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Causes for failure of ACL reconstruction and influence of meniscectomies after revision

Christophe Trojani · Abderahmane Sbihi · Patrick Djian · Jean-François Potel · Christophe Hulet · Frank Jouve · Christophe Bussière · François-Paul Ehkirch · Gilles Burdin · Frédéric Dubrana · Philippe Beaufils · Jean-Pierre Franceschi · Vincent Chassaing · Philippe Colombet · Philippe Neyret

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Abstract The purpose of this multicenter retrospective study was to analyze the causes for failure of ACL reconstruction and the influence of meniscectomies after revision. This study was conducted over a 12-year period, from 1994 to 2005 with ten French orthopaedic centers participating. Assessment included the objective International Knee Documenting Committee (IKDC) 2000 scoring system evaluation. Two hundred and ninety-three patients were

C. Trojani (✉)
Service de Chirurgie Orthopédique, Hôpital de l'Archet 2,
151 rte St A. de Ginestière, 06200 Nice, France
e-mail: Chir-orthopedique@chu-nice.fr; trojani@unice.fr

A. Sbihi
Cabinet Medical, 118 rue Jean Mermoz, 13008 Marseille, France
e-mail: sbihi@wanadoo.fr

P. Djian
Cabinet Goethe, 23 avenue Niel, 75017 Paris, France
e-mail: djian@genou.net

J.-F. Potel
Clinique du Cours Dillon, 1 rue Peyrolade,
31300 Toulouse, France
e-mail: jf.potel@wanadoo.fr

C. Hulet
Département d'Orthopédie, CHU de Caen,
14033 Caen Cedex, France
e-mail: hulet-c@chu-caen.fr

F. Jouve
Clinique St George, av de Rimiez, 06000 Nice, France
e-mail: franckjouve@yahoo.fr

C. Bussière
Clinique Du Val Fleuri, rue de l Héritan,
71000 Macon, France
e-mail: cbubus@libertysurf.fr

F.-P. Ehkirch · V. Chassaing
Clinique des Maussins, 67 Rue de Romainville,
75019 Paris, France
e-mail: fpehkirch@free.fr

V. Chassaing
e-mail: vchassaing@orange.fr

G. Burdin
Orthoipédie, CHU de Caen, Avenue de la Côte-de- Nacre,
14033 Caen cedex, France
e-mail: gillesburdin@orange.fr

F. Dubrana
Service Orthopédie CHU Cavale Blanche, 29200 Brest, France
e-mail: frederic.dubrana@chu-brest.fr

P. Beaufils
Hôpital A. Mignot, 78157 Le Chesnay Cedex, France
e-mail: pbeaufils@ch-versailles.fr

J.-P. Franceschi
Hôpital de la Conception, Service Prof Groulier,
13005 Marseille, France
e-mail: jpfrance@club-internet.fr

P. Colombet
9 rue Jean Moulin, 33700 Mérignac, France
e-mail: philippe.colombet5@wanadoo.fr

P. Neyret
Centre Livet, 8 rue de Margnolles, 69300 Caluire, France
e-mail: philippe.neyret@chu-lyon.fr

available for statistics. Untreated laxity, femoral and tibial tunnel malposition, impingement, failure of fixation were assessed, new traumatism and infection were recorded. Meniscus surgery was evaluated before, during or after primary ACL reconstruction, and then during or after revision ACL surgery. The main cause for failure of ACL reconstruction was femoral tunnel malposition in 36% of the cases. Forty-four percent of the patients with an anterior femoral tunnel as a cause for failure of the primary surgery were IKDC A after revision versus 24% if the cause of failure was not the femoral tunnel ($P = 0.05$). A 70% meniscectomy rate was found in revision ACL reconstruction. Comparison between patients with a total meniscectomy ($n = 56$) and patients with preserved menisci ($n = 65$) revealed a better functional result and knee stability in the non-meniscectomized group ($P = 0.04$). This study shows that the anterior femoral tunnel malposition is the main cause for failure in ACL reconstruction. This reason for failure should be considered as a predictive factor of good result of revision ACL reconstruction. Total meniscectomy jeopardizes functional result and knee stability at follow-up.

