



Review Article

Proposed Autograft Superiority to Allograft Use in Return to Sport Rates Following Revision ACL Reconstruction: A Literature Review

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Introduction

The number of primary Anterior Cruciate Ligament (ACL) reconstruction surgeries performed in the United States has drastically increased in recent years to approximately 200,000 cases annually and is a common procedure for athletes of any age and level of skill/play [1]. Despite improvements in patients' surgical outcomes, primary ACL reconstruction only has a success rate of 75% - 97% [2, 3, 4]. As such, revision ACL reconstruction has paralleled this increase in the number of primary reconstructions; there may be anywhere between 3,000 and 10,000 revision ACL reconstructions performed per year [2,3]. Revision surgery is indicated for patients who have experienced postoperative complications such as infection, graft rejection, recurrent instability due to graft failure, surgical technique failures during primary reconstruction, or any combination of the above [2,5]. Revision may also be indicated in athletes who, after a failed primary reconstruction, wish to return to sports which require frequent cutting and pivoting [2,5].

Of great interest is the surgical method which will return a patient undergoing revision ACL reconstruction to physical activity as efficiently- and safely- as possible, because it is known that revision yields substantially inferior functional results compared to primary ACL reconstruction [6-8]. Since type of graft used may predict post-surgical outcomes for patients [5], it has understandably been an area of focus for revision surgery. Many studies have compared the efficacy of autograft and allograft use in patient outcomes following revision surgery by evaluating various postoperative factors, such as graft function (measured by International Knee Documentation Committee (IKDC) [9], Knee Injury and Osteoarthritis Outcome Score (KOOS) [10], Tegner [11] score, and Lysholm [12] score), graft failure, and patient satisfaction with outcome [13]. However, despite the high incidence of ACL re-injuries and failures following primary reconstruction in athletes, few studies have directly compared the

impact of autograft and allograft use on athletes' rate of Return to the Pre-Injury Sport (RTS) following a revision reconstruction procedure.

While most authors agree that autograft is superior to allograft use in providing athletes fewer postoperative complications following revision ACL reconstruction [14-16], optimal graft use for this population with respect to providing the most efficient RTS rates is still unclear due to the relative sparsity of its supporting literature. Additionally, missing from the literature is a general summary of those studies which assesses this important topic, as it carries great implications for athletes of all ages and skill levels. To our knowledge, the present review is the first of its kind to provide a succinct, qualitative overview of the impact of graft choice on RTS rates following revision ACL reconstruction surgery and support autograft superiority to allograft use in predicting subsequent RTS rates.

Methods

Our search of the literature began with electronic databases such as PubMed, ScienceDirect, Cochrane, and the Cochrane Library; reference managers such as Mendeley and EndNote were also used to manage citations. Search queries were conducted using the following keywords: "autograft," "allograft," "revision ACL," "return to sport," and all relevant articles from 1990 to 2018 were evaluated. Additionally, bibliographies of identified studies were searched for titles which included similar keywords. Studies and both literature and systematic reviews which included descriptions of autograft and allograft use in revision ACL reconstruction, patient outcomes following revision with autograft, patient outcomes following revision with allograft, return to sport rates following autograft and allograft use following autograft and allograft use, direct comparison of patient outcomes and return to sport following revision with either autograft or allograft were included.

The Case for Autograft Superiority in Revision ACL Reconstruction

Common practice for most patients undergoing revision ACL reconstruction surgery has favored the use of an autograft - typically a hamstring tendon graft or Bone-Patella Tendon-Bone (BPTB) graft [6] - in comparison to an allograft tendon. Among the strongest support for autograft use lies with their increased stability. Using data from the Danish national ACL reconstruction registry Lind, et al. (2012) demonstrated an increased risk of rupture with allograft use following revision ACL reconstruction, as well as lower overall failure rates when an autograft was used [7,14]. Similarly, autograft use yields a lower rate of re-revisions when compared with allografts, further owing to their stability and hardness [8]. These findings are largely explained by the fact that allografts appear to take longer than autografts to incorporate into the body due to their slower time to undergo revascularization and remodeling processes necessary for incorporation [17]. Likewise, allografts have a less complete course of incorporation into the body [17], are associated with a greater risk of bacterial infection [18], show higher re-revision rates [19], higher failure rates in young athletic and active patients that are 15 times higher than autografts [19], and have been shown to be biomedically inferior to autografts [20].

