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## Factors affecting outcome of ACL reconstruction in over-50-year-olds

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### A B S T R A C T

**Introduction:** With increasing life expectancy and ever-improving quality of life in industrialized countries, functional demand and sports levels are increasing in older subjects, who are thus exposed to central pivot lesions almost as much as younger ones. While non-operative treatment provides acceptable results, it entails significant reduction in sports level. The aim of the present study was to analyze medium-term clinical, functional and radiological results of anterior cruciate ligament (ACL) reconstruction in over-50-year-olds, in order to identify factors for failure.

**Hypothesis:** The study hypothesis was that surgical management provides good results if patient selection is rigorous.

**Patients and methods:** A multicenter retrospective study included 398 patients undergoing ACL reconstruction between April 1, 2009 and December 6, 2016. Inclusion criteria comprised: age  $\geq 50$  years, with proven ACL tear. Preoperatively, clinical work-up was supplemented by measurement of differential anterior laxity and radiologic assessment of cartilage status. Functional level was assessed on the objective IKDC score. Intraoperative data comprised type of graft and meniscal and cartilage status. The same parameters were assessed postoperatively. Functional results were assessed on objective IKDS, KOOS and ACL-RSI scores.

**Results:** The mean follow-up was 42.2 months. The mean improvement in differential anterior laxity was 4.2 mm. Pivot-shift showed improvement, with 97% absent or glide ( $p < 0.001$ ). Objective IKDC score showed significant improvement ( $p < 0.0001$ ). 23% of patients had poor clinical results: IKDC C or D. Preoperative explosive pivot-shift ( $p < 0.0001$ ), medial tibiofemoral osteoarthritis ( $p < 0.0001$ ) and medial meniscus lesion ( $p < 0.002$ ) emerged as risk factors for poor functional outcome.

**Conclusion:** ACL reconstruction in over-50-year-olds provided satisfactory clinical and functional results. Rigorous patient selection is mandatory, as radiologic signs of medial tibiofemoral osteoarthritis indicate a risk of poor outcome. Surgery may be proposed in patients with high functional and athletic demand, before medial meniscal lesions can set in. In case of explosive pivot shift, associated anterolateral reconstruction should be considered.

#### Keywords:

Anterior cruciate ligament

Age

Risk factors

Meniscus

Pivot shift

### 1. Introduction

Anterior cruciate ligament (ACL) reconstruction is one of the most frequent interventions in orthopedic surgery. In the USA,

more than 200,000 ACL reconstruction procedures were carried out in 2014 [1]. Moreover, with increasing life expectancy and improvements in quality of life in industrialized countries, athletic level and demand are rising in older subjects. While non-operative treatment gives satisfactory results in patients with low athletic demand, there is a risk of secondary instability if the athletic activity level is high [2–4]. In recent decades, considerable progress has been made with respect to surgery (more reproducible and less invasive

techniques) and to postoperative course (outpatient management, codified rehabilitation protocols). These developments mainly target young athletic patients, but the range of indications is extending to a larger population, from growing children to middle-aged sports players.

Since the early 2000s, an increasing number of studies have reported satisfactory functional results in over-50-year-olds undergoing surgery for ACL tear [5–8]. All, however, reported small cohorts with short follow-up.

Furthermore, to the best of our knowledge, none of the studies analyzed independent factors affecting outcome. The aim of the present study was therefore to analyze medium-term clinical, functional and radiographic results of ACL reconstruction in over-50-year-old patients, with a view to identifying factors for poor outcome. The study hypothesis was that there are a number of anthropometric, clinical and radiographic risk factors.

## 2. Material and method

### 2.1. Type of study

A retrospective study was performed in 10 centers specializing in ligament surgery. Patients aged  $\geq 50$  years, undergoing ACL reconstruction between April 1<sup>st</sup>, 2009 and December 6<sup>th</sup>, 2016, were included, with clinical and radiographic follow-up at a minimum 12 months.

Informed consent was obtained. Institutional Review Board (IRB) approval was obtained from the CCPPRB biomedical research review board (*Comité consultatif de protection des personnes dans la recherche biomédicale*) (RCB 2016-A01140-51).

### 2.2. Inclusion criteria

Inclusion criteria comprised: ACL reconstruction, and age  $\geq 50$  years at surgery.

Exclusion criteria comprised: multiligament lesions, history of ipsi- or contra-lateral ACL, and associated osteotomy.

### 2.3. Preoperative analysis

Preoperative data comprised:

- interview: gender, age at trauma and date of trauma, work-accident status, previous sports activity and level, and Tegner activity level [9];
- clinical examination: body-mass index (BMI), differential anterior laxity, and pivot-shift test;
- radiography: cartilage status in both tibiofemoral compartments and patellofemoral compartment on the International Knee Documentation Committee (IKDC) classification;
- functional level on IKDC score [10].