Keywords ACL reconstruction · Failure · Revision · Menisectomies

Introduction

Among medical reports on revision anterior cruciate ligament (ACL) reconstruction, no series was found reporting the incidence and influence of meniscectomies. Furthermore, the causes for failure of ACL reconstruction are analyzed in short series [7, 12, 41]. In these series, technical errors are considered to be the most frequent causes for failure of ACL reconstruction but no author emphasizes the consequences of these errors on the results of further revision. For these reasons, on the basis of a large series of revision ACL reconstruction conducted by the French Arthroscopic Society [8], this study specifically focused on causes for failure and on the role of the meniscal status. The hypothesis was that medial meniscectomy has a negative influence on the final results of revision ACL reconstruction.

Materials and methods

This retrospective multicenter study was conducted over a 12 year period, from 1994 to 2005 with ten French orthopaedic centers participating. Inclusion criteria were failure of a primary autogenous ACL reconstruction, intact posterior cruciate ligament, non-operated contralateral knee and revision ACL reconstruction performed with an autogenous graft. ACL reconstruction is commonly considered a failure for one of the two following reasons: loss of knee motion due to the development of progressive arthrofibrosis or loss of stability secondary to recurrent patholaxity [19]. In this study, only the primary ACL reconstructions that lead to the recurrence of knee instability and to revision ACL reconstruction were considered as a failure. Failures of synthetic grafts were excluded to render the patient group as homogenous as possible. The minimum follow-up required was 1 year. To be included in the study, patients had to be evaluated with the subjective and objective International Knee Documenting Committee (IKDC) 2000 scoring system [25] at follow-up. The subjective IKDC 2000 form is based on a 100-point score. The objective IKDC 2000 form includes ligament, mobility and radiographic assessment. Radiographic assessment included 30° flexion monopodal weight-bearing AP and lateral radiographs of both knees and comparative 45° flexion AP views ("Schuss" view). Ligament assessment was performed clinically by the pivot shift test, whereas for anterior laxity, clinical and instrumental measurements (TELOS or KT 1000) were performed. Data for each patient was collected in a database edited on File Maker Pro 6. Data was collected on both the primary and the revision ACL reconstruction, the post-operative rehabilitation, the complications and reoperations, the subjective and objective IKDC 2000 scores after the revision ACL reconstruction and the radiographic status before and after the revision surgery. Furthermore, two parameters were carefully assessed: the causes for failure and the meniscal status. The following mechanisms of failure were searched for: untreated laxity, femoral tunnel malposition, tibial tunnel malposition, radiological impingement between the ACL graft and the intercondylar roof, failure of fixation, new trauma and infection. Femoral tunnel malposition was evaluated following previously published criteria [1] as well as tibial tunnel positioning [21]. Impingement between the intercondylar roof and the graft was analyzed following Howell's recommendations [21, 23]. Based on these, tunnel positioning was analyzed on AP and lateral radiographs. Failure of graft fixation was considered as such only when it occurred in the early post-operative period, before graft incorporation. It occurred at one of the fixation sites and depended on both the type of fixations and the type of grafts [31, 32, 43]. Considering the menisci, data was collected at each stage of the knee story. Meniscal surgery was observed before, during or after primary ACL reconstruction, and then during or after revision ACL surgery. Two hundred and ninety-three patients were available for statistics [8]. There were 203 men and 173 right knees. The median age at time of surgery was 23 years (13 to 57), the interval between primary and revision surgery was 5 years (2 months to 15 years) and the median age at revision was 28 (14 to 63). The median follow-up was 30 months (12 to 160). The primary ACL reconstruction was a bone-patellar tendon-

bone (BTB) graft in 200 cases (68%), a semi-tendinosus and gracilis (STG) graft in 87 (30%) and a quadricipital tendon (QT) graft in 6.