Autograft Use and Subsequent RTS Rates Following Revision

Autograft success has been well documented in patient-athletes of different ages and skill levels undergoing revision, and there are numerous studies in the literature which support high RTS rates following revision surgery using an autograft. Most recently, Saper et al. (2018) recorded a 90.5% RTS rate in 19 adolescent athletes ages 10-19 who underwent revision using either a hamstring or BPTB autograft, with 68.4% of patients

able to return at their pre-injury level for at least one season [21]. Other research has reported similar findings and found long-term efficacy and stability of autografts as indicated by patients' RTS rates. O'Neill (2004) found a 75% RTS rate after an average of 90 months' post-surgery for patients receiving a previously unharvested ipsilateral autograft use for revision [22]. Similarly, Garofalo, Djahandiri, & Siegrist (2006) demonstrated a 93% RTS rate for patients receiving some quadriceps tendon-patellar bone autograft after an average of 4.2 years [23]; quadriceps tendon-patellar bone autograft success has also been shown by Noyes and Barber-Westin (2006), where an RTS rate of 71.4% was reported after 4.1 years of patient follow-up [24]. Finally, Shelbourne et al. (2014) noted RTS rates of approximately 74% and 62% in competitive high school/college athletes and recreational athletes over 5 years, respectively, when a BPTB autograft was used for revision [25]; Salmon et al. (2006) demonstrated similar success using hamstring autograft with respect to predicting high RTS rates for college-aged athletes [26].

With respect to autograft choice for revision surgery, hamstring or BPTB autograft, although more common, may not necessarily be a requirement for use. In a population of both competitive and recreational patient athletes, Mirouse et al. (2016) successfully showed that use of a fascia lata autograft produced RTS rates like those studies mentioned above after a follow-up period of 4.6 years [27]; postoperative subjective IKDC scores and Sports and Recreation subscale of the KOOS also increased postoperatively [27].

Collectively, these authors show revision RTS rates following autograft use which are markedly higher than those first reported by Reinhardt et al. (2012), where an RTS rate of only 50% was reported in a population of competitive athletes 3 years following surgery [28] (table 1).

Study	Average time to follow-up (years)	Type of autograft	RTS rate (%)	IKDC A-B* (%)
Saper et al. [21]	3.87	Ipsilateral or contralateral hamstring or BPTB	90.5	87.5
O'Neill. [22]	7.5	Ipsilateral hamstring or BPTB	75	84
Garofalo et al. [23]	4.2	Quadriceps tendon-patellar bone	93	93
Shelbourne et al. [25]	5	BPTB	74; 62	86.1
Noyes and Barber-Westin [24]	4.1	Quadriceps tendon-patellar bone	71.4	81
Salmon et al. [26]	7.4	Hamstring	70	56

*IKDC A-B, International Knee Documentation Committee (grade A or B).

Table 1: Studies evaluating effect of autograft use on RTS rates following revision ACL reconstruction.

Lack of Data Supporting Effect of Allograft Use on Postoperative RTS Rates

When autogenous tissue is not either available or compromised by the primary reconstruction, allograft use in revision ACL reconstruction may be a viable alternative, as its use has been shown to be associated with benefits such as shorter operating time, less postoperative pain, a smaller incision, and shorter tourniquet time [29-31]. Allograft use has been more commonly used for revision than for primary reconstruction: The Multicenter ACL Revision Study [14] reported that approximately 54% of the study’s cohort received either a BPTP, tibialis anterior, Achilles, or tibialis posterior tendon allograft for revision [14]. This increase in the number of revisions performed using allograft may be attributed to improvements in both graft harvesting and surgical techniques in recent years - as well as more effective graft sterilization techniques [32]. However, there are often very limited graft options that exist for patients when an autograft tendon is used for primary ACL reconstruction - especially when the patient is an athlete who wishes to return to competitive sports - and therefore allograft use may be a preferred option to spare otherwise healthy tissue and minimize donor-site morbidity [33-35].

Past research that failed to show differences in postoperative functionality between autografts and allografts [36,37] from more than twenty years ago is largely outdated, and newer studies previously mentioned have elucidated the various inferiorities of allograft use for revision. Furthermore, a thorough search of the literature did not return any studies showing a preference for allograft over autograft use in predicting faster patient postoperative RTS rates. This is consistent with known complications associated with allograft use for revision surgery [17-20] - as well as surgeons’ general preference for autograft use because of these risks [38] - and likely explains researchers’ disproportionate focus on autograft rather than allograft use for patients undergoing revision ACL reconstruction (table 2).

