

# Guidelines on Infection after ACL Reconstruction

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## Abstract

Infection after ACL reconstruction (ACLR) is a rare but disastrous event that increases the cost of treatment and affects the short and long term outcome. Clinicians must be aware of the best preventive practices and be knowledgeable regarding the early diagnosis and prompt management to minimise the complications following ACLR. Recent literature has identified the risk factors for infection after ACLR and has proposed recommendations for its management. This article reviews the recent literature and proposes a plan for prevention of infection and its treatment. Specifically, the use of Bone Patellar Tendon Bone graft in patients at a higher risk of infection and Vancomycin wrapping of graft are the two interventions that can reduce the risk of infection. A surgeon must have a low threshold for suspecting infection and early graft preserving arthroscopic lavage must be performed on suspicion of infection. Culture directed antibiotics must be given for 6 weeks following infection. Graft and hardware must be removed in patients requiring repeat debridement. Revision ACLR is offered only for those patients who report instability.

**Keywords:** Infection, ACL reconstruction, Prevention, Management.

## Introduction

Anterior cruciate ligament reconstruction (ACLR) is a commonly performed procedure. Infection after ACLR is rare, the overall frequency is less than 1%, but infection can affect the short term and the long-term outcome, besides increasing the cost of treatment and delaying the recovery. Clinicians must be aware of the best preventive practices and be knowledgeable regarding the early diagnosis and prompt management to minimise the complications following ACLR. Since infection after ACL reconstruction is rare, the scientific evidence is not complete for the various factors affecting the incidence of infection and its management and so the optimal preventive, diagnostic, and management strategies are unclear. We have reviewed the recent reports on ACL

infection from India and have described the guidelines on the treatment of infection after ACLR, prevention of infection, diagnosis, and management of infection after ACLR. The purpose of this review is to propose a practical algorithm for the prevention, diagnosis, and management, based on a review of recent literature and a recently published survey on the practice preferences of Indian arthroscopy surgeons. The recommendations have been listed in Figures 1-3.

## Epidemiology

The incidence of infection following ACLR is less than the incidence of infection in Trauma surgeries and Arthroplasty (1)(2,3). In Indian literature, the reported incidence varies from 0.02% (4) to 0.84%(5) with significant more incidence in double bundle reconstructions(5). Mishra et al, in prospective study with 1152 patients in a three-year period reported an incidence of 0.84% in Single Bundle ACL reconstruction and 2.52% in double bundle

reconstruction while Gupta et al reported an incidence of 0.018%. The reported incidence in the international literature is similar(3,6-8). The most common infecting organism reported are *Staphylococcus aureus* and *Staphylococcus epidermidis* (CONS, Coagulase Negative *Staphylococcus*), (7-10). However, often no organism is grown (4,7) and sometimes *Mycobacterium* (11), Fungal (12,13) organisms or other bacteria (14,15) have been isolated. Hence the knee aspirate must be analysed to rule out less common organisms as well.

## Prevention

### Patient factors

Prevention of infection begins with careful patient selection. Patient factors contributing to an increased risk of infection are the tobacco use(16), steroid injection to knee(4), and immunocompromised status like diabetes (3) or long term systemic steroid use. There is no literature support to describe management of ACL insufficiency in patients with an increased risk of infection. The current practice is to

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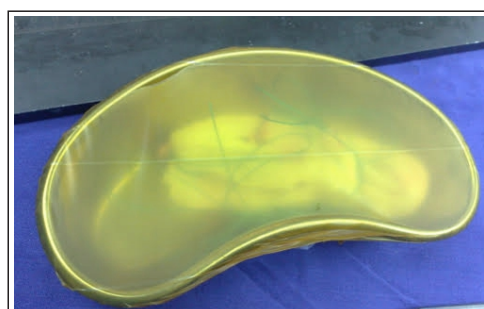
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Patient selection- Optimise Diabetes Mellitus, Ask for history of steroid injection • Many Case series.
Preparation- Hair clippers in OT • Expert Opinion
Prophylactic Antibiotics-First Generation Cephalosporins • Expert Opinion
Graft Preparation-Use Vancomycin wrap • Many cohort studies, experimental studies
Instrument Sterilisation-Autoclave or ETO • Expert Opinion, case reports
Instrument Cleaning- Remove adherent tissues • Case reports
Dropped graft- consider alternate graft source/wash with chlorhexidine or betadine • Experimental studies
Fixation devices - Avoid fixation with screw and sheath, limit foreign bodies in fixation • Case series
Post operative- Two doses of antibiotics • Expert Opinion

