



# Infection after reconstruction of the anterior cruciate ligament

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## Abstract

**Aim:** Postoperative infection after the anterior cruciate ligament reconstruction (ACLR) can destroy the knee cartilage, necessitate graft removal, and cause arthrofibrosis, instability, limitation of motion, chronic pain, and disability. While being an uncommon complication, the actual number of infected patients might be rather high due to a large number of operations performed. As the operation is usually indicated in young, healthy, and active individuals, failure to achieve the expected improvement, due to complications, is perceived as much graver. The purpose of this study was to analyze the infecting organisms in patients that underwent ACLR at our institution, a tertiary care center, for precise microbiological diagnosis and bacterial susceptibility and resistance to antibiotics.

**Methods:** The rate of infection, the infecting organisms, the antibiotic susceptibility, and the resistance were analyzed in 1,395 patients that underwent ACLR using descriptive statistics.

**Results:** Three patients (0.93%) were diagnosed with a postoperative infection; all underwent arthroscopic debridement and lavage. All infections were caused by *Staphylococci* [3 *Staphylococcus aureus* (*S. aureus*, all oxacillin sensitive), 6 coagulase-negative *Staphylococci* (3 oxacillin resistant)]. No gram-negative, gastrointestinal tract bacteria, fungal or polymicrobial infections were detected. Thirty eight and a half percent of patients had returned to previous or near previous levels of activity.

**Conclusions:** Preventing infection by controlling risk factors, prophylactic antibiotics, proper surgical preparation, and surgical technique is mandatory. When infection does occur, rapid recognition and prompt treatment are necessary to avoid irreversible damage to the knee joint and the need for graft removal. Despite appropriate treatment, the functional outcomes were inferior to expected after an uncomplicated ACLR.

## Keywords

Anterior cruciate ligament reconstruction, postoperative infection, bacterial resistance, surgical complications



## Introduction

Since Hey Groves proposed an intra-articular repair with fascia lata for ruptures of the anterior cruciate ligament (ACL) in 1917 [1], the popularity of surgical procedures intended to treat anterior instability of the knee has grown considerably. Two hundred and fifty thousand ruptures of the ACL are reported annually in the US and reconstructions are performed in growing numbers [2]. While the incidence of postoperative infection reportedly is 0.14–1.7% [3], the actual number of infected patients might be rather high due to the large number of operations performed. Since the operation is usually indicated in young, healthy, and active individuals and intended to improve life quality, the indications for surgery are considered to be relative. In this situation, complications and failure to achieve the expected improvement are perceived as much graver. Septic arthritis might destroy the knee cartilage, necessitate graft removal, and cause arthrofibrosis, instability, limitation of motion, chronic pain, and disability [3–5]. The purpose of this study was to analyze the infecting organisms in patients that underwent ACL reconstruction (ACLR) at our institution, a tertiary care center, for precise microbiological diagnosis and bacterial susceptibility and resistance to antibiotics.

## Materials and methods

This retrospective study was approved by the institutional review board and a waiver of informed consent was granted. All medical record data were collected at one tertiary care center. The hospital information system was queried for all the patients that underwent ACLR at our institution between 2010–2020 and had positive post-operative tissue, synovial fluid, pus, wound, or blood cultures up to 6 months postoperatively or was diagnosed having a postoperative infection with negative cultures, using MDClone platform. Superficial wound infections were excluded. For each included patient all available positive cultures were retrieved from the microbiology laboratory. All cultures were analyzed for antibiotic resistance and susceptibility. Positive cultures that appeared later than 6 months after surgery were not included. Skin and epidemiological survey cultures (nose, rectum) were ignored and considered to represent the real infecting organism. All patients underwent an arthroscopic ACLR procedure. Ten patients (77%) received an autograft, 3 an allograft (23%). Three surgeons participated in 9 operations (69%), 2 surgeons in 3 operations (23%), and in 1 operation the data regarding the number of surgeons could not be found. No data was available regarding the length of surgery due to a change in computer systems at the institution.

One patient was previously operated on for a tibial plateau fracture on the same knee. One patient had revision surgery for a rupture of an old ACL graft. None had a previous infection in the same knee. One patient had a knee dislocation with a multiligament injury. Seven patients had an associated meniscal injury that was either debrided or sutured (5 medial meniscic, 2 lateral meniscic). None had risk factors for infection such as immune suppression, diabetes mellitus, renal failure, etc.

Patients not allergic to penicillin or cephalosporins received perioperative intravenous cefazolin. Allergic patients received clindamycin or vancomycin according to the surgeon's preference.

Functional outcomes and return to sports were assessed by extracting the needed information from the outpatient charts (1. returned to previous/near previous level; 2. returned to decreased level; 3. unable to return to sports). No specific questionnaires/knee scores were used.

## Results

One thousand three hundred ninety five ACLRs were performed at the institution during the 2010–2020 period (81.9% men). The average age of the patients ( $\pm$  standard deviation) was 26.91 ( $\pm$  9.61).

