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Primary repair of the anterior cruciate ligament: A paradigm shift

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ABSTRACT

Over the last century, many surgical treatments have been developed in the orthopedic field, including treatments of anterior cruciate ligament (ACL) injuries. These treatments ideally evolve in a process of trial and error with prospective comparison of new treatments to the current treatment standard. However, these evolutions are sometimes not linear and periodically undergo paradigm shifts.

In this article, we review the evolution of ACL treatment and explain how it underwent a paradigm shift. Open primary ACL repair was the most common treatment in the 1970s and 1980s, but because multiple studies noted deterioration of outcomes at mid-term follow-up, in addition to several randomized clinical trials (RCTs) that noted better outcomes following ACL reconstruction, the open primary repair technique was abandoned.

At the end of the primary repair era, however, several studies showed that outcomes of open primary repair were good to excellent and did not deteriorate when this technique was selectively performed in patients with proximal ACL tears, whereas primary repair led to disappointing and unpredictable results in patients with mid-substance tears. Unfortunately, enrollment of patients in the aforementioned RCTs was already finished, ultimately leading to abandoning of open primary repair, despite the advantages of ligament preservation.

In this review, we discuss (I) why the evolution of ACL treatment underwent a paradigm shift, (II) which factors may have played a role in this and (III) what the future role of arthroscopic primary ACL repair is in the evolution of ACL treatments.

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Introduction

Over the last century, many surgical techniques and treatments have been developed in the field of orthopedic surgery.

These evolutions generally consist of a process of trial and error with (prospective) comparison of new treatments to the current treatment standard. If carefully executed and well documented, techniques with superior outcomes would then

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be further developed. More often, however, evolutions of surgical treatments undergo periodic “paradigm shifts” instead of progressing in a linear way. Thomas Kuhn described this in 1962¹ and stated that, because of these paradigm shifts, the scientific truth cannot only be determined by objective criteria but is defined by a consensus of a scientific community.

The evolution of anterior cruciate ligament (ACL) treatments started in 1895 when Mayo Robson reported on primary repair of an ACL injury.² A 41-year old male, who had both cruciate ligaments torn from the femoral wall, underwent primary repair in which the ligaments were stitched back to the femur using catgut ligatures. Over the following decades, Ivar Palmer^{3,4} and Don O'Donoghue^{5,6} further popularized primary repair for the treatment of ACL injuries. Following their work, open primary ACL repair was the most commonly performed surgical treatment in the 1970s and 1980s for ACL injuries,^{7–12} and the initial short-term results of primary repair were good.^{9–15} However, Feagin and Curl were the first to note that the results deteriorated at mid-term follow-up.¹⁶ Reporting on only 50% of their original cohort, they found a 53% reinjury rate at five-year follow-up, along with high rates of pain, stiffness and instability. Following this study, some others also noted deterioration of the results at mid-term follow-up.^{17–19} In addition, several randomized, prospective clinical trials showed better results following ACL reconstruction when compared to primary ACL repair.^{20–26} Taken together, these studies led to the abandoning of open primary ACL repair as a treatment for ACL injury in the early 1990s, and also led to the eventual adoption of ACL reconstruction as the new standard for all patients. With primary repair, however, the native ligament is preserved and the surgery is less invasive, which has some advantages over ACL reconstruction, including maintaining proprioception^{27,28} and preventing complications in graft harvesting, tunnel widening and revisions.^{29–31}

The evolution of primary ACL repair is often believed to have been a natural and linear evolution of ACL treatments. However, with modern-day understanding we carefully reviewed the evolution and abandonment of primary ACL repair, and we noted that the evolution of treatment of ACL injuries underwent a paradigm shift. We feel that this shift led to the suboptimal treatment algorithm currently used for ACL injuries. In this article, we will discuss (I) why this evolution underwent a paradigm shift, (II) which factors may have contributed to this and (III) what the future role of primary repair might be in the evolution of ACL treatments.

Evolution of primary ACL repair through the prism of modern-day understanding

Looking back at the evolution of primary ACL repair, several interesting observations can be made. The most important observation was made by Sherman et al., in 1991,¹⁹ when they reported their mid-term results in what was considered a landmark paper on primary ACL repair.¹⁹ The authors also noted a deterioration of their results at mid-term follow-up, although not as severe as in the cohort of Feagin and Curl, and they sought to find an explanation for this. They performed an

extensive subgroup analysis and found a trend of better clinical results in certain subgroups of patients, including those with proximal (type I) tears. They were, however, not the first to note the role of tear location on the outcomes of primary ACL repair. Already in the early 1980s several authors suggested this correlation.^{12,13,32–34} Weaver et al., for example, reported their outcomes of primary ACL repair in patients in the four Aspen skiing areas in 1985¹² and found that 52 of the 66 patients (79%) with proximal tears were satisfied following primary repair, while only 3 out of 13 patients (23%) with midsubstance tears reported being satisfied with the result at 3.5-year follow-up. They stated, “selection can be made with some predictability of the type of injury to the ligament as to which patients will do better.”¹² Surprisingly, however, this study by Weaver et al., and other studies that suggested a role for proximal tears,^{32–34} were not frequently cited and did not seem to be a part of the worldwide discussion in the literature regarding the treatment of ACL injuries.

Outcomes of open primary ACL repair stratified by tear location

Many of the early authors did not specify the location of the ACL tear,^{16,35–38} which is not surprising, since a possible relationship between tear location and outcomes was made relatively late in the evolution of primary ACL repair. When looking at studies that mainly, or only, treated patients with midsubstance tears (Fig. 1a), it was noted that the results of primary ACL repair were poor. As mentioned, Weaver et al., showed only a 23% satisfaction rate in 13 patients with midsubstance tears. Frank et al., reported similar poor results of primary repair in 42 patients with midsubstance tears. At four-year follow-up, they reported that 22% of the patients had a positive pivot shift, 44% had a +2 or +3 anterior drawer test, and only 61% reported being satisfied with the procedure.³⁹ Odensten et al., reported the outcomes of primary repair in a subgroup of 22 patients with all midsubstance tears and noted a revision rate of 20% at 1.5-year follow-up.²⁵ Furthermore, Kaplan et al., reported their mid-term follow-up of 70 patients treated with primary ACL repair, of which 56 had midsubstance tears.¹⁸ They reported a 17% failure rate, 42% laxity on KT-1000, and only a 62% return to sport rate. They concluded that, “although ... primary repair of the anterior cruciate may work in some patients, it is an unpredictable operative procedure.”

On the contrary, when reviewing studies that treated patients with mainly, or only proximal tears (Fig. 1b), it was noted that good to excellent results were seen in the literature.^{14,32,33,40–43} Kühne et al., reported treatment of 75 patients with proximal tears treated with primary ACL repair at four-year follow-up and reported 0% failure rate, negative pivot shift in 88% of the patients, a 0 or +1 Lachman test in 87% and a return to sports in 89% of patients.⁴² Similarly, Genelin et al., reported their results of 42 patients treated with proximal tears at five- to seven-year follow-up.⁴¹ They found negative pivot shift in 81% of patients, 0 or +1 Lachman test and anterior drawer test in 81% of cases, and reported that 86% of patients were satisfied with the procedure at mid-term follow-up. Raunest et al., reported outcomes of primary repair in 51 patients with proximal ACL tears at average 3.5-year

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