**Figure 1: Prevention**

perform ACLR in all patients in whom the procedure is indicated, irrespective of the increased risk of infection(17). Though there is no good quality evidence, a survey of Indian experts suggests an extended course of antibiotics in this population group(17). The most common infecting agents in infection after ACLR are skin commensals like *Staphylococcus aureus* and other staphylococcal species like *CONS* and hence a proper technique of skin preparation will reduce the risk of infection. Chlorhexidine has been shown to be superior to povidone iodine for surgical site preparation(18,19) and hair removal with clippers instead of shaving has been recommended for infection control in other orthopaedic procedures(20).



**Figure 4:** Wrapping the graft in an adhesive drape

Suspect infection in patients with knee swelling. • Expert opinion
Blood investigations must be done to rule out infection in knee swelling that is not warm • Expert Opinion
Knee aspiration must be performed in warm knee swellings • Expert opinion, case series
Synovial fluid WBC count is the most reliable indicator of infection • Case series
Arthroscopic Lavage with graft preservation must be performed in all cases with infection • Multiple Case reports
Though Coagulase negative staphylococcus aureus is the most common agent, other organisms have also been reported. Samples must be sent for Gram stain and stains for fungus and mycobacteria. • Multiple Case reports
Culture directed antibiotics must be given for 6 weeks • Case reports
Levofloxacin and Rifampicin is given when no organism is grown • Case report

**Figure 2: Diagnosis and Management**

### Operating room environment

In a study evaluating the efficacy of vancomycin wrap for graft, Perez-Preito et al have reported that graft may be contaminated during the process of preparation(21). It is reasonable to assume that the contamination must be improper handling of tissues or from the operation theatre air. Basic theatre discipline including limiting the number of persons inside the operation theatre, reducing the theatre door opening to the minimum required, good quality drapes and gowns, wearing mask at all times are basic actions to be performed at all times. Besides the operation room air, contaminated equipments can be a source of infection. Parada et al reported infections in a series of patients caused by contaminated Intrafix fixation systems(22). Tuman et al reported on a series of infection caused by contaminated tendon harvester(23). Thorough cleaning and sterilisation by autoclave or ETO is recommended for instruments. All instrumentation must be disassembled before cleaning and sterilisation(23). Camera covers are a good alternative if arthroscopic equipment cannot be sterilised. Though there are reports that camera covers can be compromised(24), its use has been satisfactory.

Graft and hardware must be removed in cases requiring repeat debridement • Case reports
Hardware removal, without graft removal can be performed in chronic cases • Case reports
Infection at the graft harvest site can be managed with local debridement without joint lavage • Expert opinion
After graft removal, revision ACL surgery is indicated only if patient has instability • Case reports Expert opinion.

**Figure 3: Graft and Hardware Management**

### Graft and Hardware selection.

In a meta-analysis of the risk of infection after ACLR, Bansal et al reported that BPTB graft has a lower rate of infection than Hamstring autograft(25). Brophy et al have also reported that the hamstring autograft is associated with a higher rate of infection(6). The authors have also suggested that BPTB autograft may be used in patients with a higher risk of infection. The reason for the increased risk of infection with hamstring autograft is not known. However Hurvits et al have reported that the use of screw and sheath configuration for fixation of hamstring autografts have a higher risk of infection than fixation without the screw and sheath configuration(26).

### Technical factors

ACL graft harvest and handling can contaminate the graft(27,28). The single most important recommendation in recent years has been pre-soaking antibiotics with vancomycin. The in vitro elution characteristics of Vancomycin from a Bovine Tendon was first reported by Grayson et al in 2011(29) and their clinical application was first described by Vertullo et al in 2012 (30). The authors described wrapping hamstring tendon autografts in a sterile gauze swab, which had been previously saturated with 5-mg/mL vancomycin solution. In a study group with 1135 patients, the incidence of infection was reported to be 4 infection in 285 patients (1.4%) in the subgroup without vancomycin treatment of graft and no infection was noted in the second subgroup with 870 patients in

