

# Anterior Cruciate Ligament Reconstruction in Patients Older Than 50 Years

## A Descriptive Study With Minimum 10-Year Follow-up

Grégoire Micicoi,\* MD, PhD, Rayan Fairag,\* MD, PhD, Axel Machado,\* MD, Adil Douiri,\* MD, Nicolas Bronsard,\* MD, PhD, Justin Ernat,<sup>†</sup> MD, and Jean-François Gonzalez,\*<sup>‡</sup> MD, PhD  
*Investigation performed at the Institut Universitaire Locomoteur et du Sport (iULS), Hôpital Pasteur 2, Nice, France*

**Background:** Anterior cruciate ligament (ACL) reconstruction is increasingly being performed in patients >50 years old; however, the long-term outcomes are unclear.

**Purpose:** To analyze the functional results, osteoarthritic progression, reoperation rate, and failure rate at minimum 10-year follow-up in patients >50 years old who have undergone primary ACL reconstruction.

**Study Design:** Case series; Level of evidence, 4.

**Methods:** Included in this study were patients >50 years old who underwent primary ACL reconstruction and had at least 10 years of follow-up data. All patients had instability with limitation of their activities, indicating the necessity of surgical intervention. Patients with revision surgeries, ACL repairs, and nonoperative treatment were excluded. Failure was defined as the presence of revision, high-grade Lachman, positive pivot shift (2+), or subjective instability. The Knee injury and Osteoarthritis Outcome Score (KOOS), subjective and objective functional scores, and osteoarthritic progression were analyzed at final follow-up.

**Results:** A total of 38 patients were identified. The mean age at surgery was  $56.8 \pm 5.7$  years (range, 50.6-70 years). The mean clinical follow-up was  $16.2 \pm 4.3$  years (range, 10.9-23.3 years). The failure rate was 10.5% (4/38): 1 of the 4 patients had a recurrence of instability at 13 years postoperatively and underwent revision with a modified Lemaire extra-articular tenodesis, 1 patient had a positive pivot shift (2+) without subjective instability, and 2 patients underwent total knee arthroplasty. The overall KOOS was  $74.2 \pm 22.2$ , and 91.4% of patients were satisfied or very satisfied with the results of the procedure. Radiographic osteoarthritis was identified in 88.5% of patients at final follow-up; however, there was no statistical significance on clinical outcomes ( $P > .05$ ). Concomitant partial medial meniscectomy ( $P < .01$ ) and meniscal repair ( $P < .01$ ) were associated with the presence of Ahlbäck grade 3 or 4 osteoarthritic manifestations.

**Conclusion:** In patients over the age of 50 years who underwent primary ACL reconstruction, there was a low long-term failure rate and a high level of patient satisfaction, despite osteoarthritic progression in 88.5% of cases. Concomitant meniscal procedures were associated with more severe osteoarthritic progression.

**Keywords:** ACL; 50 years old; failures; functional outcomes; long-term; osteoarthritis

Anterior cruciate ligament (ACL) rupture is a common pathology, affecting 68.6 patients per 100,000 per year in the United States.<sup>23</sup> Reconstruction is usually proposed in young and athletic patients with very good functional

results.<sup>4</sup> The restoration of long-term knee stability and function remains the basic principle of surgical treatment to limit the risk of serious sequelae related to meniscal or cartilage injuries and, in particular, the progression of degenerative changes.<sup>6,17</sup> The management of older patients with ACL ruptures has been debated. Some authors have reported that nonoperative treatment achieves good clinical results but with a high rate of dissatisfied patients.<sup>8</sup> Others have argued that ACL

The Orthopaedic Journal of Sports Medicine, 12(12), 23259671241292071  
 DOI: 10.1177/23259671241292071  
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reconstruction in patients >50 years old allows an easier return to sports and leisure activities, with results comparable with those of younger patients.<sup>11,14,21</sup> ACL rupture in patients >50 years old remains relatively rare compared with younger patients. However, the increase in the aging population and their participation sporting activities is encouraging many surgeons to perform ACL reconstructions in this population.<sup>13</sup>

The existing literature reveals predominantly short- or medium-term outcomes, highlighting a noticeable deficiency in comprehensive investigations of long-term follow-up in this subject area.<sup>7,20,24,25,27,28</sup> Baker et al<sup>5</sup> evaluated the outcomes of ACL reconstruction in patients >60 years of age at 9.6 years of follow-up for 13 patients, showing good-to-excellent subjective outcomes with no reported subjective laxity. To our knowledge, however, no study has reported long-term ( $\geq 10$  years) functional results as well as failure rates after ACL reconstruction in patients >50 years old.

