

ACL Repair

Subjects: **Others**

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The anterior cruciate ligament (ACL) is able to heal and subsequently restabilize the knee.

anterior cruciate ligament

ACL repair

dynamic intraligamentary stabilization

suture tape augmentation

suture tape reinforcement

suture anchor primary repair

bridge-enhanced ACL repair

1. Introduction

Anterior cruciate ligament (ACL) repair returned to the spotlight with the introduction of modern ACL repair techniques. Although initially good short-term results after open ACL repair were presented in the 1970s, midterm results deteriorated. Feagin et al. reported a significant reinjury rate after repair of the ACL in 17 out of 32 patients treated with an open repair and five-year follow-up [1]. The technique used for open ACL repair consisted of an arthrotomy, suturing of the ACL with drill holes in the femur and cast immobilization for 4–6 weeks [2]. This open repair technique was replaced by arthroscopic ACL reconstruction (ACL recon) in the 1980s.

ACL recon is the gold standard for surgical treatment of the ruptured ACL despite a number of problems related to this surgery: anterior knee pain (20%), kneeling pain (15%), hamstring muscle weakness following harvesting (10%), rotatory instability with a positive pivot shift (24%), rerupture (6%, up to 28% in high-risk populations), and clinical failure (10%), and only 50% to 65% of recreational athletes return to their preinjury level of sports [3][4][5]. Another disadvantage of conventional ACL recon is the extensive rehabilitation period. On average, patients return to their work after 11 weeks and are allowed to return to sports after 9–12 months [6]. ACL recon has a huge socio-economic impact, as the majority of ACL injuries occur in people of working age [6][7]. ACL reconstructed knees and nonoperatively treated knees demonstrated a risk of 4.71 times and 2.41 times, respectively, for development of moderate to severe arthritis compared with controls [8]. In a prospective study of 958 patients treated with bone–patellar tendon–bone or hamstring–tendon graft ACL recon with two years of follow-up, the total rate of complications was 39% and the surgical revision rate for any reason was 28% [3]. Given the limitations and risks associated with the current gold standard treatment of an ACL rupture, there is room for improvement.

It was common thought that the ACL was not able to heal and restore knee stability, until Costa-Paz et al. and Steadman et al. documented the healing of the ACL in 2012 [9][10]. In the past decade, four different modern ACL repair techniques have been introduced. ACL repair could be a promising surgical technique with theoretical advantages over ACL recon. Modern ACL repair techniques are less invasive compared to ACL recon. If bone

tunnels are drilled for the repair techniques, they are less than half the size of the bone tunnels needed for ACL recon. There is no graft harvesting morbidity as no graft is needed. Preservation of the native ACL ligament and its proprioceptors contributes in the feedback on position and dynamic stability of the knee, which could reduce the rehabilitation period and therefore the economic burden^[11]. ACL repair has the potential to preserve the native insertion site as well, which may in turn lead to more normal joint mechanics and decreased risk of post-traumatic osteoarthritis^[12]. Another advantage is that in the event of a rerupture, a standard ACL recon can be performed. “No bridges are burned.” The author started with ACL repair in 2014 as an early adaptor and has performed more than 130 ACL repairs with three of the four ACL repair techniques.

2. Present

the ACL is able to heal and subsequently restabilize the knee. ACL healing and subsequent knee stabilization has been proven clinically, during rearthroscopy and on MRI. Previously, it was thought that the ruptured ACL responds differently than the other knee ligaments and that it is not able to heal^[9]. The continuous flow of synovial fluid in the knee hampers the formation of a stable fibrin–platelet clot between the ruptured ends of the ACL, which in turn will form stable scar tissue^[12]. By bringing the ruptured ACL ends tight against each other (DIS/ STA/SAPR) or by placing a bioactive scaffold to bridge the gap between the torn ligament ends (BEAR), the synovial fluid does not prevent the formation of stable scar tissue.

ACL repair could be a promising surgical technique with previously mentioned theoretical advantages over ACL recon. The question remains whether these advantages can be demonstrated in clinical practice and whether the midterm results will not deteriorate, as in the 1970s with the old ACL repair techniques. Can it be a game changer or will history repeat itself?

The four previously described ACL repair techniques show promising results published by the developers, which encouraged further research. Firstly, it was confirmed that the ACL is able to heal with modern arthroscopic ACL repair techniques. Secondly, the repaired ACL is able to stabilize the knee again, as measured with instrumented AP knee laxity. Thirdly, the rerupture rate of 0% to 10% for the first smaller case reports with two-year follow-up was promising. This rerupture rate increased to between 2.9% and 14% in larger studies, but was still reported as acceptable. Finally, PROMs were in the same range as ACL recon.

