

Septic arthritis of the knee following anterior cruciate ligament reconstruction

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Abstract

Septic arthritis of the knee is a rare complication after arthroscopic anterior cruciate ligament reconstruction, and the most appropriate treatment is unclear. All case series reported so far have been retrospective, and case numbers of septic arthritis have ranged from 4 to 11. From a consecutive case series of 1,283 patients who underwent arthroscopic anterior cruciate ligament reconstruction between January 1997 and May 2008, we report on 3 patients (0.23%) with post-operative septic arthritis. All patients had acute infection ("2 weeks), bacterial cultures showed *Staphylococcus* species in 2 patients, while the bacterial culture was negative in the third. All of them underwent immediate arthroscopic debridement and lavage with continuous irrigation, as well as antibiotic treatment. The results were evaluated with physical and radiographic examination, functional testing, KT-2000, Lysholm and Tegner scales. The infection was successfully eradicated without further surgical treatment and the ligament graft was retained in all patients. Follow-up, at an average of 33 months, revealed that the patients had full symmetric knee range of motion and no effusion. The average Lysholm score was 91 points. In the patient with a lower subjective score, radiographs demonstrated patellofemoral joint-space narrowing, which is most probably in correlation with his anterior knee pain problems and lower activity level. The 134 N KT-2000 arthrometer side-to-side differences averaged 13 mm. Their performance in the single-legged hop test gave excellent results. The goals of treatment for septic arthritis after anterior cruciate ligament reconstruction are, primarily, to protect the articular cartilage and, secondly, to protect the graft. Through early diagnosis and prompt treatment, the infection can be successfully eradicated, with stability of the knee and full range of motion achieved.

Introduction

Septic arthritis is a rare complication following arthroscopic anterior cruciate ligament (ACL) reconstruction.^{1,2} An incidence between 0.14% and 1.7% has been reported in published studies, all of which were retrospective.^{1,3,9} The treatment used was often not standardized and included various procedures (long-term application of intravenous antibiotics, constant irrigation, arthroscopic or open synovectomy with or without graft retention).¹⁰ The small number of reported cases precludes the determination of risk factors and selection of the most appropriate management. Common predisposing factors for joint infection (age, diabetes, chronic liver and kidney failure, rheumatoid arthritis and compromised immune system) are very rare in ACL reconstruction, due to the occurrence of an ACL rupture in younger and more active members of the population. *Staphylococcus aureus*, coagulase-negative *Staphylococcus* sp. and methicillin-resistant *Staphylococcus aureus* are isolated in 90% of cases, with *Streptococcus* sp., *Pseudomonas aeruginosa* and other gram-negative bacteria being responsible for the rest.¹¹

Historically, management of septic arthritis consisted of arthrotomy with open necrectomy.^{12,13} Since the advance and widespread use of arthroscopically assisted surgery, arthroscopic methods have become a successful alternative.^{14,15} The degree of bacterial infection has been suggested to be a decisive factor in the choice of treatment.¹⁶ Arthroscopic methods are successful in cases of acute and subacute infections (1-8 weeks). Open surgery is considered more appropriate in cases with a chronic infection and a thickened joint capsule. Gachter believes that septic arthritis after intra-articular joint fractures or an ACL reconstruction should be treated only with an open method.¹⁴

The aim of this retrospective study was to review our experience with septic arthritis following arthroscopic ACL reconstruction.

Methods

Between January 1997 and June 2008, 1,283 arthroscopic ACL reconstructions were performed by the senior author (MS). A retrospective review of ACL reconstructions was undertaken and patients who developed post-operative septic arthritis were examined. Patients included 3 men (0.23% incidence) with an average age of 31 years at the time of injury (Table 1). Clinical signs of the infection were present in all patients, a culture from the knee aspiration was positive in 2 patients, while aspirate and tissue cultures remained nega-

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tive in the third patient. The exclusion criteria was less than 1.9×10^9 white blood cells/mL in synovial fluid of the knee and negative bacteriological culture.