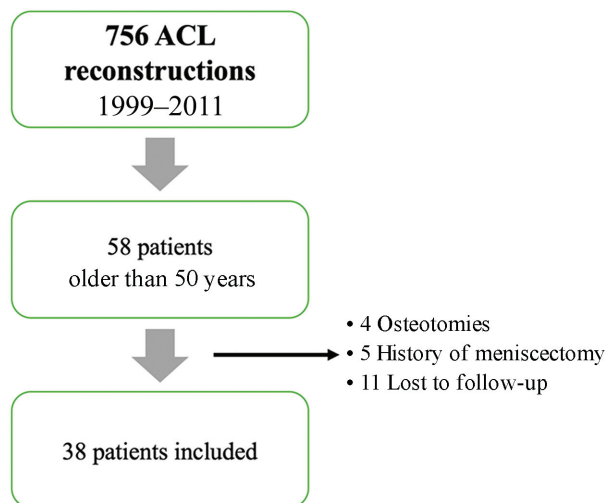
The purpose of this study was to analyze failure rates, reoperation rates, functional results, and osteoarthritic progression at a minimum of 10 years of follow-up in patients over the age of 50 years who have had a primary ACL reconstruction. We hypothesized that ACL reconstructions after age 50 years would have a low long-term failure rate.

## METHODS

### Study Population

This retrospective monocentric study included patients >50 years old who underwent surgery between 1999 and 2011 for an ACL rupture. As this was a level 4, noninterventional study, according to the Jardé 2020 law, no authorization from an ethics committee was required. Data analysis was retrospective and anonymized, and data collection was performed on an encrypted spreadsheet in the routine care setting. All patients were indicated for ACL reconstruction due to persistent limitation of their professional and/or sports activities. Patients with concomitant meniscal procedures were included. Patients with revision ACL reconstruction surgeries, concomitant bony procedures or osteotomies performed during the same operation, and a previous history of meniscectomies were excluded from the analysis.

During the analysis period, 756 ACL reconstructions were performed, including in 58 patients >50 years of age; 4 patients were excluded from the analysis for



**Figure 1.** Flowchart description of the study. ACL, anterior cruciate ligament.

osteotomy associated with ACL reconstruction, 5 had meniscectomy before ACL reconstruction, and 11 were lost to follow-up, resulting in 38 patients who were included in the final analysis (Figure 1). A complete radiographic assessment was available at a minimum of 10 years of follow-up for 26 patients. Three patients were excluded from the functional analysis at final follow-up, as they had undergone reoperation for recurrence of instability or prosthetic knee replacement.

### Surgical Technique

Bone– patellar tendon– bone (BPTB) autografts were harvested through a single longitudinal incision at a point in the middle third of the tendon (10 mm wide). The tendon graft was removed with 2 rectangular bone blocks (20 mm long). For the 4-strand hamstring reconstruction, the gracilis and the semitendinosus were harvested through an incision centered 1 cm medial and 1 cm distal to the medial border of the tibial tuberosity; the graft was left pediculated to the tibia. The ruptured ACL was resected arthroscopically, and the tibial and femoral anatomic footprints were identified and left intact. The tibial bone tunnel was made with a tibial drill guide set at 55°; the intra-articular tip was positioned in the anteromedial part of the ACL stump on the tibial side. The femoral bone tunnel was performed at 120° of knee flexion in the

‡Address correspondence to Jean-François Gonzalez, MD, PhD, Department of Orthopaedic and Sports Surgery, Institut Universitaire Locomoteur et du Sport (iULS), Hôpital Pasteur 2, 30 voie Romaine, Nice, 06100, France (email: gonzalez.jf@chu-nice.fr).

\*Institut Universitaire Locomoteur et du Sport (iULS), Hôpital Pasteur 2, Nice, France.

<sup>†</sup>Orthopaedic Center, University of Utah Health, Salt Lake City, Utah, USA.

Final revision submitted April 15, 2024; accepted April 23, 2024.