Thirteen patients (0.93%) were diagnosed with an intraarticular postoperative infection; all of them underwent arthroscopic debridement and lavage using the standard portals, mean of 20.3 ( $\pm$  11.7) days after the index operation. Ten had stage I intraarticular infection according to Gächter (77%), and 1 patient had stage II [6]. No staging information regarding 2 patients was available. None developed systemic sepsis. Eleven patients underwent complete synovectomy (85%), 1 patient partial synovectomy, and 1 patient no data was available. On average 1.23 arthroscopic debridement and lavage procedures were performed per

patient [11 patients 1 procedure (85%)], 1 patient 2 procedures, 1 patient 3 procedures. No data regarding the number of intra-articular synovial samples that were taken was available.

Nine patients (69.2%) had a positive wound, synovial fluid, or tissue cultures (Figure S1). Three had growth of *Staphylococcus aureus* (*S. aureus*, 33.3%), and 6 had coagulase-negative *Staphylococci* [*epidermidis*, *lugdunensis*, *capitis*; 66.7%]. Four patients had a clinical diagnosis of infection with sterile cultures (30.8%). All *Staphylococci aureus* were oxacillin sensitive. Out of the coagulase-negative *Staphylococci*, 3 were oxacillin resistant (50%). No gram-negative, gastrointestinal tract bacteria, fungal or polymicrobial infections were detected.

Debridement, lavage, and appropriate intravenous antibiotic treatment lead to complete clinical and laboratory resolution of the infection in all patients. All patients had long-term ambulatory follow-ups regarding functional outcomes and return to sports. The longest follow-up was 11 years. Five patients (38.5%) had returned to previous or near the previous level of activity. Five patients (38.5%) had returned to a decreased level of activity. Three patients (23%) were unable to return to sports, due to complaints of pain, insufficient ability to develop muscle strength, and limitation of motion (Figure S2).

## Discussion

As any operation intended to improve the quality of life, rather than reducing mortality or preventing serious disability, ACLR should be judged more strictly regarding complications and the rate of success. Preventing infection by controlling risk factors [7], prophylactic antibiotics, proper surgical preparation, and surgical technique is mandatory. When infection does occur, rapid recognition and prompt treatment are necessary to avoid irreversible damage to the knee joint and the need for graft removal. Gobbi et al. [5] reviewed the infection rate after ACLR; 0.37% of infections (7 patients) were found among 1,850 operations performed by a single surgeon. In a literature review, Gobbi et al. found reported infection rates of 0.68% (0.14–2.6%). According to the study of Gobbi et al. [5], 2/7 infected patients remained with functional limitations (29%), while in this study 8 out of 13 patients (62%) had functional limitations. Coagulase-negative *Staphylococci*, *S. aureus*, and *Propionibacterium* are the most frequently isolated organisms; among coagulase-negative *Staphylococci*, *S. epidermidis* is the most common. This study reports quite similar findings. Arthroscopic lavage and debridement with multiple samples that would provide the precise microbiological diagnosis and bacterial susceptibility, as was demonstrated, will enable recovery. Despite that, even with optimal treatment the functional outcomes were significantly inferior to what is expected after an uncomplicated ACLR. Early infection is caused by inoculation during surgery and it is impossible to overestimate the importance of proper patient preparation for surgery. Systemic factors that increase the risk for infection such as diabetes mellitus or renal insufficiency should be controlled in the best possible manner. Local factors such as previous injury of the same joint and revision surgery are known but naturally unavoidable. Proper perioperative antibiotics, sterile theater, skin preparation, draping, and surgical technique with minimal soft tissue injury are well-known subjects.

Approximately 30% of patients with a clinically definite infection had negative (sterile) synovial tissue or fluid or deep wound cultures. No clear explanation for this phenomenon is known but it is possible to hypothesize that at least in part of the cases, slow-growing bacteria were involved such as *Cutibacterium acnes*, or bacteria with a need for a specific medium for culture such as mycoplasma. Sterile cultures in joint infections are a well-known issue in orthopedics [8], Declercq et al. [9] found 22% of sterile results in total hip and knee prosthesis infections. Polymerase chain reactions are used to improve diagnostic accuracy, but this discussion is beyond the scope of this work [10].

The results of this study should be interpreted in light of certain limitations. The nature of the study used hospital data compounding our results. As this study retrospectively reviewed patients this could have been susceptible to several biases. Finally, it was possible to further analyzed functional outcomes.

## Abbreviations

ACL: anterior cruciate ligament

ACLR: anterior cruciate ligament reconstruction

## Supplementary materials

The supplementary material for this article is available at: [https://www.explorationpub.com/uploads/Article/file/10075\\_sup\\_1.pdf](https://www.explorationpub.com/uploads/Article/file/10075_sup_1.pdf).

## Declarations

### Author contributions

EK: Conceptualization, Investigation, Formal analysis, Writing—original draft, Writing—review & editing. GM: Formal analysis. AG: Formal analysis. YW: Formal analysis, Writing—review & editing. All authors read and approved the submitted version.

### Conflicts of interest

The authors declare that they have no conflicts of interest.

### Ethical approval

This study was approved by the Tel-Aviv Sourasky medical center institutional ethics committee (0826-20-TLV).

### Consent to participate

Patient's consent was waived due to the retrospective nature of the study.

### Consent to publication

Not applicable.

### Availability of data and materials

All data is digitally saved and available for review at the Tel Aviv Sourasky medical center data center (<https://www.health-tourism.com/medical-centers/tel-aviv-sourasky-medical-center/>).

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Not applicable.

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