



## Septic arthritis of the knee following anterior cruciate ligament reconstruction

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### Abstract

**Background:** Knee septic arthritis after anterior cruciate ligament reconstruction is a rare but very serious complication. The purpose of this study is to evaluate the clinical course and outcome of a series of such patients.

**Methods:** Ten patients with knee joint infection after anterior cruciate ligament reconstruction were enrolled. Demographic data and information related to the surgical technique were collected. Onset time from index procedure, clinical and laboratory findings, interval between onset of symptoms and first debridement, number and type of operations were recorded. The latest status of patients and the relationship between onset time of symptoms with final results and also time interval between onset and debridement with the final results were also studied.

**Results:** Ten patients, all male, mean age 25(19-31) years, were followed for an average of 33 (18-112) months. Four patients had acute infection, 5 subacute and the remained one chronic infection. In subacute and chronic infections, patients often had not systemic symptoms. For each patient 2.3 times of joint debridement and lavage were performed. The graft was removed in 50% of cases. Increased erythrocyte sedimentation rate (ESR) and C – reactive protein (CRP) levels and synovial fluid polymorphonuclear (PMN) cells count were highly helpful in the diagnosis. Joint fluid culture was positive in 40% of the patients. In the latest survey, 20% had pain with vigorous activity, 30% had symptoms of instability and 20% had limited knee range of motion.

**Conclusion:** Because symptoms of infection may overlap with postoperative natural course, the diagnosis of this complication may require special attention. Early detection and timely intervention can lead to graft preservation and better final results.

**Keywords:** Septic arthritis, Anterior cruciate ligament, Reconstruction, Infection.

### Introduction

Infection following anterior cruciate ligament (ACL) surgery is an uncommon but potentially serious complication. The relevant literature consists of few series with small numbers of patients treated with management protocols ranging in aggressiveness

from arthroscopic irrigation to radical debridement with graft and hardware removal (1). The prevalence of infection following ACL reconstruction is very low and ranges from 0.14% to 1.74% (2, 3). Overall, septic arthritis following ACL surgery was caused by staphylococcal species in vast majority of cases (88%) (3-6). The diagnosis may not be easy and classic signs of knee sepsis can be masked by postoperative changes (7, 8).

Because of the small number of reported cases, it is difficult to determine risk factors, the success of different treatment options, and treatment results. However, optimal clinical management guidelines have not been completely established. Published recommendations have differed on graft retention, open versus arthroscopic treatment, type and duration of antibiotics, and time to revision (3-6,9). While some authors rec-

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ommend to remove the graft immediately (3, 4, 10), others remove the graft only in case of persistent infection (5).

To our best of knowledge, only a few articles have previously described the clinical presentation, treatment, and adverse consequences of septic arthritis following ACL reconstruction (1, 4, 9, 11). The aim of this study is to review clinical presentation and outcomes of a case series of these patients in our institute.

### Methods

The study was approved by institutional review board. This cross sectional study was conducted in knee surgery service of Shafa Orthopedic Hospital, Tehran, Iran. All patients with ACL reconstruction (with or without concomitant procedures) were included in this study. From June 2002 to January 2011, 1112 ACL reconstructions were performed. Among them ten patients were involved with septic knee arthritis following ACL reconstruction. No patient was excluded. The records of each patient were reviewed to identify previous or concomitant treatment to the affected knee, risk factors associated with ACL reconstruction, clinical symptoms at presentation, duration of symptoms before diagnosis and surgical debridement, operative procedures, type of graft fixation and graft preservation or removal.

All reconstructions were performed arthroscopically, with hamstring tendons and with single incision technique by the first author. Femoral tunnel was created in anatomic position through anteromedial portal. Tibial tunnel was carried out in anatomic footprint with the angle of 55 degree to joint axis plane. Femoral fixation was achieved with Endobutton (Smith & Nephew, Andover, MA) and graft was fixed in tibial side with bio-absorbable screw (Smith & Nephew, Andover, MA) and cortical staple.

One patient had meniscal repair, one had microfracture for cartilage lesion and another had high tibial osteotomy as concomitant procedures with ACL reconstruction. All procedures were performed using pneumatic tourniquet. All patients had taken prophylac-

tic antibiotic preoperatively and for 48 hours postoperatively.

Postoperative intra-articular infection was defined as a positive culture from a knee aspiration or a cell count consistent with intra-articular infection ( $\geq 10,000$  cells/mL,  $\geq 90$  % PMN) in patients with symptoms (progressive pain, fever, effusion, warmth) consistent with septic arthritis. After the diagnosis of infection, patients were placed on intravenous antibiotics and immediate irrigation and debridement. Standard rehabilitation for ACL reconstruction was allowed.

Patients were followed for at least 18 months. Overall treatment outcome was determined at the final follow up and included clinical interview and knee examination for pain, range of motion and stability.