One or more of the authors has declared the following potential conflict of interest or source of funding: J.E. has received grant support from Arthrex, education payments from Arthrex and Smith+Nephew, and consulting fees from DePuy/Medical Device Business Services. J.-F.G. has received consulting fees from Amplitude. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Ethical approval for this study was waived by the Université Côte d'Azur (ref No. 2021-055).

11-o'clock position for a right knee and at 1-o'clock for a left knee with an in-out tunnel technique. Fixation was provided by 2 BioRCI screws (Smith + Nephew) in all cases, and the graft was then cycled in the cases of autograft BPTB ligament reconstruction. Postoperatively, patients were immobilized in an extension splint. Full weightbearing was allowed based on pain level directly after surgery. Pivotal sports activities were allowed after 6 to 9 months.

## Outcome Measures

Failures were defined as the presence of a revision including reoperation for instability or total knee arthroplasty, a high-grade Lachman (2B+), a positive pivot shift (2+), or subjective instability.<sup>3,10</sup> Lachman and pivot-shift measurements were assessed according to the International Knee Documentation Committee (IKDC) objective form.<sup>2</sup> Functional assessment was performed preoperatively and at the final follow-up using the Knee injury and Osteoarthritis Outcome Score (KOOS),<sup>22</sup> IKDC subjective score,<sup>2</sup> and Lysholm score.<sup>26</sup> Patient satisfaction was assessed at final follow-up with the Subjective Knee Value by asking patients to grade their knee function as a percentage (from 0% to 100%, with 100% being a perfect knee).<sup>19</sup> Patients were classified into 3 groups: very satisfied, satisfied, or disappointed. Objective clinical evaluation was performed according to the IKDC objective form for those patients with a complete radiographic workup (n = 26), in which scores are classified into 4 grades (A, normal; B, near normal; C, abnormal; D, very abnormal).<sup>2</sup>

The baseline preoperative manifestation of osteoarthritis was evident radiographically and at final follow-up, facilitating assessments of progression of osteoarthritic changes. Frontal radiographs of the knee in monopodal support, profile at 30° of flexion and patellofemoral deflection were taken to assess the prevalence of tibiofemoral and patellofemoral gonarthrosis according to the Ahlbäck<sup>1</sup> and Kellgren-Lawrence<sup>18</sup> classifications preoperatively and at final follow-up. Knees with Kellgren-Lawrence grades 1 and 2 were classified as having minor osteoarthritic progression, and those with grades 3 and 4 were classified as having major osteoarthritic progression.<sup>24</sup>

## Statistical Analysis

Statistical analysis was performed using XLstat software (2015; Addinsoft). The quantitative variables were calculated in terms of their means and standard deviations and minimum and maximum values. The normal distribution of the variables was verified by the Shapiro-Wilk test. Analysis was performed using the chi-square test for categorical variables and the Student *t* test for continuous variables. An analysis of variance was performed to evaluate the influence of osteoarthritis on clinical outcomes. Multiple comparisons were adjusted using Tukey post hoc tests where appropriate. We chose a test significance level of *P* < .05, with a 95% confidence interval. This was a continuous series; thus, a power analysis was not performed.

TABLE 1  
Characteristics of the Study Population  
(N = 38 Knees in 38 Patients)<sup>a</sup>

Characteristic	Value
Age at surgery, y	56.8 ± 5.7 (50.6-70)
Sex	
Female	17 (44.7)
Male	21 (55.3)
BMI, kg/m <sup>2</sup>	25.1 ± 5.3 (19.4-33.8)
Injury-to-surgery time, y or mo	4.2 ± 4.1 y (2-150 mo)
Follow-up, y	16.2 ± 4.3 (10.9-24.5)
Operated side	
Left	22 (57.9)
Right	16 (42.1)

<sup>a</sup>Data are presented as mean ± SD (range) or n (%). BMI, body-mass index.

