Knee Osteoarthritis after Reconstruction of Isolated Anterior Cruciate Ligament Injuries: A Systematic Literature Review

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Abstract

Purpose The aim of this review was to analyze the current literature on osteoarthritic evolution of knees without any combined meniscal or ligament lesions undergoing anterior cruciate ligament (ACL) reconstruction.

Methods A PubMed/MEDLINE research was performed using the following keywords: "Anterior Cruciate Ligament Reconstruction" [Mesh] AND "Osteoarthritis, Knee" [Mesh]. Only English language literature and articles published after 2005 were included. Studies including concomitant meniscal tears, posterior cruciate or collateral ligament injuries, previous surgery in the affected knees, infections, osteochondral defects, loose bodies, synovial plica syndrome, and posteromedial or posterolateral corner injuries were not considered in this review.

Results Twelve studies were selected. These papers included 892 patients (mean age at the time of surgery was 22.3 years), with an average follow-up of 11 years. Imaging at follow-up was obtained with standard radiographs in nine studies, magnetic resonance imaging (MRI) in one study, and both X-rays and MRI in two studies. Eight studies reported osteoarthritic evolution, with different prevalence.

Conclusion Only few high-quality studies focused on these specific patients have been published. When reconstructed, isolated ACL-deficient knees have a low risk of osteoarthritic evolution, but mild signs of joint degeneration are reported by the current literature.

Level of Evidence Level IV, systematic review of level I to level IV studies.

Keywords
- cruciate ligament
- anterior
- osteoarthritis
- knee
- surgical procedures
- operative

Introduction

Anterior cruciate ligament (ACL) is one of the most commonly injured ligaments of the knee. Professional athletes in basketball, soccer, and other contact sports report an annual incidence of 0.15 to 3.7% of ACL injury, with an higher rate in female population.[1,2] Thirty-five years ago, it was stated that a rupture of the ACL was "the beginning of the end" of the knee.[3]

Controversy still exists concerning the proper treatment of a knee with a deficient ACL. The current literature reports a large number of studies describing different surgical techniques and comparing results of these treatments. Many of these papers recommend earlier surgical reconstruction after ACL injury to prevent further meniscal damage and to decrease the risk of degenerative arthritis.[4–6] During the last years, a small number of studies compared the results of surgical and conservative treatment of acute ACL injuries in young population.[7] Medial and lateral meniscal tears are described as a risk factor for osteoarthritis (OA) in the injured knee.[8] Many factors are not assessed or adequately evaluated by several studies, such as age, gender, meniscal tear pattern, mechanical alignment, activity level, combined ligament

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injuries, and previous surgery. Also, a persistent and evolving disturbance in cytokine and keratin sulfate profiles was also observed in ACL-deficient knees compared with uninjured knees.[9,10] These confounding factors have a clinical relevance, and a systematic review analyzing the risk of knee OA after ACL reconstruction in isolated ACL injuries has not yet been reported in current literature.

Aim of this review was to analyze the current literature on osteoarthritic evolution of knees without any combined meniscal or ligament lesions undergoing ACL reconstruction.

Methods

A systematic review of scientific articles listed in medical databases (PubMed, MEDLINE) was performed in February 2016, according to the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) guidelines.[11] The search for relevant articles was performed using the following key words: "Anterior Cruciate Ligament Reconstruction"[Mesh] AND "Osteoarthritis, Knee"[Mesh]. English language literature and article published after 2005, involving also groups of patients with previous traumas were considered. Only clinical studies with radiographic results evaluated up to the final follow-up were considered, whereas those without controls over time were excluded. If a case series was included in more than one article, the one with the longest follow-up was considered. When two series of patients were described in the same article, only the one respecting inclusion criteria was analyzed. Original scientific prospective or retrospective articles with a level of evidence of I to IV were included. Review studies, expert opinions, book chapters, and abstracts of meetings or scientific conferences were excluded. Studies including concomitant meniscal tears, posterior cruciate or collateral ligament injuries, previous surgery in the affected knees, infections, osteochondral defects, loose bodies, synovial plica syndrome, and posteromedial or posterolateral corner injuries were not considered in this review. If in a study a cohort of patients respecting inclusion and exclusion criteria was found and compared with another cohort of patients with collateral injury, the study was included but only patients respecting inclusion and exclusion criteria were analyzed.