### Results

All patients were male with a mean age of 25 years at the time of surgery (range 19-31 years) and mean follow up period of 33.4 months (range 18-112). The overall incidence of infection in our series was 0.9%. The average time to presentation after ACL reconstruction was 21 days (range 7-75). Four patients had acute (presented less than two weeks postoperatively), 5 patients had subacute (between 2-8 weeks) and one patient had chronic (more than 8 week) infection. Vast majority of infections presented between 7 to 20 days postoperatively. Mean delay between presentation and surgical treatment was 7.4 days. This delay in surgical intervention is a combination of delay in patient referral and delay in correct diagnosis. No patient had any comorbidity to increase risk of infection but one patient with acute infection had prolonged surgical time due to impaired operative setup.

All patients had knee pain, effusion, warmth and painful range of motion. Three out of 4 (75%) patients with acute infection had fever and general illness. While only one of six patients (16.7%) with subacute and chronic infection had these symptoms. The only patient with chronic infection had purulent discharge from proximal leg incision.

In laboratory tests, mean white blood cell (WBC) count was 6800 per mm<sup>3</sup> and differential count value of 76% of polymorphonuclear (PMN) cells. Mean erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels were 83.4 mm/hr and 24 mg/dl, respectively. Synovial fluid analysis revealed mean WBC count as 35,000 per mm<sup>3</sup> with 92% of PMN. Culture was positive in 40% of patients (one staphylococcus aureus, one coagulase negative staphylococcus, one acinetobacter and one pseudomonas).

Mean duration of antibiotic therapy was 7 weeks. Three patients had open irrigation and debridement and remaining 7 arthroscopic lavage and debridement. Mean number of operations were 2.3 procedures for each patient. In 4 patients continuous irrigation system was applied for minimum of 48 hours. In 50% of patients the graft was retained (3 out of 4 in acute group and 2 out of six in subacute and chronic group) and in another half was removed finally. In patients with excised graft, the delay time between initiation of infection symptoms and surgical debridement was more prolonged (8.5 days in compare to 6.6 days in graft retention group).

In final assessment 3 patients (30%) with excised graft had instability symptoms, 2 (20%) had knee pain and also 2 (20%) had limited range of motion (knee range of motion 0-120 degrees). The worst outcome was in patient with chronic infection who had tunnels osteomyelitis and another patient with acute infection by pseudomonas, both had knee pain and limited range of motion at final follow up.

### Discussion

Septic arthritis after arthroscopic ACL reconstruction is rare. Our study is a retrospective analysis of the patients who were treated for proven septic arthritis after an arthroscopic ACL reconstruction in our institution. Reports in the literature indicate an incidence of 0.14%–1.70% in patients undergoing arthroscopic ACL reconstruction (2, 6, 8). Our incidence of infection, i.e.

0.9%, is similar to the other reports in the literature.

Systemic host factors to increase risk of infection are not as prevalent in ACL surgery compared with other procedures because most patients undergoing ACL reconstruction are relatively young, active, and healthy (12). In our study no patient had any comorbidity to increase the risk of infection.

Local risk factors for infection include previous knee surgery or concomitant surgical procedures performed during initial ACL reconstruction, reconstructions with hamstrings graft, concomitant or previous meniscal repair, the use of a post and washer fixation of the graft on the tibia or the Endobutton femoral tunnel fixation were associated with increased risk of intra-articular infections (4, 12-14). In this study all of these factors were present and three patients had concomitant procedures with ACL reconstruction (one meniscal repair, one microfracture for cartilage lesion and one high tibial osteotomy). However, the role of secondary procedures in development of infection is not clear, as the existing studies have not performed a comparison between infected and control patients. Contamination through the surgical incision or the arthroscopic portals at the time of ACL reconstruction may be the most probable cause of an acute infection (6).

Infections have been classified as acute (presenting less than 2 weeks postoperatively), subacute (2 weeks to 2 months), and late (more than 2 months) and most of the patients have acute or subacute intra-articular knee infections after ACL reconstruction (2, 5). The mean time for development of infection following ACL surgery ranged from 8 days to 25 days (8). In our study the average time to presentation after ACL reconstruction was 21 days (range 7 -75 days). Except one chronic infection, all others were acute and subacute infections. Vast majority of infections presented between 7 to 20 days postoperatively.

Despite its low incidence, it is important to diagnose an infection properly and treat it without delay because of devastating conse-

quences, such as failure of the graft, loss of hyaline cartilage and arthrofibrosis (14). The cartilage loses more than half of its glycosaminoglycan and collagen within 7 days from the onset of infection. Full thickness cartilage lesions, diffuse chondral thinning, degenerative arthritis and osteomyelitis are severe sequelae of knee sepsis (2, 6)

In this study, diagnosis was performed at an average interval of 7.4 days (range 1 -20 days) from the onset of symptoms. McAllister et al (6) reported 4 cases of septic arthritis that all were diagnosed within 24 hours, while according to Indelli et al (3) in 5 cases, diagnosis was performed at an average of 7.5 days (range 2-20 days) from the onset of infection. This delay in diagnosis can affect final outcome adversely (3).