Statistical analysis: After inclusion and complete review of the data, data files were centralized for correction and statistical analysis. In a univariate analysis, the statistical tests used were the Chi-square test and the Student t test, when required. Statistics were performed using Statview 5.0 (Symantec Inc.). The level of significance was set at $P < 0.05$.

Results

The causes for failure of primary ACL reconstruction leading to revision are summarized in Table 1. Technical problems (anterior femoral tunnel, malposition of tibial tunnel, failure of fixation) represent 50% of the failures. Anterior positioning of the femoral tunnel was found in 36% of failures (108 cases out of 293). The second most frequent reason for failure was a true new trauma, which was observed in 30% of the failures. In this series, "supposed" traumatisms were not considered as responsible for failure, because in this etiology, another reason was always found to explain the failure. Tibial tunnel malposition was three times less frequent than femoral tunnel malposition and occurred in 11% of the patients (32 out of 293). This tunnel was positioned either too far anteriorly or posteriorly. Radiological impingement between the primary ACL graft and the intercondylar notch was found in the same percentage of cases. Failure of the fixation system, untreated peripheral laxity and hyperlaxity represented around 5% of the failures. Finally, no reason for failure was found in 15% of the patients (44 cases out of 293). It was observed that only the malpositon of the femoral tunnel was predictive of a better functional result of revision surgery. Indeed, at final follow-up, 44% were IKDC A after revision in the group of patients with an anterior femoral tunnel as a cause for failure of the primary surgery, versus 24% if the cause of failure was not the femoral tunnel. This difference was statistically significant ($P < 0.05$).

Table 1 Causes for failure of ACL reconstruction leading to revision (two causes or more are possible for each patient)

Causes for failure	$n = 293$ (%)
Femoral tunnel malposition	36
New traumatism	30
No cause found	15
Impingement	12
Tibial tunnel malposition	11
Untreated laxity	5
Failure of fixation	5
Hyperlaxity	4
Infection	2

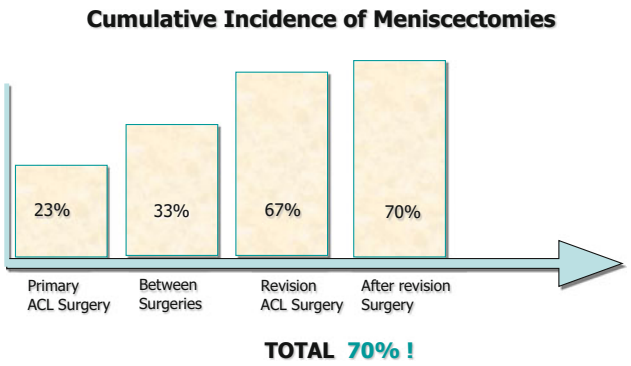

Fig. 1 Incidence of meniscectomies in revision ACL reconstruction

The cumulative incidence of medial and lateral meniscectomies was 70%. The evolution of the meniscal status during the knee story is summarized in Fig. 1. Meniscectomies were performed before or during primary surgery in 23% of the patients. The rate of meniscectomies increased to 33% between the primary and the revision ACL reconstruction because of isolated meniscectomies performed during this period. The rate of meniscectomies was raised to 67% when adding those performed during the revision ACL reconstruction and finally, the inclusion of meniscectomies following revision ACL reconstruction further increased this rate to 70%. The meniscal status is of significant influence on the objective IKDC score and on knee stability, as summarized in Table 2. At final follow-up, patients with conserved menisci had a better functional result and a better knee stability than those with a total meniscectomy ($P = 0.04$).