Clinical data such as mean age, gender, affected limb, dominant limb, mean period between trauma and the intervention, sports activity, type of treatment, complications, clinical scores and radiological evaluation at follow-up were collected.

The primary outcome of this review was to analyze the osteoarthritic evolution of the knee that underwent an ACL reconstruction.

Results

The initial literature search revealed 119 potentially relevant papers. All exclusion criteria were applied to these selected studies, and 12 studies were selected for inclusion in this review (►**Table 1**). Four studies focused on isolated ACL reconstruction without any other injury. The remaining papers compared a cohort of patients with isolated ACL tear with patients having a meniscal tear; for those studies, only data from isolated ACL-injured patients were collected.

The studies included 892 patients, with an average follow-up of 11 years. Men age at the time of surgery was 22.4 years at the time of surgery. Imaging at follow-up was obtained with standard radiographs in nine studies, magnetic resonance imaging (MRU) in one study, and both X-rays and MRI in two studies.

The International Knee Documentation Committee (IKDC) scale was used in three studies, the Kellgren–Lawrence classification of OA was used in four studies, and the Jager–Wirth classification was used in one study; the other papers only demonstrated generic signs of articular degeneration. When MRI was performed, the International Cartilage Research Society (ICRS) guidelines or the Haughom scale was used. One paper compared results of surgical and conservative treatment.

Kievit et al[12] demonstrated an osteoarthritic evolution in patients with isolated ACL tears at a mean follow-up of 5.1 years, but this degenerative process was much faster in patients with correlated meniscal injuries. Data on severity of OA were not reported in the study, and a generic indication about cartilage status was described.[12]

Jones et al[13] considered a cohort of 159 patients who underwent ACL reconstruction for an isolated ACL tear and compared with 103 patients with associated meniscal tear. At an average follow-up of 2.3 years, they found no signs of OA in isolated ACL tears. The results of this study are similar to those reported by Lidén et al,[14] Hoffelner et al,[15] and Struewer et al.[16]

Kessler et al[17] compared results of surgical and conservative treatment in isolated ACL tears. No differences were found in osteoarthritic evolution between the two groups at an average follow-up of 11.1 years. Only 45% of patients that underwent surgical reconstruction had a Kellgren-Lawrence grade 0, compared with 61% of patients treated conservatively. Results of this study evidenced an osteoarthritic evolution without any advantage for the ones who underwent surgical reconstruction.[17]

Aït Si Selmi et al[18] reported on a cohort of 44 patients at an average follow-up of 17.4 years, evaluated with the IKDC scale. They observed an osteoarthritic evolution in 13% of isolated ACL-reconstructed knees compared with 37.2% of patients with associated meniscal injuries.

Leiter et al[19] analyzed 68 patients with reconstructed ACL using hamstrings tendon at an average follow-up of 14.6 years. The authors concluded that reconstructed knees have a greater incidence and severity of OA than nonreconstructed knees, which suggests that degenerative changes are secondary to ACL rupture. Medial meniscus surgery was a strong predictor of OA.

Zaid et al[20] evidenced on MRI scans that altered tibial position in the ACL-reconstructed knee correlates to degenerative cartilage changes in the contact areas of the medial compartment of the knee, as early as one year following ACL reconstruction. This relationship suggests that alteration in tibial position following ACL reconstruction is one of the