whom graft was wrapped in vancomycin saturated graft. Since then many studies have reported that vancomycin soaking reduces the risk of infection(1,31–38) and vancomycin soakage does not affect the biomechanical properties of the graft (39,40) or increase the rate of re-rupture(41). The technique for the Vancomycin Soakage/ Wrapping has been described in detail(32). 100ml normal saline must be taken in a tray and mixed with 500mg Vancomycin. The graft is briefly immersed in this solution and then wrapped with a sterile gauze saturated with this solution and left to stand till the time of graft implantation. Vancomycin wrapping did not affect the function or return to sport either(42). Vancomycin wrapping is useful for both reducing the contamination during graft preparation(27) as well as acting as a drug-eluting substrate in the immediate post-operative period. Antibiotic prophylaxis also effective in reducing infection(43). Still there are concerns regarding the long term biomechanical properties, the cost and the risk of developing antimicrobial resistance(44). Indian arthroscopy surgeons have used gentamycin for soaking autograft and have faced no issues with long term biomechanics or toxicity(17). Yazdi et al have suggested the use of Gentamycin in irrigation solution to reduce the chance of infection.(45)

### **Dropped graft**

A graft that is accidentally dropped on the floor will be contaminated and will be a source of infection. Authors have described techniques to avoid this scenario by retaining the tibial attachment of the hamstring tendon during the stages of graft preparation and tunnel drilling(30). The tibial attachment may be released just before flipping the cortical fixation device, or before final tightening the graft while employing cortical fixation devices with adjustable loop. Another option is to keep the graft in basin covered by an adhesive dressing

(Fig 4). If a graft is dropped on the floor, the options for a surgeon are immersing the graft in a chlorhexidine gluconate solution or povidone-iodine solution. Though such antiseptic treatment does not completely eradicate the possibility of infection (28,46,47), this significantly reduces contamination of the graft(28,46,47) and the surgeon must decide on an individual case basis to decide if an alternate graft option is better.

### **Diagnosis**

Infection after ACL reconstruction may present in acute (<2weeks) or subacute (2weeks to 6 weeks) periods. Late infection, though possible is uncommon. Gupta et al have reported that the mean interval from the index ACL procedure to the onset of symptoms was 12.4 days (range 3–21 days)(4). In another series, Mishra et al reported an average interval of 15.12 days(5). In a systematic review, Wang et al reported an interval of  $16.8 \pm 10.5$  days(8). Though the most common agents are Staphylococcus species including MRSA and CONS (Coagulase negative staphylococcus including Staphylococcus epidermidis) (4,5), other rare organisms have also been described(11,12,48–50) and so it is important to send tissues for gram stain, fungal stains, and myco-bacterial stains and as well as cultures for anaerobes and fastidious organisms, besides culture for gram-positive cocci. The most common presenting complaints are a pain in the knee, warmth, swelling, and reduction in the range of movements. Fever is often present in patients presenting in the acute or subacute stage. Chronic infections present with a reduction in the range of movements. Discharging sinus in the graft harvest site indicates infection in graft harvest site, with or without coexisting articular infection. Physical examination findings include swelling and warmth in the knee. Swelling in an operated knee without warmth, pain or reduction in range of movements, in an

afebrile patient does not indicate infection(17). Serological findings include increased ESR, CRP, and elevated WBC count. However, these are not specific for infection and may not be seen in chronic infections. Moreover, these inflammatory markers are raised in all patients in the immediate post-operative period. Rhee et al studied ESR, CRP, Total WBC count and Neutrophil count in patients undergoing shoulder surgeries and reported that only CRP consistently returned to the normal value in 2 weeks in Cuff surgery and 4 weeks in Shoulder replacement(51). Nam et al, on patients undergoing Total knee replacement reported that the CRP value returns to the baseline in 81.4% of the patients in 4 weeks(52). We do not have similar data on patients undergoing Anterior Cruciate Ligament reconstruction. Synovial fluid aspiration must be performed in all patients with suspected articular infection and sent for WBC count, staining, and culture and sensitivity(17). The synovial fluid aspirate WBC count was found to be the most reliable test for the diagnosis of infection following ACL reconstruction. While the sensitivity of synovial fluid culture is affected by previous antibiotic treatment, synovial WBC count is not influenced and proved to be useful in the diagnosis of this uncommon complication (53). MRI has been used to identify the graft status, pockets of fluid, and to rule out osteomyelitis, though it is not directly contributing to the diagnosis of septic arthritis.