### 2.4. Surgical analysis

Surgical data comprised:

- trauma-to-surgery time;
- type of graft; presence and treatment of joint, meniscus or cartilage lesions; intra- and immediate postoperative complications.

### 2.5. Postoperative analysis

Postoperative data comprised:

- interview: sport at last follow-up and Tegner activity level [9];
- clinical examination: differential anterior laxity and pivot-shift test;

- radiography: cartilage status in both tibiofemoral compartments and patellofemoral compartment on the IKDC classification;
- functional level on IKDC [10], Knee injury and Osteoarthritis Outcome Score (KOOS) [11] and Anterior Cruciate Ligament-Return to Sport after Injury (ACL-RSI) [12] scores.

### 2.6. Statistical analysis

Statistical analysis was performed independently, by the Resurg company.

Normal distribution was assessed on Shapiro-Wilk test. For non-normally distributed quantitative data, inter-group comparison used Wilcoxon rank sum tests (Mann-Whitney U test) and Kruskal-Wallis test. For matched (pre- to postoperative) groups, the t test was used. Inter-group correlation was assessed on Pearson correlation coefficient. For non-normally distributed qualitative data, inter-group comparison used the Fisher exact and Chi<sup>2</sup> tests.

Multivariate linear regression was used to assess associations between 5 results and  $> 15$  independent variables.

Continuous variables: global KOOS score, differential laxity, Tegner score, return to sport.

Binomial variables: return to sport (yes/no) and dichotomized IKDC (A&B vs. C&D).

Independent continuous variables: age, BMI, trauma-to-surgery time, preoperative differential laxity.

Independent qualitative variables: gender, sport, work-accident, preoperative IKDC score, preoperative pivot shift, medial osteoarthritis, medial and lateral meniscal lesions, graft type, early complications.

Analysis used R software, version 3.3.2 (R Foundation for Statistical Computing, Vienna, Austria).

The significance threshold was set at  $p < 0.05$ .

## 3. Results

### 3.1. Series

A total of 398 patients were included: 216 female (54%), 182 male; mean age at surgery,  $54 \pm 4.1$  years; mean BMI,  $24.3 \pm 4$  kg/m<sup>2</sup>.

ACL tear occurred during sport in 90% of cases, the other 10% being work accidents.

A total of 218 patients (54%) played pivot or contact sports, notably skiing (45%). Mean preoperative Tegner score was  $5.3 \pm 1.3$ .

Mean differential laxity was  $6.6 \pm 3.4$  mm. Pivot shift was marked or explosive in 247 cases (62%).

On X-ray, 107 patients (28%) showed incipient medial tibiofemoral osteoarthritis (IKDC B or C), 15 (3%) incipient lateral tibiofemoral osteoarthritis (IKDC B or C), and 25 (6%) incipient patellofemoral osteoarthritis (IKDC B or C).

A total of 355 patients (89%) had preoperative objective IKDC grades C or D.

### 3.2. Surgical data

Mean time to surgery was 28.4 weeks (range, 0.3–530.8 weeks).

Graft used patellar tendon in 32% of cases, and hamstring in 68%. Anterolateral reconstruction was associated in 8% of cases.

There was a meniscal lesion in 69% of cases: medial 45% ( $n = 180$ ), lateral 8% ( $n = 31$ ), bicompartamental 16% ( $n = 63$ ).

Medial meniscectomy was performed in 39% of cases and suture in 8%, with 8% abstention. Lateral meniscectomy was performed in 11% of cases and suture in 4%, with 8% abstention.

A total of 284 patients (71%) had cartilage lesions: 21% isolated medial condylar, 2% lateral condylar, and 6% isolated patellar, with 42% multicompartamental involvement (Table 1).

**Table 1**  
Intraoperative cartilage findings.

	Number	Rate
Isolated medial cartilage lesion	84	21%
Isolated lateral cartilage lesion	8	2%
Isolated patellar cartilage lesion	24	6%
Multicompartment cartilage lesions	168	42%
Total cartilage lesions	284	71%

**Table 2**  
Late postoperative complications.

	Number	Rate
Late complications	78	20%
Revision surgery	46	12%
Meniscal lesion	11	3%
Retear	6	1.5%
Stiffness	16	4%
General pain	13	3.5%

**Table 3**  
Mean KOOS scores.

	Mean	Standard deviation
Symptoms and stiffness	87.1	16.4
Pain	89.6	13.7
Daily living	91.6	12.5
Sports	75.8	22.7
Quality of life	78.9	22
GLOBAL KOOS	87	17.2

Knee injury and Osteoarthritis Outcome Score.

