Ipsilateral Graft and Contralateral ACL Rupture at Five Years or More Following ACL Reconstruction

A Systematic Review

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Background: Injury to the ipsilateral graft used for reconstruction of the anterior cruciate ligament (ACL) or a new injury to the contralateral ACL is a devastating outcome following successful ACL reconstruction, rehabilitation, and return to sport. Little evidence exists regarding the intermediate to long-term risk of these events.

Methods: The present study is a systematic review of Level-I and II prospective studies that evaluated the rate of rupture of the ACL graft and the ACL in the contralateral knee following a primary ACL reconstruction with use of a mini-open or arthroscopic bone-tendon-bone or hamstring autograft after a minimum duration of follow-up of five years.

Results: Six studies met the inclusion and exclusion criteria. The ipsilateral ACL graft rupture rate ranged from 1.8% to 10.4%, with a pooled percentage of 5.8%. The contralateral injury rate ranged from 8.2% to 16.0%, with a pooled percentage of 11.8%.

Conclusions: This systematic review demonstrates that the risk of ACL tear in the contralateral knee (11.8%) is double the risk of ACL graft rupture in the ipsilateral knee (5.8%). Additional studies must be performed to determine predictors for these injuries and to improve our ability to avoid this devastating outcome.

Level of Evidence: Prognostic Level II. See Instructions to Authors for a complete description of levels of evidence.

Patients undergoing anterior cruciate ligament (ACL) reconstruction typically have good short-term results. Following postoperative rehabilitation and return to activity, one of the most devastating outcomes for the patient who has had an ACL reconstruction is a tear of the ACL graft in the ipsilateral knee or a tear of the ACL in the contralateral knee. This issue has been most extensively studied in terms of the graft in the ipsilateral knee. Multiple studies have demonstrated a rate of graft rerupture in the range of 2% to 6% after less than five years of follow-up17. The rate of ipsilateral ACL rerupture and contralateral ACL rupture is similar after short-term follow-up, with a risk of approximately 3%54.

Increased knowledge regarding the risk of additional ACL injuries after longer-term follow-up would assist in counseling patients with regard to the expected outcome of ACL reconstruction. This patient group is typically young, with expectations of resuming and maintaining their activities. While two-year results are important, patients really want to know how long the knee can maintain the activity level that they desire. Thus, results after five years or more are pertinent. The primary aim of the present systematic review was to compare the overall ipsilateral ACL rerupture rate with the contralateral ACL rupture rate on the basis of published prospective studies with a minimum duration of follow-up of five years. Our hypotheses

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are that the contralateral knee remains at equal or higher risk with longer-term follow-up and that both knees have increased failure rates in longer-term as compared with shorter-term studies.

**Materials and Methods**

**Literature Review**

A MEDLINE literature search was performed to identify all studies published from January 1, 1966, through May 1, 2009, in which the long-term outcomes of ACL reconstruction were evaluated. A search for articles containing the terms “reconstruction,” “follow-up,” and either “anterior cruciate” or “ACL” yielded 1381 results. The title, abstract, and full text were reviewed when the title or abstract suggested appropriateness of these publications. Studies that failed to meet the inclusion and exclusion criteria (see Appendix) were excluded. Both retrospective and prospective series were initially reviewed. The full-text versions of the resulting forty-two articles were obtained. Subsequent review led to the exclusion of twenty-two studies that were retrospective in nature, two that were repeat publications, and one that included patients who were represented at longer follow-up in another included study. The literature search is summarized in Figure 1.

A search of the Embase database was then performed with use of the same search strategy. The title and abstracts of the resulting 974 studies were reviewed, and 933 papers were excluded in the same manner as in the MEDLINE search. Thirty-six of the remaining forty-one articles had previously been identified in the MEDLINE search. The full text of the remaining five articles was obtained, and four of those studies were excluded because they were retrospective. A Cochrane search did not demonstrate previous reviews of this topic.