## RESULTS

For the 38 study patients, the mean age at surgery was 56.8 ± 5.7 years (range, 50.6-70 years), and the mean follow-up time was 16.2 ± 4.3 years (range, 10.9-23.3 years). Five patients (13.2%) received a BPTB autograft, and 33 (86.8%) received a 4-strand reconstruction using the semitendinosus-gracilis tendon. Injuries of the medial meniscus were observed in 36.8% (14/38) and of the lateral meniscus in 7.9% (3/38) of cases, with partial meniscectomy in 28.9% (11/38, 8 medial meniscus and 3 lateral meniscus), meniscal repair in 7.9% (3/38, 1 lateral meniscus and 2 medial meniscus), and no additional procedures in 7.9% (3/38). Two patients (5.3%) were involved in sporting activities at the professional level, 5 (13.2%) played competitively, 28 (73.7%) were involved in recreational sporting activities, 2 (5.3%) were active without any sports participation, and 1 (2.6%) was sedentary. The most common sport was skiing (n = 26 patients; 68.4%). The characteristics of the study population are summarized in Table 1.

The failure rate was 10.5% (4/38). One of these patients had a recurrence of instability at 13 years postoperatively with a secondary surgery being the addition of a modified Lemaire extra-articular tenodesis, 1 had a positive pivot shift (2+) at final follow-up without subjective instability, and 2 underwent total knee arthroplasty at 13 and 16 years, respectively, after ACL reconstruction. The risk of failure was not influenced by the type of graft used: 1 of these patients had a BPTB autograft and 3 had a 4-strand reconstruction (*P* = .44).

Knee functional scores improved from pre- to postoperatively for the KOOS (overall Δ = 19.9 ± 1.8; *P* = .001; symptoms Δ = 16.7 ± 2.8; *P* = .017; pain Δ = 20.2 ± 3.1; *P* = .002; activities of daily living Δ = 18.6 ± 2.4; *P* = .003; sports/recreation Δ = 24.5 ± 2.8; *P* = .005; and quality of life Δ = 34.8 ± 23.5; *P* = .001) as well as for the IKDC subjective score (Δ = 25.2 ± 2.2; *P* < .001) and Lysholm score (Δ = 37.7 ± 4.7; *P* < .001) (Table 2).

The IKDC objective score at final follow-up was classified as A in 15.4% (n = 4/26), B in 26.9% (n = 7/26), C in

TABLE 2  
Pre- and Postoperative Functional Results<sup>a</sup>

Score	Preoperative	Postoperative	P
KOOS			
Overall	54.3 ± 19.1	74.2 ± 22.2	.001
Symptoms	61.5 ± 13.3	78.2 ± 15.5	.017
Pain	64.2 ± 21.2	84.4 ± 18.7	.002
Activities of daily living	68.8 ± 22.1	87.4 ± 20.6	.003
Sports/recreation	37.4 ± 18.3	61.9 ± 21.3	.005
Quality of life	36.7 ± 23.1	71.5 ± 25.1	.001
IKDC subjective score	44.6 ± 19.5	69.8 ± 17.3	<.001
Lysholm score	48.4 ± 15.7	86.2 ± 11.3	<.001

<sup>a</sup>IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score.

42.3% (n = 11/26), and D in 15.4% (n = 4/26) of cases. The mean Subjective Knee Value was 85% ± 13.6%. Patients were very satisfied or satisfied with their surgeon in 91.4% of cases (n = 32/35) and disappointed in 8.6% of cases (n = 3/35).

Preoperatively, 18.4% (n = 7/38) of patients had Ahlbäck grade 1 osteoarthritis and 2.6% (n = 1/38) had grade 2 osteoarthritis. At final follow-up, radiographic osteoarthritis was identified in 88.5% of patients (n = 23/26). Overall, 19.2% (n = 5/26) had Ahlbäck grade 1 osteoarthritis, 46.2% (n = 12/26) grade 2, 19.2% (n = 5/26) grade 3, and 3.8% (n = 1/26) grade 4 (Figure 2). According to the Kellgren-Lawrence classification, 19.2% (n = 5/26) of the patients had minor osteoarthritic progression and 69.2% (n = 18/26) had major osteoarthritic progression (Table 3). The osteoarthritis was predominant in the medial tibial-femoral compartment in 84.6% (n = 22/26) of the patients, in the lateral tibial-femoral compartment in 19.2% (n = 5/26) and in the patellofemoral compartment in 30.8% (n = 8/26) of the patients.