Thirty-four patients (9%) showed early postoperative complications. 11 patients underwent revision surgery: 10 for hematoma, 1 for deep sepsis.

Seventy-eight patients (20%) showed late complications. 46 patients underwent revision surgery: 11 cases of recurrence of meniscal lesion, 6 of traumatic iterative tear, 16 of stiffness, and 13 of generalized pain (Table 2).

### 3.3. Postoperative data

Mean follow-up was  $42.2 \pm 19.9$  months. There was no loss to follow-up.

Mean differential laxity was  $2.2 \pm 2.5$  mm. Pivot-shift was rated marked or explosive in 3% of cases.

There was significant 4.2 mm improvement in laxity and significant improvement in rotational control ( $p < 0.001$ ).

A total of 23% of patients were graded C or D on postoperative objective IKDC score, showing significant improvement ( $p < 0.0001$ ).

Global KOOS score was  $87.4 \pm 14.3/100$  (Table 3), and ACL-RSI score  $73.9 \pm 23.3/100$ .

There was an excellent correlation between KOOS and objective IKDC scores, with all KOOS item scores and global score significantly poorer in IKDC C and D than in A and B. ( $p < 0.0001$ ) (Fig. 1).

A total of 15.6% of patients with IKDC grade C or D at follow-up had explosive pivot-shift preoperatively, versus only 8% of those with IKDC A or B ( $p < 0.02$ ) (Fig. 2).

Mean Tegner score was  $5.1 \pm 1.4$ . There was a significant fall in sports level at last follow-up, of  $0.3 \pm 0.9$  points ( $p < 0.001$ ).

A total of 331 had returned to sport at last follow-up (83%). 27.7% of those with poor functional results (IKDC C or D) had not returned to sport, versus only 13.8% of those with IKDC A or B ( $p < 0.001$ ).

Mean preoperative Tegner score was 5 in the postoperative IKDC C or D group, versus 5.4 in the A or B group. 80% of patients in the A or B group had preoperative Tegner score  $\geq 5$ , versus 69% in the C or D group ( $p = 0.085$ ).

Radiographically, 127 patients (32%) showed incipient medial tibiofemoral osteoarthritis (IKDC B or C) at last follow-up, 4% more than preoperatively; 28 (7%) showed incipient lateral tibiofemoral osteoarthritis (IKDC B or C) at last follow-up, 4% more than preoperatively, 27 (7%) showed incipient patellofemoral osteoarthritis (IKDC B or C) at last follow-up, 1% more than preoperatively.

Preoperative radiographic signs of medial tibiofemoral osteoarthritis was a factor for poor outcome: 22.4% of patients with IKDC A or B showed such signs, versus 39.9% of those graded C or D ( $p < 0.0001$ ).

Intraoperative findings of medial meniscal lesions influenced outcome: 49.9% of patients with IKDC A or B had such lesions, versus 68.9% graded C or D ( $p < 0.002$ ).

A total of 21.1% of patients with IKDC C or D had medial tibiofemoral cartilage lesions, versus 11.1% graded A or B ( $p < 0.086$ ); 20.4% of patients graded A or B had patellofemoral cartilage lesions, versus 31.1% graded C or D ( $p < 0.084$ ).

## 4. Discussion

With 398 patients, this was, to our knowledge, the largest retrospective study of ACL reconstruction results in over-50-year-olds.

Results were good, with good correction of initial clinical laxity, significantly improved functional scores, a good rate of return to sport, and acceptable short-to-medium term complications rates.

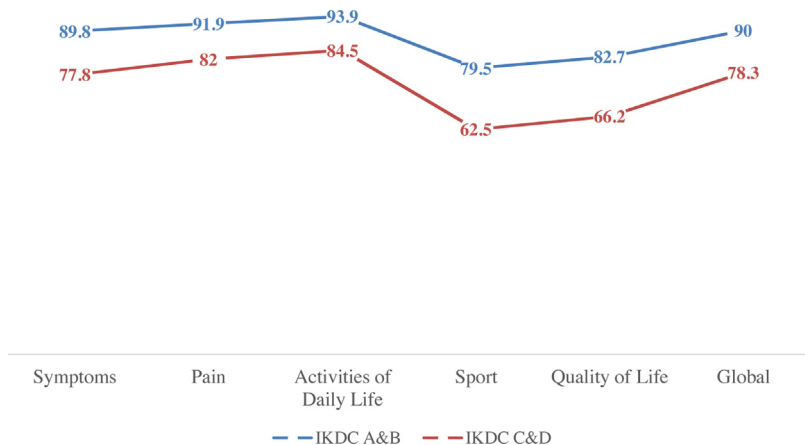
Several other studies likewise assessed ACL reconstruction results in over-50-year-olds, with good clinical and functional results [5–8,13–18].