The bibliographies of the remaining eighteen studies were reviewed, and no additional manuscripts meeting the criteria were identified. Twelve papers were excluded as they did not mention ipsilateral and contralateral failure rates. The remaining six papers constituted the data used in the following analysis. All papers included prospective (Level-I or II) data and had a minimum duration of follow-up of five years. The study by Drogset and Grøntvedt included two groups: one with and one without a ligament-augmentation device. For the purpose of the present study, both groups were used to determine the contralateral rupture rate. Only the group without a ligament-augmentation device was utilized to determine the ipsilateral rupture rate.

**Data Extraction**

A templated evidence-based medicine literature-review form was utilized to assist in data collection. Extracted data included demographic characteristics (age, sex, and body-mass index), graft choice, surgical technique, rehabilitation details, duration of follow-up, and ACL graft and contralateral ACL failure rates. Data were extracted by two authors (R.A.M., W.R.D.) independently, and discrepancies were resolved by consensus.

**Statistics**

Heterogeneity was assessed qualitatively by comparing the populations and designs of individual studies as well as quantitatively with use of a chi-square test. In order to account for between-study variation (heterogeneity), a random-effects model was developed in Review Manager version 5 (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark), which uses the method of DerSimonian and Laird to calculate an overall pooled estimate of effect. This method uses an inverse-variance approach to adjust the study weights.
according to the extent of heterogeneity present among the varying effects reported in the individual studies.

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**Results**
The six studies that were identified during the literature review included one randomized controlled trial,²⁵ and two prospective cohort studies comparing the outcomes of ACL reconstruction with bone-patellar tendon-bone autografts with those of reconstruction with hamstring tendon autografts, one randomized controlled trial comparing the outcomes of ACL reconstruction with and without the use of a ligament-augmentation device,⁶ and two prospective reports describing the outcomes of ACL reconstruction at a minimum of five years postoperatively.⁴,⁵ The study involving the augmentation device only included the group without the device for determination of the ipsilateral failure rates.

**Demographic Characteristics**
The mean age at the time of reconstruction for the 2026 included patients was 23.4 years, with the mean age in the six studies ranging from twenty-three to twenty-seven years. Overall, 67% of the patients were male, with the percentage in the six studies ranging from 45% to 72%. The time from injury to ACL reconstruction varied considerably between the studies. In all studies, ACL reconstruction was performed with use of autograft and all-arthroscopic, arthroscopic-assisted, or two-incision mini-arthrotomy techniques. The exclusion criteria varied among the studies, but all studies excluded knees with multiple ligamentous injuries other than low-grade medial collateral ligament injuries. Demographic information is detailed in Table I.

**Rehabilitation**
All reports included details on the rehabilitation protocol. Immediate full weight-bearing was allowed in all studies. Postoperative extension bracing was utilized in two studies for time periods ranging from one to three weeks. A table in the Appendix details the protocols for each study.

**Follow-up**
All studies had a minimum of five years of follow-up after ACL reconstruction. The mean duration of follow-up ranged from five to fourteen years.

**Ipsilateral Rerupture Versus Contralateral Rupture**
The ipsilateral ACL graft rupture rate ranged from 1.8% to 10.4%, with a pooled percentage of 5.8%. The contralateral ACL injury rate ranged from 8.2% to 16.0%, with a pooled percentage of 11.8%. An annualized rate of injury was 0.73
for ipsilateral tears and 1.69 for contralateral tears (Table II). A sensitivity analysis was performed to determine if the large sample size of the study by Shelbourne and Gray was overly influential, and the pooled estimates were similar with and without this study included in the model. The results of the individual studies are listed in Figure 2, along with a forest plot that graphically displays the point estimates on a common scale surrounded by the 95% confidence interval.

**Discussion**

An ACL graft rupture or a new ACL rupture on the contralateral side remain among the most devastating complications.
following primary ACL reconstruction. Patients are greatly dismayed to face repeat surgery and the long process of rehabilitation after having previously successfully completed this process. Educating patients with regard to the risk of these complications is important following the treatment of an ACL injury.