Both concomitant partial medial meniscectomy ( $P < .01$ ) and meniscal repair ( $P < .01$ ) were associated with the presence of Ahlbäck grade 3 or 4 osteoarthritis. The severity of radiographic osteoarthritis at follow-up according to Ahlbäck classification did not influence the KOOS ( $R^2 = 0.01$ ;  $P > .05$ ), IKDC subjective ( $R^2 = 0.06$ ;  $P > .05$ ), or Lysholm ( $R^2 = 0.003$ ;  $P > .05$ ) scores.

## DISCUSSION

The results of this study suggest that patients >50 years old who undergo ACL reconstruction have a low long-term failure rate. The results also showed a high rate of satisfaction despite osteoarthritic progression for the majority of patients. To our knowledge, this is the first study to assess the long-term results of patients >50 years old with a minimum follow-up of 10 years.

Several other studies have attempted to evaluate the outcomes of ACL reconstruction in patients over the age of 50 years at the short- and midterm. The series by Baker et al,<sup>5</sup> which analyzed the results of patients over 60 years



Figure 2. Radiograph showing Ahlbäck stage 3 osteoarthritis of the medial compartment after ACL reconstruction at 12-year follow-up. The patient was 56 years old at the time of surgery. ACL, anterior cruciate ligament.

TABLE 3  
Osteoarthritis Progression According to Ahlbäck and Kellgren-Lawrence Classifications (n = 26 Patients)<sup>a</sup>

Classification	n (%)
Ahlbäck	
1	5 (19.2)
2	12 (46.2)
3	5 (19.2)
4	1 (3.8)
Kellgren-Lawrence	
1	1 (3.8)
2	4 (15.4)
3	13 (50)
4	5 (19.2)

<sup>a</sup>Data missing for 3 patients.

of age with a follow-up of 9.7 years, found only 1 revision by total knee arthroplasty out of 15 patients (6.7%) who underwent ACL reconstruction. Similarly, Osti et al<sup>20</sup> observed only 1 ACL rerupture in 20 patients operated on after 50 years of age, comparable with the results found in this series. In addition, the series of Panisset et al<sup>21</sup> showed a similar rate of late complications between patients >50 and <40 years old, although there was a higher incidence of postoperative hematoma for patients >50 years old. Blyth et al<sup>7</sup> showed an improvement of 30 points in the Lysholm score in 30 patients >50 years old

at a mean follow-up of 3.8 years, comparable with the present study, although these improvements were herein maintained at  $\geq 10$  years of follow-up.

It has been suggested previously that the presence of a preoperative severe pivot shift, a medial meniscal lesion, or female sex may negatively affect the outcomes of patients  $>50$  years old.<sup>12,15</sup> In our series, the presence of a medial meniscectomy was associated with a major osteoarthritic progression, yet it did not affect the clinical outcome of the included patients. The meta-analysis by Cinque et al<sup>9</sup> showed that the prevalence of osteoarthritis after ACL reconstruction increases significantly with the time elapsed after surgery and that this osteoarthritic progression depends essentially on the timing of surgical management after ACL rupture and also on the age of the patient at the time of surgery. When considering patients of all ages, the functional results of ACL reconstruction were satisfactory at  $>20$  years of follow-up (mean Lysholm score, 89.3; mean IKDC score, 78.6) and the osteoarthritis rate was 73.3%, which is comparable with the results of our population of patients  $>50$  years old.<sup>16</sup>

### Limitations

The limitations of this study are related to its retrospective nature. Missing preoperative data did not allow for an exhaustive analysis of the risk factors for the long-term development of osteoarthritis. The number of patients in the cohort was small, and the number of patients who were lost to follow-up was not negligible. However, our results of ACL reconstructions after 50 years of age at a minimum of 10 years are novel and comparable with previous studies reporting long-term outcomes or outcomes in an “older” population. Finally, the absence of a control group is a limitation. Thus, the influence of age on the failure rate and the increased risk of osteoarthritis could not be assessed under the conditions of this study, even though meta-analyses suggest a correlation between the age of the patient at surgery and the risk of developing osteoarthritis after ACL reconstruction.

### CONCLUSION

This study provides some answers in this selected population on long-term failure results, surgery survival, functional results, and osteoarthritic progression. In patients over the age of 50 years who have received a primary ACL reconstruction, there was a low long-term failure rate associated with a high level of satisfaction despite osteoarthritic progression in 88.5% of cases. Concomitant meniscal procedures were associated with more severe osteoarthritic progression.

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