Table 1 Studies included in this review

Authors	No. of patients	Follow-up (y)	Age at surgery (y)	BMI	Cartilage status (scale)	X-ray evaluation (scale)	Conservative treatment	Consideration
Aït Si Selmi et al[18]	44	17.4	22 (12–38)	No	Not considered	IKDC: 13% pre-osteoarthritis	Not considered	Osteoarthritic evolution in isolated Injury
Kessler et al[17]	60	11.1 (7.5–16.3)	30.7 (12.5–54)	No	Not considered	Kellgren–Lawrence: Grade 0: 45% Grade 1: 10% Grade 2: 42% Grade 3: 3%	Kellgren–Lawrence: Grade 0: 61% Grade 1: 14% Grade 2: 20% Grade 3: 4%	No reduction of osteoarthritic evolution
Nakata et al[21]	46	11.5 (10–14)	20 (12–33)	No	Not considered	Generic signs of osteoarthritis 26%	Not considered	Osteoarthritic evolution, faster in associated meniscal tears
Lidén et al[14]	33	7.0 (5.5–9.8)	28 (15–59.0)	No	Not considered	Ahlback–Fairbank score: Medial: grade 0 Lateral: grade 0 Combined: grade 0	Not considered	No evidence of osteoarthritis in isolated ACL ruptures
Li et al[22]	212	7.8 (2.1–20.3)	26.4 (16.2–36.6)	27	Not considered	IKDC: 34.0% pre-osteoarthritis	Not considered	Osteoarthritic evolution, faster in associated meniscal tears
Hoffelner el al[15]	28	10 (6.7–12.5)	22.3 (13.3–31.6)	24	ICRS guidelines: Grade 1–2: 12% Grade 3: 7% Grade 4: 14%	Kellgren–Lawrence: Grade 0: 66.7% Grade 1: 8.3% Grade 2: 0% Grade 3: 8.3% Grade 4: 16.7%	Not considered	No evidence of osteoarthritis in isolated ACL ruptures
Struewer et al[16]	112	10.2 (8–13)	40.4 (24–62)	No	Not considered	Jager–Wirth score: No signs of degeneration: 90.2% Initial osteoarthritis: 9.8%	Not considered	No evidence of osteoarthritis in isolated ACL ruptures
Gerhard et al[23]	63	16 (15–17)	27 (20–34)	No	Not considered	Kellgren–Lawrence: Grade 0: 32% Grade 1: 40% Grade 2: 8% Grade 3: 15% Grade 4: 5%	Not considered	Good results but difficult to evidence of preserving from osteoarthritis
Kievit et al[12]	11	5.1 (2.0–11.1)	33.1 (19–57)	25	0 (ICRS grading scale)	IKDC	Not considered	Generic indication of osteoarthritis in patients with meniscal tears
Leiter et al[19]	68	14.6 (12.7–16.5)	31.2 (22.1–40.3)	28	Not considered	Kellgren–Lawrence: Grade 0: 35% Grade 1: 44% Grade 2: 18% Grade 3: 3%	Not considered	Osteoarthritic evolution, faster in associated meniscal tears
Zaid et al[20]	56	27.7 (20.3–35)	1 (0.8–1.3)	23	MRI signs of cartilage damage in treated knees	Not considered	Not considered	Signs of cartilage structural modification after isolated ACL reconstruction
Jones et al[13]	159	2.3 (2–3.3)	30	23.1	Not considered	JSW: comparable with normal knees	Not considered	At 2 y follow up reconstruction without meniscal tear: no osteoarthritis

Abbreviations: ACL, anterior cruciate ligament; ICRS, International Cartilage Repair Society; IKDC, International Knee Documentation Committee; JSW, joint space width; MRI, magnetic resonance imaging.
Note: The structure of the study, follow-up time, age at surgery, instrumental evaluation, and synthetic consideration are reported.

mechanisms for the accelerated cartilage changes commonly seen following ACL reconstruction.

Nakata et[21] reported on a cohort of 46 patients at an average follow-up of 11.5 years. They found generic signs of OA in 26% of patients with reconstructed ACL without meniscal tears and 86% in patients with associated meniscal tears. There was a statistically significant difference in the incidence of radiographic degenerative joint changes between meniscus-preserved knees and meniscus excised knees. Similar results were found in a study performed by Li et al[22] on a cohort of 212 patients at an average follow-up of 26.4 years and in a study performed by Gerhard et al[23] on a cohort of 63 patients at an average follow-up of 16 years.

