

[Orthopaedic Surgery]

Postoperative Infection After Anterior Cruciate Ligament Reconstruction

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Context: Infection after anterior cruciate ligament reconstruction (ACLR) is uncommon; if it occurs, it can lead to disastrous complications.

Objective: To analyze post-ACLR infections and identify related complications to provide the most effective treatment protocol.

Study Design: Clinical review.

Level of Evidence: Level 4.

Results: Among approximately 1850 ACLRs performed by a single surgeon over the past 20 years, 7 cases of post-ACLR infection were identified (incidence, 0.37%). Five patients presenting with low-severity infection were successfully treated without any complication or residual functional disability. The remaining 2 patients, although successfully treated, presented with minor residual limitations. From a literature review, 16 studies including 246 cases of infection were reported among 35,795 ACLRs, making the rate of infection 0.68% (range, 0.14%-2.6%).

Conclusion: With proper treatment protocols, post-ACLR infection is rare but can compromise outcomes.

Keywords: ACL; knee; articular infection; septic arthritis

Infection after anterior cruciate ligament reconstruction (ACLR) is relatively uncommon.^{17,27,28} However, when present, it becomes a disaster due to its dramatic consequences, such as graft failure, arthrofibrosis, and articular cartilage loss, and may even require graft removal.^{5,7,9} According to an ongoing study in the United States, the incidence of ACL injury is roughly 1 in 3000 people per year, and an estimated 200,000 ACLRs are performed annually.¹⁸ Most intra-articular post-ACLR knee infections are acute (<2 weeks) or subacute (>2 weeks to 2 months).⁶ Full-thickness cartilage lesions, diffuse chondral thinning, degenerative arthritis, and osteomyelitis are severe sequelae of knee sepsis.^{6,11} Since cartilage loses more than half of its glycosaminoglycan and collagen within 7 days from the onset of infection,⁶ early diagnosis and prompt aggressive treatment are crucial to avoid potentially dramatic sequelae.

Most patients understand the possibility of complications after surgery. Sometimes, despite offering adequate treatment, an experienced surgeon and his or her patient might face a

dramatic postsurgery infection. The purpose of this study was to review the database of a single institution over the past 20 years to identify and analyze the total number of post-ACLR infections and associated complications. A comprehensive literature analysis was also performed, with the aim of providing data on the incidence, risk factors, causes, complications, and the most efficient treatment protocol after post-ACLR infection.

METHODS

A comprehensive review of the authors' institution's database was performed to identify and analyze all reported post-ACLR infections during a 20-year period (January 1993-December 2013). All reported complications were collected and analyzed.

To provide an updated key reference point, a thorough search in PubMed, MEDLINE, and EMBASE databases for published articles on post-ACLR infection was conducted. English-language articles concerning "ACL reconstruction" or "post-ACLR

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The authors report no potential conflicts of interest in the development and publication of this article.

DOI: 10.1177/1941738115618638

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infection" published from January 2002 to December 2013 were included. Level 1 through 4 evidence studies were included, while animal and/or experimental studies were excluded. Each author conducted an independent quality appraisal of the included studies, identifying strengths, weaknesses, and biases, and then reached consensus regarding their values.

RESULTS

Of 1850 ACL reconstructions performed, 7 patients presented with post-ACLR infections, raising the total reported incidence to 0.37% (see Table 1 in the Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>). Four patients presenting with low-severity infections were successfully treated with commonly utilized antibiotic protocols^{5,6,10,26,29} without any complication or residual functional disability. The remaining patients, although treated successfully following literature guidelines,^{5-7,10,17} presented with minor residual limitations correlated with a decrease of range of motion (see Table 1 in the Appendix).

The literature search identified 16 articles on post-ACLR infection published during the past decade: 2 studies^{1,14} were level 2, 6 studies^{3,4,12,16,21,23} were level 3, and 8 studies^{5,6,10,11,22,24,25,27} were level 4 (Tables 2-5 in the Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>). Among 35,795 ACLRs in the reviewed studies, 246 infections were identified, resulting in a mean incidence of 0.68% (range, 0.14%-2.6%).

DISCUSSION

Septic arthritis after ACLR is a rare and potentially disastrous complication, leading to dramatic consequences for the patient such as graft failure and arthrofibrosis (see Figure 1a-d, in the Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>) and may even require graft removal.^{5,7,9} A reduced total range of motion might be a consequence of postinfection fibrosis; however, loss of flexion or extension is also reported after ACLR without the presence of postsurgery infection.¹⁵ The incidence of post-ACLR infections over a period of 20 years was 0.37%, but microbiological examination identified pathogenic microorganisms in only 2 cases. The infections were successfully treated following commonly utilized antibiotic protocols^{5,6,10,26,29}; however, 3 of these patients presented with minor residual limitations in range of motion (see Table 1 in Appendix).