Discussion

The most important finding of the present study is that failures of ACL reconstruction are due to technical errors in 50% of the cases. This rate is in accordance with previous well-documented studies on causes for failure in revision ACL reconstruction [7, 10, 28]. Among technical errors, the femoral tunnel malposition is the most common

Table 2 Influence of meniscectomies on objective results and knee stability after revision ACL reconstruction

	Conserved menisci 65 patients (%)	Total meniscectomy 56 patients (%)	P
IKDC A	34	18	0.04
Negative pivot shift	80	64	0.04

cause of failure reported in all studies of revision ACL reconstruction [4, 7, 9, 11–14, 16, 17, 29, 30, 35–37, 39, 41, 44–47]. In particular, the femoral tunnel placement is exceedingly anterior in most of the cases because of difficulties of visualization of the "over the top" position on the femur during endoscopic ACL procedures [15, 27]. Despite the fact that this technical problem has been previously described and is well known as the "resident ridge pitfall", it remains the main source of ACL reconstruction failure. The anterior malposition of the femoral tunnel leads first, to a loss of flexion because the graft is overtensioned already at 90° of flexion [6, 18] and secondly, to the recurrence of instability when the too short intraarticular graft fails during rehabilitation, or when the patient goes back to sport.

This study also shows for the first time that if the failure of the primary ACL graft is due to an anterior femoral tunnel malposition, the final result of the revision ACL reconstruction will be statistically superior to revision for another cause. Therefore, we believe that an anterior femoral tunnel malposition should be considered as a predictive factor of good result of revision ACL reconstruction. Another cause or technical reason for ACL graft failure is tibial tunnel malposition, but this surgical mistake is less frequent. In this study, femoral malposition is thrice more common than tibial malposition, and this rate is in accordance with other series [7, 12, 41]. If the tibial tunnel is too anterior, it leads to a loss of extension and impingement with the intercondylar notch [1, 20, 22, 40]. If the tibial tunnel is too posterior, it leads to an incomplete control of laxity because the intraarticular graft is too vertical. It should be kept in mind that the anteriorization of the femoral tunnel is not corrected by the posteriorization of the tibial tunnel [26]: impingement between the ACL graft and the intercondylar notch is always avoided if the graft is well-positioned on the femur and on the tibia.

Another finding of this study is that true traumatic reinjury of a well-positioned and well-fixed graft is nearly as frequent as the femoral tunnel problem. The found 30% rate is in accordance with the most recent studies [7, 12, 41] and is 2 to 3 times higher than those of the case series reported in the 90's [15, 27, 28, 35, 46]. Two main reasons could explain this observation : first, the high demand of the patients, who currently expect to go back to their previous type of sports at the same level after ACL reconstruction and second, over-aggressive rehabilitation, which can run contrary to the ACL graft integration [38] and therefore to the ligamentization process [3]. Nowadays, accelerated rehabilitation, as described by Shelbourne [42], is validated for primary [5, 24], but is questionable for revision ACL reconstruction. This is demonstrated by two recent retrospective studies reporting the results of semi-tendinosus and gracilis grafts : while Ferretti [12] recommended partial weight-bearing for 3 weeks and an extension brace for 6, Salmon and Pinczewski [41] used no brace, immediate full weight-bearing and range of motion, and observed the same failure rate.

Finally, this study demonstrates for the first time that the meniscus is of significant influence on the functional result and on knee stability in knees reconstructed by revision ACL, as summarized in Table 2. Patients who sustained a total meniscectomy, at any point of the knee story, i.e. before, during or after the primary or the revision reconstruction, revealed a significantly lower IKDC score and a significantly lower pivot shift control than the patients with conserved menisci. This assessment is in accordance with the findings of McConville [33] and confirms that the meniscus is not only a cartilage keeper [2, 34] but also a knee stabilizer. Therefore, we believe that conservation of the menisci is of major importance in knee reconstruction. This goal is not yet reached, as demonstrated by the 70% rate of meniscectomies in this series, in accordance with almost all the series published on revision ACL reconstruction.

Despite these significant results on the influence of the meniscus, one must keep in mind the limits of the current study, due to its design: being a retrospective, multicenter and non-randomized study, it may include possible bias. The clinical relevance of this study is to avoid technical errors, especially anterior femoral tunnel malposition when performing ACL reconstruction and to avoid total meniscectomy at all cost.

Conclusion

This study shows that anterior femoral tunnel malposition is the main cause for failure in ACL reconstruction and that this reason for failure should be considered as a predictive factor of good result of revision ACL reconstruction. Furthermore, this study demonstrates that total meniscectomy jeopardizes the functional result and knee stability.

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