

Systematic Review

Risk of Retear Following Anterior Cruciate Ligament Reconstruction Using a Hybrid Graft of Autograft Augmented With Allograft Tissue: A Systematic Review and Meta-analysis

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Purpose: To compare the risk of anterior cruciate ligament reconstruction failure in patients who undergo anterior cruciate ligament reconstruction with either autograft tissue or hybrid grafts. **Methods:** A systematic search was performed on February 28, 2018, on PubMed, Scopus, Arthroscopy, and Cochrane Library. Included studies were clinical outcome studies of primary anterior cruciate ligament reconstructions that compared failure risk for hybrid grafts versus autografts. Baseline and outcomes data were extracted, and reporting quality was assessed via modified Coleman criteria. A random effects meta-analysis was conducted for both randomized and nonrandomized studies. **Results:** Nine studies were identified with a mean of 40.1 months of follow-up. The mean Coleman methodology score was 66.5 (standard deviation, 12.8). One randomized study (Level II evidence) was identified with no difference in failure rates (0% for both groups, 8-mm minimum graft diameter for all patients). Eight nonrandomized studies (all Level III evidence) were identified with no difference in failure risk for hybrid grafts versus autograft (pooled odds ratio, 1.29; 95% confidence interval, 0.57-2.92; $P = .55$; $I^2 = 34\%$). Mean graft diameters were significantly larger in hybrid groups (range, 8.5-9.9 mm) than in autograft groups (range, 6.4-8.8 mm) in nonrandomized studies (mean difference, 0.5-2.5 mm; $P \leq .003$). There was no evidence of small study bias or bias owing to reporting quality, and adjustment for length of follow-up, mean patient age, percentage of male patients, year of publication, or reporting quality did not improve statistical heterogeneity. **Conclusions:** Based on the current literature, although it may be theoretically detrimental to add allograft to a small-diameter autograft, it cannot be definitively shown based on the findings of this review with meta-analysis. Currently, it remains unclear that there is an advantage or disadvantage to hybridization of small autograft with allograft, although randomized studies of patients with small (<8-mm) autograft diameters are lacking. **Level of Evidence:** Level III, systematic review of Level II and III studies.

Anterior cruciate ligament (ACL) injury is quite common; it has been estimated that approximately 100,000 ACL reconstruction procedures occur

in the United States annually.¹ The 2 principle graft choices for ACL reconstruction are autograft and allograft tissue. Autograft ACL reconstruction, most commonly using patellar tendon or hamstring tendon,² has been shown in several studies to result in lower failure risk than that found with allograft,³⁻⁶ especially in younger, more active patient populations.⁷⁻¹⁰

Hamstring autograft harvest can result in a small graft size. Several clinical studies have described increased failure risk with small-diameter hamstring autografts.¹¹⁻¹⁵ It has also been shown through both clinical¹⁶ and biomechanical¹⁷ studies that there is an increase in graft strength with increased diameter. Although there are multiple solutions to small graft harvest, augmentation of autograft with allograft tissue to create a hybrid graft is a potential solution to this difficult clinical problem.¹⁸ The resulting hybrid ACL

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graft is hypothesized to have increased strength and a potentially lower risk of failure given its greater diameter.¹⁷ However, studies have suggested that despite an increase in graft diameter, there is a higher rate of failure in hybrid grafts than autografts.¹⁹⁻²²

The clinical benefit of augmentation of hamstring autograft tissue with allograft tissue is unclear and is a topic of interest among orthopaedic surgeons seeking the most successful method of ACL reconstruction. The purpose of this review and meta-analysis was to compare the risk of ACL reconstruction failure in patients who undergo ACL reconstruction with either autograft tissue or hybrid grafts. It was hypothesized that there is a greater risk of failure in hybrid grafts than autografts after ACL reconstruction.

Methods

Literature Review

A literature search was conducted on PubMed, Scopus, Arthroscopy, and Cochrane Library in accordance with Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines²³ to identify all publications regarding hybrid ACL reconstruction. A primary search on February 28, 2018, included the terms “ACL” OR “anterior cruciate ligament” AND “reconstruction,” which yielded 27,284 articles. Inclusion of the term “hybrid” yielded 252 articles. Two hundred twenty-eight articles that failed to meet inclusion and exclusion criteria (Table 1) were eliminated. Of the 24 remaining studies, 15 duplicates were removed. The remaining 9 studies underwent full-text review and met the inclusion criteria. No additional studies were included after a review of the references. The literature search is summarized in Figure 1.

Data Extraction

Extracted data included patient demographics, study characteristics, graft choice, duration of follow-up, and risk of graft failure, with failure being defined as a re-tear determined by clinical evaluation/diagnostic imaging or revision owing to recurrent instability. Data

were independently extracted by 2 authors (M.A., B.S.) with review of discrepancies by a third author (J.E.). Coleman methodology scoring was performed independently by 2 authors (M.A., B.S.); this is an assessment tool scored out of 100 points commonly used in reviews of orthopedic clinical outcome studies, with a higher score indicating that chance, bias, and confounding factors were avoided.²⁴

Statistics

All statistical tests were performed with a standard software package (STATA 13.1; StataCorp, College Station, TX). Descriptive data were generated for Coleman quality scores and study demographics. Among the included studies ($n = 9$), a random effects meta-analysis using the DerSimonian and Laird method was created to determine the effect of graft type on postoperative failure rates. Owing to inherent differences in study design, separate analyses were performed for all studies and separately for randomized and nonrandomized studies. Effect heterogeneity was assessed using the I^2 measure, and a value of $<50\%$ was defined a priori as acceptable for reporting of pooled failure rates. The meta-analysis was repeated with adjustment for mean patient age, percentage of male patients, reporting quality (Coleman score), or duration of follow-up; none of the adjusted analyses had improved heterogeneity scores (I^2). Small study bias was assessed by funnel plot and Begg's test of bias. Bias owing to study reporting quality was assessed by noting correlation between failure rates and modified Coleman methodology scores.

Results

Reporting Quality and Risk of Bias

The mean Coleman methodology score was 63.3 (standard deviation, 8.6; range, 48-71), and reported failure rates of hybrid grafts did not correlate with Coleman scores (Pearson $r = -0.68$; $P = .21$). Interrater agreement for Coleman scores was excellent (interclass correlation coefficient = 0.96). The most

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Published studies describing primary ACL reconstruction	Studies not directly involving the ACL reconstruction
Description and direct comparison of ACL reconstruction with autograft and hybrid autograft/allograft tissue	Animal studies In vitro studies
Postoperative data available on graft failure rates	Reviews Use of artificial ligaments Surgical technique articles Extraphyseal ACL reconstructions in pediatric patients Studies on hybrid ACL fixation Revision ACL reconstructions

ACL, anterior cruciate ligament.

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