The time between the injury and arthroscopic ACL reconstruction was nine months. Following the injury and prior to the ACL reconstruction, arthroscopic meniscectomy and debridement of the ACL remains had already been performed in the first patient. The skin in the operative field was normal and without signs of infection in all patients. Prophylactic antibiotic was administered as standard. They received 1g of cefazolin prior to surgery and then 3 more doses post-operatively. Double-looped semitendinosus and gracilis tendon autograft was fixed in femoral tunnel with titanium interference screw and in tibial tunnel with resorbable interference screw in all cases. The second and the third patients required partial meniscectomy together with ACL reconstruction. A standard rehabilitation protocol was followed post-operatively, and included ice, active range-of-motion exercises, electrostimulation of the quadriceps muscle and full weight bearing with a range-of-motion brace. Patients were normally discharged from the hospital on the 3rd post-operative day, and were continuing the rehabilitation protocol 2-3 times per week on an outpatient basis. All the patients were rehabilitated according to the same accelerated protocol. A rehabilitation brace was used for three weeks post-operatively. The splint was not worn during the rehabilitation protocol or during the night. The importance of reaching full extension was emphasized from the beginning. The patients had to obtain an arc of at least 0° to 90° before they were discharged from the hospital. Closed

Table 1. Data on patients with knee infection following anterior cruciate ligament reconstruction.

Patient	Age (Years)	Sex	Prior knee surgery	Graft	Fixation	Additional procedures
1	23	Male	Med. meniscal resection	Hamstring tendon	RCI screws	None
2	25	Male	None	Hamstring tendon	RCI screws	Med. meniscal resection
3	48	Male	None	Hamstring tendon	RCI screws	Med. meniscal resection

Table 2. Treatment of post-operative infections following anterior cruciate ligament reconstruction.

Patient	Post-operative day	N. of procedures	Organism	Antibiotic	Hospital stay (days)
1	8	1	<i>S. aureus</i>	Cloxacilin	14
2	14	1	<i>S. epidermidis</i>	Cloxacilin/Clindamycin	15
3	2	1	Negative	Cloxacilin/Clindamycin	12

kinetic chain exercises were started immediately after the operation. The leg extension exercise against resistance in the arc of 45° to 0° was not allowed during the first six post-operative weeks. Running was allowed at eight weeks and contact sports at six months under 3 conditions: 1) no effusion; 2) full range of motion; and 3) obtained muscle strength of 90% compared with the contralateral side.

Clinical signs of infection developed in the early post-operative period in all patients. The first patient returned to our institution eight days after the reconstruction due to a painful swelling of the operated knee. The second patient came to a regular post-operative check-up 14 days after the procedure with all classical signs of local infection (swollen, painful knee, warmer skin around the joint and inflammation of the incision wounds). The third patient developed signs of infection on the 2nd post-operative day, that is, before he was discharged.

Standard diagnostic procedure was performed in all patients, and included history with examination, laboratory tests, radiographs, as well as bacterial and biochemical analyses of aspirated synovial fluid. Hemocultures were taken only in the third patient (who had an elevated body temperature); however, these remained sterile. The mean peripheral white blood cell count was 10.8 (x10⁹/L). All patients had elevated levels of C-reactive protein (CRP) (mean 55.8 mg/L) and erythrocyte sedimentation rate (ESR) (mean 57 mm/h). Gram stains of the synovial fluid revealed gram-positive cocci in the first 2 patients; the Gram stain of the third patient showed numerous white blood cells, but no bacteria. Empirical therapy with parenteral cloxacillin (2 g / 6 h) and immediate arthroscopy were instituted in all patients (Table 2). Although the skin incisions were infected just in one case, the old incision wounds were routinely opened in all patients, the necrotic tissue around them removed and washed with an iodine solution.

We believed that skin incisions are one of the possible pathways of the infection entering the knee joint. Diagnostic arthroscopy was then performed. The stage of bacterial infection, according to the Gächter's classification, was determined.¹⁷ Gächter's classification divides the arthroscopic findings of septic arthritis into four stages, and has been used to grade infections of different joints.^{18,22}

Stage I is denoted by translucent aspirate and localized areas of hyperemic synovitis and petechial hemorrhages. Stage II is identified as the presence of purulent joint effusion and synovial hypertrophy with fibrin deposits. In stage III, hypertrophic villous synovitis with early cartilage destruction is present, however, the radiographic changes are still absent. Synovial overgrowth (synovial malignancy) and extensive cartilage destruction with roentgenographically visible erosions and subchondral cysts are classified as stage IV.

Stage I septic arthritis was found in the first and the third patient. Grafts were not changed or softened, and were therefore retained in both cases. Arthroscopy and washout of the infected knee with 3L of Ringer's solution were performed. Stage II septic arthritis was identified in the second patient. Arthroscopic partial synovectomy, with removal of fibrin deposits and intra-articular adhesions, was carried out. Fibrinous coating adhering to the graft was removed, but the graft itself was retained. Intra-articular drains were placed, and a continuous perfusion of the joint for the next three days had been instituted in all 3 cases. The conduit tube was placed in the intercondylar notch and the drain was placed in suprapatellar recessus. The perfusion was performed with 2 L of 9% NaCl solution/ 8 h.

