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## QUESTION 6: How many arthroscopic procedures are reasonable for the management of an infected anterior cruciate ligament reconstruction (ACLR) prior to considering arthrotomy?

**RECOMMENDATION:** It is reasonable to treat acute infection of the knee following ACLR with arthroscopic debridement, repeating the arthroscopy up to six times, if necessary. The use of arthrotomy in the management of infected anterior cruciate ligament (ACL) cases is not well defined.

**LEVEL OF EVIDENCE:** Limited

**DELEGATE VOTE:** Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

### RATIONALE

Infection following ACLR is rare but can be a potentially devastating complication. However, if early appropriate surgical intervention is performed, the functional outcome may be comparable to non-infected cases of ACLR [1].

Historically, septic arthritis of the native knee was treated with open debridement and varying degrees of synovectomy, as described by Ballard et al. [2]. More recently, Riel et al. demonstrated arthroscopic irrigation and debridement with good results and since then, they have become a routine treatment option for an infected ACLR [3]. Several subsequent studies have described arthroscopic debridement as the initial treatment of choice for the management of septic arthritis of the knee [4].

Makhni et al. conducted a systematic review on functional outcomes following surgical treatment of the infected knee following ACLR. The studies included in the analysis demonstrated that up to six arthroscopic procedures were performed for the resolution of infection and symptoms [4].

Böstrom et al. examined outcomes following infected ACLRs. They described a standard treatment protocol of repeated arthroscopic debridements, with a mean of 3.7 procedures per patient, although the range was wide (1 to 11 procedures) in all patients [5]. Another systematic review by Saper et al. concluded that arthroscopic debridement with graft retention is an effective treatment of infection following ACLR. The mean number of arthroscopic procedures per patient in these studies was 1.5 (range, 1 to 4) [6].

Interestingly, Petersen et al. used a treatment approach according to the Gaechter classification system. In their study, they reported complete resolution of infection following ACLR in all patients without arthrotomy. For Gaechter stage I and II patients, the mean number of arthroscopic debridement's was 2.5, while in stage III patients it was 3.4. There were no stage IV patients reported [7]. Similarly, Gille et al. utilized a treatment algorithm based on the stage of infection according to Gaechter [8]. In patients with stage III or IV infections, medial and lateral

arthrotomy with near total synovectomy was performed after initial arthroscopy.

Torres-Claramunt et al. reported mean of 1.3 (standard deviation = 0.6) arthroscopic debridements in their study, and one patient required three procedures. The authors recommended repeated arthroscopic debridement, usually after 48 to 72 hours, if clinical and laboratory parameters do not improve [9]. Abdel Aziz et al. examined 24 patients with an infected ACLR, who required between 1 and 6 arthroscopic debridements before achieving complete resolution of infection [10].

The literature on the number of arthroscopic procedures needed prior to arthrotomy for an infected ACLR is sparse. Nevertheless, studies have shown that repeated arthroscopic procedures can give good results, although the number of procedures required varies. As a consequence, there may be no need to treat an infected ACLR with arthrotomy in most cases. However, in more severe and neglected cases (Gaechter stage IV), arthrotomy should be considered after initial arthroscopic evaluation of the joint.

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## QUESTION 7: What is the optimal duration of antibiotic treatment after surgical debridement of an infected anterior cruciate ligament reconstruction (ACLR)? Should this be altered when autograft or allograft is retained?

**RECOMMENDATION:** Following surgical debridement of an infected anterior cruciate ligament (ACL), antibiotic treatment should be administered for four to six weeks and can be discontinued upon resolution of clinical signs and normalization of laboratory parameters. The available literature does not differentiate between retention or removal of autograft or allograft.