Even so, despite significant improvement in IKDC score, the rate of non-satisfactory outcomes was not negligible, with 23% of IKDC grade C or D at last follow-up. Objective IKDC score correlated very well with all KOOS items. In a series of 18 patients aged over 50 years, Trojani et al. [6] reported a 22% rate of IKDC grade C or D at a median 31 months. Blyth et al. [13] likewise reported 19% of patients with IKDC grade C. In contrast, Toanen et al. [5] had better results, with only 8% IKDC C at 49.6 months. The present results were comparable to those of Brandsson et al. [14] in younger patients.

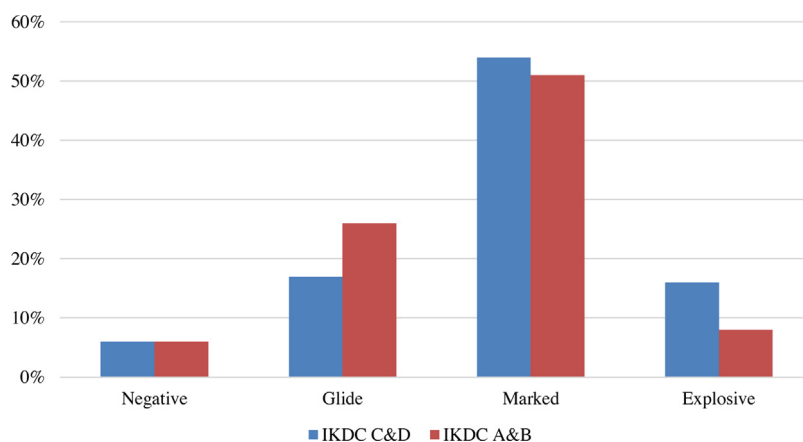
Severe laxity with explosive preoperative pivot-shift was a factor for poor clinical outcome in the present series. Ueki et al. [15], in 368 knees, reported similar results. For Magnussen et al. [16] high-grade pivot-shift was a risk factor for poor functional results and re-tear. These findings raise two issues: the interest of operating on patients with athletic demand before laxity becomes advanced; and the inadequacy of isolated intra-articular reconstruction in controlling rotational instability and the role of anterolateral reconstruction in case of explosive pivot-shift.

According to Cicotti et al. [2], non-operative results are good when sports activity is adjusted, but with a high risk of secondary instability if athletic demand is high. The present series showed 83% return to sport; although there was a significant rate of reduced sport level, it was of only 0.3 points on average. These results were similar to those of the literature, with 68–86% return to sport [5,7,17]. Clinical results significantly impacted return to sport, with 27.7% of patients with IKDC grades C or D not having resumed sports activity at last follow-up, compared to only 13.8% of those graded A or B.

A total of 32% of patients had medial tibiofemoral osteoarthritis at last follow-up, and preoperative signs were a risk factor for poor outcome. Toanen et al. [5] reported better clinical results, due to their inclusion criteria, restricted to patients free of preoperative radiographic osteoarthritis; only 8% of their patients were IKDC grade C at last follow-up, and none were grade D. For Stein et al. [18], in a series of 23 patients aged 49–64 years, signs of advanced osteoarthritis were associated with poor clinical results.



**Fig. 1.** Knee injury and Osteoarthritis Outcome Score (KOOS) scores according to International Knee Documentation Committee (IKDC) score.



**Fig. 2.** Preoperative pivot shift according to IKDC A&B and C&D.

Trojani et al. [6] reported a 22% rate of radiographic osteoarthritis at follow-up, compared to only 11% preoperatively.

Many authors stressed the importance of cartilage and meniscal lesions for functional outcome [13,19–21], only Dahm et al. [7] finding no such effect. In the present series, intraoperative findings of medial meniscal lesion were a risk factor for poor results. Although a trend appeared for poorer results in case of ICRS grade 3 or 4 medial tibiofemoral or patellofemoral cartilage lesions, it was not significant.

## 5. Conclusion

ACL reconstruction in over-50 year-olds gave satisfactory clinical and functional results, comparable to those in younger series. Rigorous patient selection is mandatory, as signs of medial tibiofemoral osteoarthritis are associated with poor outcome.

While the functional results of non-operative treatment are good if athletic level is reduced, surgery should be proposed to patients with greater athletic demand before medial meniscal lesions set in. In case of advanced laxity or explosive pivot-shift, anterolateral reconstruction may be associated to improve rotational control.

## Disclosure of interest

JM Fayard is senior consultant for Arthrex® and NewClip Technics®.

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None.

## Author contributions

J.M.F. & F.W. wrote the manuscript.

J.C.P. did the statistics.

S.L. & J.C.P. designed the study.

All the authors performed the clinical study and collected the data.

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