Lysholm knee scores and the outcome of the Lachmann and pivot shift tests were as good as those reported by others. However, only eight patients in our study were able to perform at intensities equivalent to their preinjury levels. Most patients avoided excessive sports like soccer and skiing, or they participated at a reduced intensity. However, neither the return nor the failure to return to preinjury activity levels was found to be significantly related to the development of degenerative osteoarthritis.

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