

Systematic Review

Anterior Cruciate Ligament Graft Removal Versus Retention in the Setting of Septic Arthritis After Reconstruction: A Systematic Review and Expected Value Decision Analysis

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Purpose: To provide further guidance on the optimal decision between anterior cruciate ligament (ACL) graft removal versus retention in the setting of septic arthritis following reconstruction using an expected value decision analysis. **Methods:** A systematic review and expected value decision analysis and sensitivity analyses were performed to quantify the clinical decision. A decision tree was created with 5 outcomes of interest: nonoperative complications, revision surgery, early reoperation, late reoperation, and “well.” Pooled probabilities of each outcome were generated through a systematic literature review. We included only peer-reviewed studies, published in English, with at least 6 months of follow-up. One hundred randomly selected volunteers were given descriptions of the clinical scenario, the 2 treatment options, and outcomes of interest. Patients younger than 18 and older than 50 years and those previously treated for either ACL injury or septic arthritis, or both, were excluded from the analysis to minimize bias. These hypothetical patients indicated preferences for each outcome on a visual analog scale and responses were averaged to generate overall “utility values.” Fold-back analysis summed products of pooled outcomes probabilities with respective averaged utility values. The resulting overall expected values for graft removal and debridement were compared, with the highest expected value considered to be superior. We then performed 1-way sensitivity analyses to mitigate sample bias. **Results:** Fold-back analysis revealed graft removal to be strongly favored over retention, with overall expected values of 17.2 and 8.64, respectively. The most important contributor to the difference in overall expected values was late reoperation (8.59 vs 2.50 for removal and retention, respectively). Despite adjustments made to the rates of revision and early reoperation during the 1-way sensitivity analyses, graft removal remained the optimal strategy. **Conclusions:** This expected value decision analysis revealed that ACL graft removal was strongly favored by patients over graft retention in the setting of post-operative septic arthritis when consideration was given to the probabilities of wellness, nonoperative complications, revision surgery, early reoperation, and late reoperation. Sensitivity analysis revealed that although variation in rates of other outcomes did not impact this preference, the rate of late reoperation had a substantial impact. Only a sizable increase in the probability of late reoperation (from 0% to 60%) after graft removal would cause potential patients to favor graft retention. **Level of Evidence:** Level IV, systematic review and decision analysis.

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The management of septic arthritis following anterior cruciate ligament (ACL) reconstruction is controversial.¹ Although some advocate for graft removal,²⁻⁶ especially for allograft, other authors report good clinical results following graft retention.⁷⁻¹⁵ Supporters of graft removal note that there is an increased risk of recurrent or persistent infection, reoperation, and/or functional ACL deficiency with retention.^{11,13,15-18} However, studies in favor of graft retention note that with early and thorough debridement, grafts may be successfully retained with low recurrence of infection and retained functionality.¹²

Septic arthritis following ACL reconstruction is a rare complication.^{19,20} As a result, studies investigating graft retention, debridement, or both are conflicting and largely inconclusive.¹ A survey of sports fellowship

directors found that the majority of surgeons prefer graft retention, even in the setting of allograft.¹

The nature and rarity of septic arthritis following ACL reconstruction makes evaluation of the outcomes following the various proposed treatments difficult. Studies are often retrospective, underpowered, and noncomparative.^{11,13,15-18} Furthermore, although patient-centered outcomes are becoming increasingly appreciated in orthopaedic literature, patient expectations and preferences are often not factored into decision making.

Expected value decision analysis is a tool that has been previously established in orthopaedic literature and can serve to elucidate an optimal treatment strategy in complex scenarios in the face of limited evidence.^{21,22} The probabilities of various patient-centered outcomes following opposing procedures are pooled through a review of the literature and combined with the patient value assigned to each outcome, yielding a quantitative overall expected value for each of the opposing clinical scenarios. A sensitivity analysis can then qualify the threshold for selecting a specific treatment.