Discussion

ACL reconstruction is a reproducible technique and in the recent years has become the gold standard treatment for injured knees in active, young population. The aim of this surgery is to restore the joint stability and to protect the knee from further meniscal and ligament injuries. One of the prospected advantages of ACL reconstruction is to restore the correct knee biomechanics, preventing also the articular cartilage degeneration that might evolve in knee OA.

As evidenced by many studies in the literature, meniscal tears are a positive predictor of knee osteoarthritic degeneration due to reduced contact area between femoral and tibial cartilage. Meniscal tears, especially medial posterior horn tears, can also reduce articular stability and increase osteoarthritic evolution.[24,25] Association between meniscal and ACL tears is a common finding in clinical practice, and understanding the influence of the single lesion on evolution of the articular environment is not immediate. The aim of this systematic review was to evidence the up-to-date literature trying to identify the influence of an isolated ACL tear on osteoarthritic evolution of the knee.

Only a small number of studies analyzing the radiographic or MRI results at medium- and long-term follow-up for reconstructed isolated ACL tears are available in the literature of the past 10 years. These studies have different outcomes, showing no evolution to OA[14] or signs of cartilage degeneration on MRI scans 10 years after surgery.[20]

Eight papers described the osteoarthritic evolution comparing isolated ACL tears with combined meniscal or ligament lesions. Jones et al reported no degenerative evolution in patients without meniscal tears, compared with a clear osteoarthritic degeneration in patients with meniscal lesions. These results seem to be confirmed by Lidén et al.[14] Different conclusions are described by Nakata et al[21] and Aït Si Selmi et al,[18] who evidenced a degenerative evolution of the knees in isolated ACL tears, even if not so pronounced as in the knees with meniscal tears.

The use of different scales (IKDC, Joint Space Width, ICRS, Ahlback and Fairbank score, and Kellgren–Lawrence score) makes it difficult to compare exactly the results of different studies and to perform a pooled data analysis. Moreover, the papers do not provide clear information about interobserver reliability of the outcome measurements. In addition, meniscal repairs were included in the noninjured meniscus group in some papers and in the injured meniscus group in others.

Analysis of collected data evidenced a clear indication that meniscal lesions, when combined with ACL rupture, elevate the risk of OA. Isolated ACL tears have a low risk of osteoarthritic evolution, but signs of degeneration are reported in different studies. Only two studies excluded cartilage degeneration in isolated ACL tears, but some limits can be recognized in both studies. Jones et al[13] did not use an international scale to describe their results but only the joint space narrowing. The strength of this paper is the big number of patients included in the study. Lidén et al[14] considered only 33 patients, which is a small sample size for conclusive consideration.

A limit of this review is the lack of data on the influence of knee alignment on cartilage damage in ACL-deficient knees. As reported by Noyes et al,[26] any combination of conditions leading to higher medial joint forces would be associated with factors leading to more rapid degeneration of the medial compartment in patients with ACL deficiency, varus deformity, and lax lateral ligament structures.

This review has some other limitations. First, time and language restrictions limited literature search to the English literature of the past 10 years. Second, the study solely focused on radiographic aspects of articular degeneration and did not consider the clinical aspects of OA. As reported in the literature, OA after ACL reconstruction causes symptomatic knee problems. Barenius et al[27] found symptomatic OA of the medial compartment in 39% of patients. Lohmander et al[28] found 42% of symptomatic OA in their cohort of female soccer players 12 years after an injury.

In conclusion, the current literature highlights a high risk of osteoarthritic evolution after combined ACL and meniscal tears. Isolated ACL tears treated by arthroscopic reconstruction seem to evolve in cartilage degeneration, but only a little number of high-quality studies focused on these specific patients. Multicenter studies or implementation of national registries focusing on this topic could help to understand the specific influence of ACL tears on osteoarthritic evolution of the knee.

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