We hypothesized that the rate of ACL graft rupture is greater than historical rates that have been reported after shorter follow-up and that the contralateral ACL is also at equal or greater risk after a minimum of five years of follow-up. Our hypothesis was supported by this systematic review of Level-I and II studies with a minimum duration of follow-up of five years. In our review of the literature, we identified only six Level-I and II studies that evaluated ipsilateral and contralateral injury rates after a minimum of five years of follow-up, but the findings of the six studies were consistent. The contralateral knee is at greater risk than the ipsilateral knee is with continued follow-up. Our findings demonstrated that, after a minimum of five years of follow-up, the risk of an ACL tear in the contralateral knee (11.8%) is approximately twice as high as the risk of an ACL graft rupture in the ipsilateral knee (5.8%).

A study of this type has a variety of strengths and limitations. One limitation was the difficulty of ensuring that all ipsilateral and contralateral injuries were identified. If some injuries were missed, this would only increase the already worrisome rates of injury for these knees at a minimum of five years postoperatively. Another limitation exists because of the lack of data regarding age, sex, and activity level at the time of reinjury. Future studies involving a validated activity level (i.e., the Marx activity score\(^26\)) will be able to provide this information to advise patients and clinicians. The strengths of the present study include the high level of evidence and the novelty of the data collected. This information will make counseling patients on the true long-term risk of reinjury more appropriate.

Previous studies have identified a risk for ACL graft rupture in the 2% to 5% range at two years of follow-up\(^1-4,27\). The contralateral ACL tear rate has rarely been described, but, at shorter (two-year) follow-up, it has been identified as remaining closer to the ipsilateral ACL graft rupture rate\(^3\). Pinczewski et al. described a contralateral ACL tear rate of 12% (similar to the rate in our study) at five years of follow-up\(^28\) in a group of patients whom he had initially followed for two years after primary ACL reconstruction\(^4\).

The etiology of the increased risk for the contralateral knee as compared with the initially-injured knee following primary ACL reconstruction is unknown. Risk factors for bilateral ACL tear have been hypothesized to include notch width, sex, knee alignment, and/or genetic predisposition\(^29-31\).
None of these factors explain the increased risk for the contralateral knee. Clinicians hypothesize, without evidence, that the contralateral knee may represent some form of protection for the ipsilateral reconstructed knee. While this may be true, it does not explain why the ipsilateral knee and the contralateral knee have equal injury rates at the time of the two-year follow-up whereas the contralateral knee has double the risk at more than five years of follow-up. This increased risk for the contralateral knee could result from a lack of rehabilitation of the contralateral knee that was deconditioned during the recovery from the ipsilateral knee surgery. The increased contralateral risk may be multifactorial, and it is difficult to determine predictors that could be modified to prevent these injuries. Long-term prospective longitudinal studies will need to be performed to identify predictors for these contralateral injuries. An analysis of this type is not possible in a systematic review such as ours. The overarching goal is to be able to identify strategies that will decrease the risk of injury in both knees. This may include activity modification, rehabilitation protocol modification, return to sports training modification that emphasizes training the contralateral knee, or other yet unidentified approaches.

This systematic review of Level-I and II studies with a minimum of five years of follow-up that identify ipsilateral and contralateral injury rates after primary ipsilateral ACL reconstruction demonstrates a contralateral ACL tear rate that is double (11.8%) that of the risk of ACL graft rupture in the ipsilateral knee (5.8%). This risk increases with time compared with two-year follow-up studies. Additional studies with a high level of evidence must be performed to determine predictors (age, sex, activity level, type of sport) for these injuries and improve our ability to avoid this devastating outcome.

**Appendix**

Tables showing inclusion and exclusion criteria and rehabilitation milestones are available with the online version of this article at jbjs.org.

**References**


