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.

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

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

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 posterosmedial or posterolateral corner injuries were not considered in this review. If in a study a cohort of patients respecting inclusion and exclusion 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 posterosmedial or posterolateral corner injuries were not considered in this review. If in a study a cohort of patients respecting inclusion and exclusion 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 posterosmedial or posterolateral corner injuries were not considered in this review. If in a study a cohort of patients respecting inclusion and exclusion 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 posterosmedial or posterolateral corner injuries were not considered in this review. If in a study a cohort of patients respecting inclusion and exclusion 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 posterosmedial or posterolateral corner injuries were not considered in this review. If in a study a cohort of patients respecting inclusion and exclusion 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 posterosmedial or posterolateral corner injuries were not considered in this review. If in a study a cohort of patients respecting inclusion and exclusion criteria was analyzed. Original scientifi
<table>
<thead>
<tr>
<th>Authors</th>
<th>No. of patients</th>
<th>Follow-up (y)</th>
<th>Age at surgery (y)</th>
<th>BMI</th>
<th>Cartilage status (scale)</th>
<th>X-ray evaluation (scale)</th>
<th>Conservative treatment</th>
<th>Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aït Si Selmi et al</td>
<td>18</td>
<td>44</td>
<td>22 (12–38)</td>
<td>No</td>
<td>Not considered</td>
<td>IKDC: 13% pre-osteoarthritis</td>
<td>Not considered</td>
<td>Osteoarthritic evolution in isolated injury</td>
</tr>
<tr>
<td>Kessler et al</td>
<td>17</td>
<td>60</td>
<td>11.1 (7.5–16.3)</td>
<td>No</td>
<td>Not considered</td>
<td>Kelkigen-Lawrence:</td>
<td>Kelkigen-Lawrence:</td>
<td>No reduction of osteoarthritic evolution</td>
</tr>
<tr>
<td>Nakata et al</td>
<td>46</td>
<td>11.5 (10–14)</td>
<td>20 (12–33)</td>
<td>No</td>
<td>Not considered</td>
<td>Generic signs of osteoarthritis</td>
<td>Not considered</td>
<td>Osteoarthritic evolution, faster in associated meniscal tears</td>
</tr>
<tr>
<td>Lidén et al</td>
<td>33</td>
<td>7.0 (5.5–9.8)</td>
<td>28 (15–59.0)</td>
<td>No</td>
<td>Not considered</td>
<td>Ahlback-Fairbank score:</td>
<td>Not considered</td>
<td>No evidence of osteoarthritis in isolated ACL ruptures</td>
</tr>
<tr>
<td>Liu et al</td>
<td>212</td>
<td>7.8 (2.1–20.3)</td>
<td>26.4 (16.2–36.6)</td>
<td>27</td>
<td>Not considered</td>
<td>IKDC: 34.0% pre-osteoarthritis</td>
<td>Not considered</td>
<td>Osteoarthritic evolution, faster in associated meniscal tears</td>
</tr>
<tr>
<td>Hoffelner et al</td>
<td>28</td>
<td>10 (6.7–12.5)</td>
<td>22.3 (13.3–31.6)</td>
<td>24</td>
<td>Not considered</td>
<td>ICRS guidelines:</td>
<td>Not considered</td>
<td>No evidence of osteoarthritis in isolated ACL ruptures</td>
</tr>
<tr>
<td>Struwer et al</td>
<td>112</td>
<td>10.2 (8–13)</td>
<td>40.4 (24–62)</td>
<td>No</td>
<td>Not considered</td>
<td>Jager–Wirth score:</td>
<td>Not considered</td>
<td>No evidence of osteoarthritis in isolated ACL ruptures</td>
</tr>
<tr>
<td>Gerhard et al</td>
<td>63</td>
<td>16 (15–17)</td>
<td>27 (20–34)</td>
<td>No</td>
<td>Not considered</td>
<td>Kelkigen-Lawrence:</td>
<td>Not considered</td>
<td>Good results but difficult to evidence of preserving from osteoarthritis</td>
</tr>
<tr>
<td>Kievt et al</td>
<td>11</td>
<td>5.1 (2.0–11.1)</td>
<td>33.1 (19–57)</td>
<td>25</td>
<td>0 (ICRS grading scale)</td>
<td>IKDC</td>
<td>Not considered</td>
<td>Generic indication of osteoarthritis in patients with meniscal tears</td>
</tr>
<tr>
<td>Leiter et al</td>
<td>68</td>
<td>14.6 (12.7–16.5)</td>
<td>31.2 (22.1–40.3)</td>
<td>28</td>
<td>Not considered</td>
<td>Kelkigen-Lawrence:</td>
<td>Not considered</td>
<td>Osteoarthritic evolution, faster in associated meniscal tears</td>
</tr>
<tr>
<td>Zaid et al</td>
<td>56</td>
<td>27.7 (20.3–35)</td>
<td>1 (0.8–1.3)</td>
<td>23</td>
<td>MRI signs of cartilage damage in treated knees</td>
<td>Not considered</td>
<td>Not considered</td>
<td>Signs of cartilage structural modification after isolated ACL reconstruction</td>
</tr>
<tr>
<td>Jones et al</td>
<td>159</td>
<td>2.3 (2–3.3)</td>
<td>30</td>
<td>23.1</td>
<td>Not considered</td>
<td>JSW: comparable with normal knees</td>
<td>Not considered</td>
<td>At 2 y follow up reconstruction without meniscal tear: no osteoarthritis</td>
</tr>
</tbody>
</table>

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 al\textsuperscript{11} 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\textsuperscript{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\textsuperscript{10} 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.\textsuperscript{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\textsuperscript{14} or signs of cartilage degeneration on MRI scans 10 years after surgery.\textsuperscript{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.\textsuperscript{14} Different conclusions are described by Nakata et al\textsuperscript{11} and Aït Si Selmi et al,\textsuperscript{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\textsuperscript{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\textsuperscript{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,\textsuperscript{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\textsuperscript{27} found symptomatic OA of the medial compartment in 39\% of patients. Lohmander et al\textsuperscript{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. Multi-center 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.

References

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