Study	Type of Graft	Reported Complications
Jackson et al. [17]		Slower time to incorporate into body
Nemzek et al. [18]	BPTB and tibialis anterior allograft	Highly prone to postoperative viral infection
Foster et al. [20]	Menisci, patellar, and BPTB allograft	High rate of instability associated with allograft use following revision ACLR

Wright et al. [19]	BPTB and hamstring allograft	Inferior IKDC and KOOS sports and recreation scores compared to autograft use
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Table 2: Studies Assessing Complications Associated with Allograft Use in Revision ACL Reconstruction Surgery.

Direct Comparison of Allograft and Autograft Use on RTS Rates Following Revision ACL Reconstruction

Despite evidence that autograft use in revision ACL reconstruction demonstrates high RTS rates in athletes - as well as the known complications of allograft use - there are an extremely limited number of studies which directly compare autografts and allografts in their effect on patients’ postoperative RTS rates. Those that do, however, similarly display a clear difference in athletes’ RTS rates following revision with either an autograft or allograft. Likely the most well-known study evaluating RTS rates of autografts and allografts following revision reconstruction includes data from the Multicenter ACL Revision Study (MARS) study, which showed that patients who received an autograft experienced improved sports function and lower re-rupture rates after a 2-year follow-up in comparison to patients who received an allograft, as measured by IKDC and the Sports and Recreation subscale of the KOOS [14]. Similarly, autograft patients were 2.78 times less likely to experience a re-rupture- and subsequent re-revision surgery- than allograft patients. Importantly, these results are remarkably like IKDC scores reported by primary ACL reconstruction procedures [19].

Keizer et al. (2018) reported similar results, with 75% of patients who received an ipsilateral patellar tendon autograft returning to their pre-injury level of sport after 2 years as opposed to a 43.3% RTS rate for allograft patients over the same interval [15]. Additionally, Legnani et al. (2016) noted that patient athletes who received a contralateral hamstring tendon demonstrated faster RTS rates and higher IDKC and KOOS Sports and Recreation scores at 5.2 years of follow-up than patients who received a contralateral hamstring allograft [16]. It should be noted, however, that the allograft group lacked uniformity in that some patients received BPTB allografts, whereas others received Achilles tendon allografts.

While these studies were limited in that follow-up was not evaluated beyond two years, each present finding which are in line with previously mentioned studies evaluating postoperative RTS rates following autograft and allograft use, individually (table 3).

Study	Graft type	Outcome measures	Graft favored
Wright et al. [14]	Unspecified autograft and allograft	IKDC _{subjective} KOOS, re-rupture rate	Autograft
Keizer et al. [15]	Patellar tendon allograft or ipsilateral autograft	RTS type and level, IKDC _{subjective} KOOS, and Tegner	Autograft
Legnani et al. [16]	Patellar or Achilles tendon autograft and allograft	IKDC _{subjective} KOOS, RTS time, RTS level	IKDC _{subjective} KOOS, RTS level: autograft = allograft. RTS time: autograft

Table 3: Studies Comparing the Effect of Autograft and Allograft Use on RTS Rates Following Revision ACL Reconstruction.

Conclusion

Owing to the increasing number of primary ACL reconstructions performed each year and a success rate of primary reconstruction which is still imperfect, revision ACL reconstruction surgery has become more commonplace for patient-athletes. Many studies in the literature have compared patient outcomes following both autograft and allograft use in revision surgery- with substantial support afforded to autograft use due to the fact its use is associated with decreased risk of rupture, lower re-revision rates, and fewer postoperative complications in comparison to allograft use. However, few studies exist which evaluate the impact of graft choice on patients' RTS rates following revision surgery. To our knowledge, this is the first review to directly assess autograft and allograft use on RTS rates following revision ACL reconstruction, and seeks to add to the literature a missing, yet important overview of a topic which carries significant implications for individuals seeking to return to pre-injury levels of sport.

Research focused on patient-athletes' RTS rates following revision ACL reconstruction has demonstrated successful outcomes, with autograft use generally favored over allograft use in predicting postoperative RTS rates. While few studies have directly compared the effect of autograft and allograft use on RTS rates, those that do have similarly reported preferable results following autograft use. Taken together, these findings appear to suggest autograft superiority with respect to affording patients a faster RTS rate and pre-injury level of sport.

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