**LEVEL OF EVIDENCE:** Consensus

**DELEGATE VOTE:** Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

### RATIONALE

ACLR surgery is an anatomically complex procedure with high success rates and low infection rates [1-3]. Nevertheless, the onset of an infection after reconstructive ACL surgery is a devastating complication that can cause, in a short period of time, a progressive degeneration of the articular cartilage, graft failure and loss of function of the knee [1-3]. A prompt diagnosis and correct management might reduce or even prevent these unfavorable outcomes [4]. The incidence of infection following ACLR ranges from 0.14% to 1.8% [5-8].

Arthroscopic debridement followed by antibiotic treatment is the preferred therapeutic approach in aiming to control the infection and save the graft. Indeed, satisfactory functional outcomes are achieved in several cases of septic arthritis following ACLR with a graft salvage rate of about 85% [9]. However, persistent infection, despite multiple arthroscopic debridements, requires graft removal and subsequent ACL revision surgery at a later stage [9]. The duration and the route of administration of antibiotic therapy, in particular when to switch from intravenous (IV) to enteral administration, remain controversial [4].

Even though the duration of antibiotic treatment can vary between 4 and 14 weeks, most authors agree that it should be administered for no less than 6 weeks [4,10-12]. IV administration is preferable for the first two to three weeks [3,8,13]. However, the microorganism cultured and the antibiogram together with the postoperative clinical and laboratory parameters dictate the precise duration of antibiotic treatment [14].

In a systematic review, Wang et al. [15] evaluated 17 articles that fulfilled the inclusion criteria of septic arthritis following ACLR. The authors found that the arthroscopic debridement with graft retention and IV antibiotics was the treatment of choice for infected ACLR in most studies, with delayed diagnosis and treatment being the greatest risk factors for graft removal and articular cartilage damage. Indeed, out of 176 patients included in all the studies, 86.9% (153/175) underwent arthroscopic debridement for septic arthritis. IV antibiotics were continued for an average period of 29.7 days [15]. IV antibiotics for an average of four to six weeks was recommended, which might then be changed to oral antibiotics as soon as the C-reactive

protein (CRP) levels drop to nearly normal values (< 1 mg/mL) [3,10,11]. Oral antibiotics were then administered for at least another 14 days until the CRP returned to normal [15].

Out of 176 patients present in all studies, 18.75% (33/175) underwent graft removal, but the optimal duration of antibiotic treatment was not clearly reported. In two studies, the revision surgery was performed 12 months or later after the infection had resolved [16,17]. However, in another study by Burks et al. the revision ACLR was performed within six weeks after the completion of the antibiotic therapy and after the laboratory values had returned to normal [18].

Mouzopoulos et al. [19] proposed the basic management protocol with graft retention based on IV antibiotic therapy over at least four weeks followed by oral antibiotic for two to four weeks. An extended IV antibiotic therapy was given only in patients who needed more arthroscopic lavages. However, the therapeutic management in case of graft removal or retention is not well distinguished.

Gobbi et al. [20] stated that serial arthroscopic lavages and IV antibiotics with graft retention remain the most effective treatment protocol, starting with empirical therapy at the time of presentation. IV antibiotics switch to culture-sensitive oral antibiotics as soon as the CRP levels have nearly normalized (< 1 mg/mL) for six weeks, or until normalization of clinical and laboratory parameters. The average duration of IV antibiotics ranges from 17.3 days to six weeks, followed by oral administration for up to 3.2 months [2,3,7,8,11,13,21-23].

Shuster et al. [24] created a detailed treatment algorithm in which the graft is preserved as long as possible. However, graft removal is considered in persistent infections after multiple revisions, in loosened fixation or in graft insufficiency. In patients undergoing debridement and irrigation, a chain of antibiotic (gentamicin) loaded beads was inserted, protruding through the wound to allow stepwise removal within approximately one week. Empiric antibiotic therapy (cephalosporin I or II combined with an aminoglycoside, clindamycin or rifampicin) is started and antibiotic treatment is re-evaluated every day and changed according to microbiological testing, if necessary. When patients show clinical