Currently, post-ACLR infection is considered multifactorial, since ACL grafts act as a foreign body and pathogenesis is universal. Other studies have attributed hematoma at the tibial tunnel as an origin of infection in subacute and late cases (see Table 3 in the Appendix).^{4,6,10,11,21} The reported mean time of onset of infection from index surgery is between 7.5 and 61.7 days (see Table 4 in Appendix). Grafts can act as the nidus for infection because they act as a foreign body.^{4,10,11} Incidence of infection in allograft,^{3,12,27} autologous hamstring, and bone-patellar tendon-bone (BPTB) grafts^{3,4,12,27} is between 0.44% and

1.2%, 0.57% and 1.44%, and 0.0% and 0.49%, respectively. Autologous hamstring tendon graft is more prone to infection as compared with BPTB graft.⁸ Another predisposing factor is the extended operative time of double-bundle compared with single-bundle ACLR.¹³ However, no significant time differences between double-bundle and single-bundle groups have been reported.³⁰ Apart from the risk factors provided in Appendix Table 3, the literature^{2,19,20,26,29} reports: operative time, tourniquet inflation time, contaminated sterile inflow cannula, contamination of the used autograft during operation, concomitant open surgical procedures, increased foreign body load (suture material or hardware), and use of a drain. The most commonly found pathogens in synovial fluid culture are coagulase-negative staphylococci, *Staphylococcus aureus*, and *Propionibacterium*; among coagulase-negative staphylococci, *Staphylococcus epidermidis* is the most frequently isolated.^{4,6,10,26,27}

Serial arthroscopic lavages and intravenous antibiotics with graft retention remain the most efficient treatment protocol, with

- Empirical intravenous antibiotic therapy at the time of presentation: intravenous ceftazidime (2 g/8 h) and vancomycin (1 g/12 h)²⁴, cefazolin,⁴ or flucloxacillin (6 × 1 g/d) and gentamycin (320 mg/d).¹¹
- Pathogen-specific antibiotics after culture and additional cultures during surgery. Intravenous antibiotics change to culture-sensitive oral antibiotics as soon as the C-reactive protein levels have nearly normalized (<1 mg/mL)⁷ for 6 weeks or until normalization of clinical and laboratory parameters. Average duration of intravenous antibiotics ranges between 17.3 days and 6 weeks, followed by oral administration for up to 3.2 months (see Table 5a in Appendix).^{1,4,6,10,11,21,24,25,27}
- Arthroscopic debridement and lavage: extensive arthroscopic removal of necrotic tissue with a shaver, as near total synovectomy as possible, debridement of fibrinous exudates of the graft's surface, arthroscopic lysis of fibrous adhesions, and extensive pulsatile lavage with 10 to 15 L of saline. Additional lavage needed if clinical and laboratory parameters are not satisfactory (see Table 5a in Appendix).^{1,3,6,10,21,24,27}; graft removal resulted in 0% to 34% of patients in 12 studies (see Table 5a in Appendix).^{1,3,4,6,10-13,16,21,24,25,27}
- Concomitant open incision and drainage through old arthroscopy scars and meniscal repair portals at the same time as arthroscopic lavage (in cases of complicated or infected wounds) to avoid extra-articular fluid collection and eliminate infection.²⁵ The wounds should be left open with only a sterile dressing applied to promote secondary wound closure.²² Continuous irrigation drains in the joint may be used for 2 days.²¹
- Immediate graft removal should be considered if the graft is unstable, resulting in a nonfunctional ligament during clinical examination and arthroscopic evaluation and causing instability or block. It should also be considered if the diagnosis is *Staphylococcus aureus* and the treatment has

been delayed for more than a few days after the onset of the symptoms.^{10,25,28}

Ten studies^{1,4,6,10,11,16,21,22,24,25} (see Table 5b in Appendix) reported satisfactory follow-up with the most effective treatment protocol. Lachman test was negative in 54.5% to 100% of patients at a mean final follow-up of 11.7 to 60 months.^{1,4,6,16,21,24,25} Mean differences in KT-1000 arthrometer measurements between control and infected groups ranged from 1 to 5 mm at a mean 21 to 102.5 months.^{1,4,6,10,11,16,21,22,24} Of 142 infected patients, 47 had a flexion deficit ranging from 6° to 30°; 26 patients had an extension deficit ranging from 3° to 5°.^{1,4,6,10,11,16,21,22,24} Mean Lysholm, Tegner, and International Knee Documentation Committee (IKDC) subjective scale values were variable (see Table 5b in Appendix)^{6,10,11,15,16,22,25}; other complications were reported to occur (see Table 5c in Appendix).

CONCLUSION

Infection after ACLR is a relatively infrequent but devastating complication for patients. Better knowledge of the proper treatment protocols will contribute to improved quality of care for patients.

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