### **Management**

#### **Early arthroscopic debridement.**

Whenever the synovial fluid aspirate suggests infection or clinical examination is strongly suggestive of infection, arthroscopic debridement must be performed(17). Gachter's classification has been used by some authors for arthroscopic grading of infection, to assess graft management, and to offer a prognosis(54). Repeat arthroscopic



debridement may be needed.

Culture-directed antibiotics must be prescribed for a minimum of 6 weeks. However, no growth may be identified in culture following debridement (2,4). There is no data for the empiric antibiotic use following debridement of infected ACL. One case series with infection by coagulase-negative streptococci reported that a 6-week course of Levofloxacin and Rifampicin was effective for treatment (55).

### Graft management

Graft must be managed judiciously during arthroscopic debridement to eradicate infection. Graft material is an avascular tissue and hence can be a substrate for an infecting organism to thrive. Hence a graft that is necrotic, poorly tensioned or in a non anatomic position is debrided. When a graft is removed all associated implants are also removed and a thorough debridement of tunnels is performed. In cases where the graft is healthy, anatomic and is of proper tension, the surgeon has to carefully consider preserving the graft. Adequate debridement with graft preservation has been shown to be successful.

Pogorzelski et al evaluated patients with septic arthritis, after ACLR, whose grafts were either retained or removed. They have reported that graft retention showed superior postoperative results when compared with patients who underwent initial graft resection, although sub-analysis showed comparable outcomes between graft retention and reimplantation. So, graft-retaining protocols must be attempted in the treatment of infection after ACLR, graft reimplantation should be performed in cases where graft resection becomes necessary (56). Waterman et al have reported that the

risk of knee laxity did not differ between the graft retention group and the group in which the graft has been reimplanted. Hence, in cases with unhealthy graft or when repeat arthroscopic debridement is essential, graft may be debrided and staged revision ACLR may be planned at a later date (57). The Indian survey has reported that Indian arthroscopy surgeons prefer to do a revision ACLR only if patient develops instability (17). In chronic cases, hardware removal without graft removal must be performed.

Kusnezov performed a systematic review and expected value decision analysis and sensitivity analyses regarding the patient preference between graft retention and resection. He reported that "ACL graft removal was strongly favoured by patients over graft retention in the setting of postoperative septic arthritis when consideration was given to the probabilities of wellness, nonoperative complications, revision surgery, early reoperation, and late reoperation". However, sensitivity analysis revealed that variation in rates of other outcomes did not impact this preference, and only the rate of late reoperation had a substantial impact. In other words, patients chose graft removal with the principal intention of avoiding reoperation which might be necessitated by a persistent infection in a graft retention group. (58).

However, literature indicated that 43.8% of patients who have the graft removed later go on to have a revision ACL reconstruction compared with only 6.5% among those whose graft is retained (59) and hence the patient preferred treatment protocol would be a graft preserving procedure, as long the debridement is thorough, and the risk of reoperation is minimised. With optimal

treatment, a patient with an infection after ACLR can hope to have the outcome of an uncomplicated ACL reconstruction, in terms of stability, pain and prevention of articular degeneration. However the knee function is expected to be reduced (60).

### Conclusion

To summarise, the best management strategy in infections following ACL reconstruction is prevention. This review proposes to identify the patients with higher risk or infection, patients with diabetes mellitus, history of tobacco use, history of steroid injection, and opting for patellar tendon autograft in those patients, as well as using a longer course of antibiotics. Wrapping the graft with a gauze piece saturated with Vancomycin solution must be standard practice. There should be a low clinical threshold for suspecting infection and patients with warm swelling in the knee should be evaluated for infection. Synovial fluid aspiration is the investigation of choice and WBC count must be analysed. Though typically WBC count is more than one Lakh/mm<sup>3</sup>, a low WBC count does not rule out infection. Early arthroscopic debridement preserving the graft and implants must be followed by a culture directed antibiotic course for a minimum of 6 weeks. In cases requiring repeat debridement, and when the graft is unhealthy, the graft is debrided. Revision ACL reconstruction is indicated only if the patient develops instability.

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