The purpose of this investigation was to provide further guidance on the optimal decision between ACL graft removal versus retention in the setting of septic arthritis following reconstruction through an expected value decision analysis. We hypothesized that when presented with the probabilities of each of the outcomes, patients would more strongly prefer graft removal given our finding of generally greater reoperation rates with retention.^{2,6,23}

Methods

The authors performed a systematic review and standard 5-step expected value decision analysis, which has been previously described and validated in orthopaedic literature.²⁴⁻²⁶ This includes (1) establishing a decision tree for a clinical question, (2) determination of outcome probabilities for the various branches, (3) assigning patient utility values to each outcome, (4) performing a fold-back analysis to ascertain the overall expected values for the respective clinical scenarios, and lastly (5) a sensitivity analysis of these overall expected values.

Step 1: Decision Tree

We created a decision tree to evaluate ACL graft removal versus retention for septic arthritis of the knee following reconstruction. Five outcomes were established for each treatment, including nonoperative complications, revision surgery, early reoperation, late reoperation, and finally a general state of wellness defined as discharge to full activity and no limitations within the catchment period of the study (Fig 1). Revision surgery entailed ACL reconstruction for

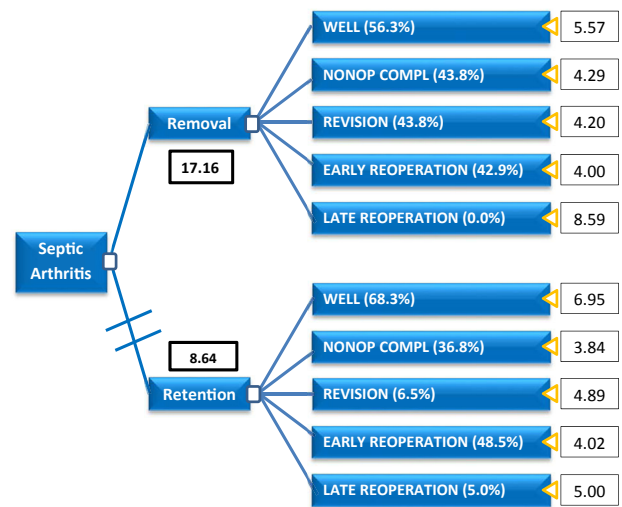


Fig 1. Decision tree depicting the 2 treatment options, possible outcomes with associated pooled probabilities, as well as individual and overall patient-assigned expected values resulting from fold-back analysis. (NONOP COMPL, nonoperative complications.)

symptomatic instability. Early reoperation encompassed repeat surgery for early recurrence or persistence of septic arthritis during the same hospitalization, whereas late reoperation occurred following discharge, most often for persistent subclinical infection or osteomyelitis. Nonoperative complications included those that required no further surgical management (postoperative stiffness, pain not attributable to infection, asymptomatic laxity), or conditions that may have required medical management without need for reoperation (e.g., deep venous thrombosis, pulmonary embolism, cardiopulmonary events, symptomatic laxity, pain attributable to osteoarthritis, or stiffness requiring manipulation under anesthesia).

Step 2: Outcome Probabilities

We performed a systematic review of the literature through PubMed, Medline, and Cochrane databases with combinations of the following search terms: (1) *anterior cruciate ligament reconstruction*, (2) *post-operative septic arthritis/infection/osteomyelitis*, (3) *reoperation*, and (4) *graft retention/debridement/removal*. Studies included were (1) peer-reviewed clinical series of Level I to IV evidence, (2) published in English, (3) with at least 6 months of follow-up, (4) specifically reporting outcomes for the septic arthritis group patients with at least 1 outcome of interest following graft removal, retention, or both. Based on a preliminary literature review to help define inclusion criteria, 6 months of postoperative follow-up was found to be sufficient to capture most cases of both early and late reoperation for postsurgical infection. Case reports and articles that did not differentiate between outcomes following graft removal or retention were excluded from the analysis.

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