Through time, clinical results of early adaptors of the ACL repair techniques were published and the discussion became more diverse. Compared to the developers' results, there seemed to be an overall higher rerupture rate and resurgery rate for other reasons than revision. Risk factors were described for failures and patient selection was emphasized. Risk factors for failure are a young age, high preinjury sports activity level, midsubstance ruptures, and impaired integrity of the ACL bundles and the synovial sheath. In a five-year follow-up study with 57 DIS patients Ahmad et al. underlined the potential of ACL repair, but also highlighted the danger of the procedure if strict patient selection is not appreciated^[13]. In contrast, the higher rerupture and resurgery rates were not reflected in the three RCTs that have been published so far^{[14][15][16]}. The two DIS versus ACL recon and the BEAR versus ACL recon RCTs with a two-year follow-up did not show a significant rerupture rate difference. The three RCTs

reported a noninferiority or comparable results for PROMs for ACL repair compared to ACL recon. The number of reviews on ACL repair is remarkable. In the past four years, 12 reviews have been published on ACL repair [17][18][19][20][21][22][23][24][25][26][27][28]. The overall consensus in these reviews is that prospective studies comparing ACL repair with ACL recon with sufficient follow-up are needed. Two reviews favor ACL recon over ACL repair [23][28]. Three reviews address the poor amount of high-quality evidence, which makes it difficult to establish the role of ACL repair [22][27][28]. The seven other reviews highlight the promising results or describe ACL repair as a (safe) treatment option for the acute ruptured ACL.

Currently the debate on ACL repair is continuing. The publications of the past few years taught us that the ruptured ACL is able to heal, but patient selection is critical.

3. Future

There are several issues that should be addressed in future ACL repair research. As mentioned in the ACL repair reviews, high-quality large RCTs between ACL recon and ACL repair, as well as between the different ACL repair techniques, are needed [73,74]. PROMs, return to work and sports, instrumented knee laxity, magnetic resonance imaging outcome, cost/utility analysis, reintervention for another reason than rerupture, and rerupture and failure rates and their risk factors should be addressed in these studies. As young patients (below the age of 25) and high-level athletes seem to have a higher risk of rerupture following ACL repair, possibly this subgroup is better treated with ACL recon. Although these groups have a higher risk on rerupture after ACL recon as well, the reported rerupture chance in the ACL repair case reports are higher (up to 44% at five years follow-up) [17][25]. The reported average age for an ACL rupture varies from 29.1 to 33.9—not only young and highly active teenagers rupture their ACLs [29][30]. In addition, proximal ACL ruptures are found more in the age group of 25 and older [29]. Several publications emphasize patient selection criteria of patients older than 25 and the non-high level athletes with an acute proximal bundle ACL rupture [31]. These patients could be the ideal candidates for ACL repair. That raises the question whether ACL repair is needed altogether for this group. Conservative treatment and rehabilitation under supervision of a dedicated physiotherapist is an underestimated treatment. Muaidi et al. describe in their systematic review a good short- to midterm prognosis in terms of self-reported knee function and functional performance after conservatively managed ACL-deficient knees [32]. However, subjects reduced their activity levels on average by 21% following injury. RCTs between conservative management, ACL repair and ACL recon could provide an answer for the patient group older than 25 and non-high athletes. A downside for conservative ACL treated patients with persistent instability is the diminished possibility for a successful ACL repair after 3–6 months.

Another interesting development is the improved understanding in the anterolateral complex [33]. ACL repair together with an anterolateral extra-articular procedure could reduce the rerupture rate. This could be especially interesting for patients younger than 25 and high-level athletes.

ACL reconstructed knees and nonoperatively treated knees demonstrated a 4.71 times and 2.41 times risk, respectively, for development of moderate to severe arthritis compared to controls [8]. ACL repair preserves the native insertion site as well the native ACL proprioceptors, which may in turn lead to more normal joint mechanics

and decreased risk of post-traumatic osteoarthritis. [12] Long-term follow-up has to show if, in contrast to ACL recon or conservative treatment, ACL repair protects against the increased risk of post-traumatic osteoarthritis.

ACL recon still remains the gold standard until more ACL repair data can prove otherwise. Therefore, all ACL repair patients should be closely monitored and followed up, preferably in high-quality large RCTs.

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