The classic clinical symptoms of septic arthritis – including swelling, rapidly progressive knee pain, local erythema and warmth accompanied by fever – was present, to some extent in all of our acutely presenting patients. But in most patients in subacute and chronic group clinical course was more subtle and general illness and fever were absent. The problem is the often indolent presentation of septic arthritis with moderately aggressive pathogens such as coagulase-negative Staphylococcus (1, 7, 8).

Markers of inflammation, such as the ESR and CRP were elevated and helpful in the diagnoses.

Elevated CRP has been invariably reported in patients with ACL postoperative infections; the mean CRP levels ranged from 2.6 to 12.3 mg/dl in the previous studies. Elevated levels of ESR have been similarly reported in the literature, with mean values ranging from 48 to 87 mm/hr (6, 14-16). Mean ESR and CRP levels were 83.4 mm/hr and 24 mg/dl in our study, respectively. Margheritini et al. (8) reported that CRP returns to nearly normal levels by postoperative day 15, which was faster than the ESR. Elevated levels of CRP beyond the postoperative day 15 or any secondary rise strongly point toward a septic etiology for the patient's symptoms. The authors concluded that the CRP is a more sensitive indicator of

postoperative septic complications (7, 11, 17).

The mean synovial WBC count has ranged from 49,400 per mm<sup>3</sup> in the study by McAllister et al (6) to 91,000 per mm<sup>3</sup> in the study by Indelli et al (3). Despite this variability in the absolute number of WBC in the joint aspirate, the differential count reveals mean values of 90% to 94% of polymorphonuclear (PMN) cells. The synovial fluid analysis revealed mean WBC count 35,000 per mm<sup>3</sup> with 92% of PMN in our study.

Positive synovial culture was reported between 14- 82% (16, 17). Several microorganisms are reported as causative agents, such as Staphylococcus aureus (most common cause), coagulase-negative Staphylococcus, or rarer agents like nonhaemolytic Streptococcus, Peptostreptococcus, Enterobacter species, and other anaerobic or gram-negative organisms (3- 6). Many cases of persistent septic knee arthritis are polymicrobial (2, 3, 12, 16). In our study synovial culture was positive in 4 cases in which two were Staphylococcus species.

There is a lack of consensus in the orthopedic literature concerning the specific treatment of septic arthritis of the knee following ACL surgery. Matava et al after sending a questionnaire to 74 surgeons found that five different treatments are proposed for severe infections (10). Most of the surgeons proposed initial debridement with graft retention. For resistant infection, 50% recommended hardware removal, and 36% selected graft removal as part of the treatment regimen (10).

Immediate surgical management has been proposed by several authors. Arthroscopic irrigation and debridement appear to be the most commonly used methods of initial management for patients with a septic knee following ACL surgery (1, 2, 4, 5). Most authors have attempted to retain the graft in the initial management of septic arthritis after ACL surgery, but removal of the graft at a later time was necessary in some persistent cases (1, 2, and 6).

For our patients we attempted to retain the graft in all patients but in 50% of cases be-

cause of persistence of infection, graft was finally excised. For each patient an average of 2.3 procedures of irrigation and debridement were performed.

Williams et al (4) removed 1 of 7 grafts because the graft appeared to be loose and nonfunctional. In 3 of the 6 knees with retained grafts, the infection persisted and a repeat procedure was performed. The graft was removed in another 3 cases and overall the graft was successfully salvaged in 3 of 7 cases (5). Indelli et al (3) attempted to retain all grafts. Repeated procedures were needed in 5 of 6 patients and 2 grafts were subsequently removed, and finally 4 of 6 grafts were retained (3). Other investigators were able to retain all implanted grafts (2, 6, 18). In contrast, Burks et al (12) proposed an aggressive protocol that included graft removal at the initial irrigation and debridement procedure. The four patients in this series had no recurrence of infection, and all underwent repeat ACL reconstruction (12). McAllister et al (13) reported that, despite the acute presentation of infections (8 to 18 days) and the immediate (within 24 hours) intervention, two to four repeated surgical procedures were necessary in each patient to control the infection and restore range of motion of the knee (13).

Graft removal during the initial procedure should be performed if the graft is loose and nonfunctional, if there is a delay in presentation and an ongoing infection has been untreated for more than a few days, if the articular cartilage seems to be already affected, if septic arthritis is persistent after the initial irrigation and debridement or if a virulent organism is present (3, 5, 19). The type of graft is another consideration; allograft contamination has been reported, and surgeons are more prone to acutely remove an allograft compared with an autograft (10).

Persistent septic arthritis following failure of the arthroscopic irrigation and debridement procedure with graft retention to control the infection are of particular concern. If the infection cannot be controlled by the initial procedure, the articular cartilage will be exposed to the detrimental effects of a per-

sistent infectious process for a prolonged period of time, and the avascular graft and hardware will provide substrate for biofilm formation, which may prevent eradication of infection (20).

### Conclusion

Even though septic arthritis after ACL reconstruction is a potentially devastating complication, our study suggests that with a prompt diagnosis of infection, within 2 weeks after surgery (acute phase), and early treatment consisting of intravenous antibiotics followed by an oral antibiotic plus thorough irrigation of the knee, ACL grafts can be saved with acceptable ACL function and reasonable clinical results.

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