Staphylococcus aureus was isolated in the aspirate from the first patient and *Staphylococcus epidermidis* from the second patient. Both were methicillin sensitive and previous empirical antibiotic therapy was continued for 14 days. Although all cultures remained sterile

in the third patient, clinical signs and laboratory data (white blood cell count, CRP, ESR) showed improvement after the initial empirical antibiotic treatment. The therapy with cloxacillin was therefore continued. All patients had received intravenous antibiotics for 14 days and were afterwards discharged from the hospital. Subsequently, they were treated with oral antibiotic for four weeks; the first patient with cloxacillin 500 mg / 6 h, the second and the third with clindamycin 600 mg / 8 h. Laboratory values returned to normal after six weeks of antibiotic treatment in all patients.

Physical therapy was initiated immediately after the operation. The knee was intensively cooled during the period of continuous perfusion. To facilitate full extension, a pillow was placed under the ankle. After the drains were removed, passive motion on a kinematic machine was started. Active exercises were added upon clinical improvement. Out-patient physical therapy was resumed after discharge. Full and painless range-of-motion was attained in all patients following outpatient physical therapy.

A comprehensive physical examination and clinical evaluation were performed at an average follow-up of 33 months (range, 4-61 months). To evaluate the clinical outcome, a side-to-side difference in ligament laxity with KT-2000 and a single-legged hop test were used.²³ Plain radiographs were taken for the assessment of joint space loss and the degree of arthrosis. Patients evaluated stability, motion, swelling and pain of the affected knee according to the Lysholm knee scoring scale.²⁴ Activity levels before injury and at the follow-up were rated by the Tegner activity score.²⁵ Levels 0 to 3 correspond to daily activities, levels 4 to 6 correspond to physical fitness sports and individual competitive sports, and levels 7 to 10 to competitive contact sports.

Results

All patients had a full range-of-motion of the affected knee at the follow-up. Moderate patellofemoral crepitation with pain at the extreme of flexion was present in the second patient. No patient had signs of an infection. Lachman's test was negative in all patients, the pivot-shift test was positive (1+) in the second patient. The mean side-to-side difference in ligament laxity between the involved and the contralateral knee was 1.3 mm (Table 3). All patients felt that the stability of the knee in everyday and sports activities was good. The mean Lysholm score before the ACL reconstruction was 42. At the follow-up, the Lysholm score significantly improved, the average score was 91. The patient with the lowest Lysholm score had a knee pain upon kneeling and during physical activities. The mean pre-injury Tegner activity score was 7. The first and the third patient had retained the level of sports activity enjoyed prior to the injury, the second patient had lower level of activity (pre-injury 6, post-infection 5) due to the knee pain. All patients achieved an excellent grade at the single-legged hop test (>90% of the distance attained with the contralateral side). All radiographs before the reconstruction were normal. Plain radiographs at follow-up revealed a narrowed patellofemoral joint in the second patient.

Discussion

The first case of septic arthritis after arthroscopic ACL reconstruction was described in 1988.²⁶ Only 8 retrospective studies on the subject have been published since.^{1-3,9} The incidence of intra-articular infection after arthroscopic ACL reconstruction has ranged between 0.14% and 1.7%. Our series consisted of a total of 1,283 patients who underwent arthroscopic ACL reconstruction. Septic arthritis as a complication after the procedure occurred in 3 patients (0.23% incidence). As in other studies, risk factors for hematogenous bacterial infection of the knee (old age, extra-articular infection with bacteriemia, non-infectious arthritis, diabetes mellitus, immunodeficiency, intravenous drug abuse) were not found in

patients with septic arthritis. None of our patients had previously received intra-articular steroids, which was shown to be a predisposing factor for joint infection.²⁷ Any previous knee surgery was also found to increase the likelihood of a septic arthritis following ACL reconstruction. Knee surgery preceding reconstruction has been reported in 53-75% of cases with septic arthritis.^{1,3,7,8} In our study, surgery (arthroscopic resection of the injured medial meniscus and removal of the ACL remnants) prior to the ACL reconstruction was carried out in the first patient. A concomitant partial meniscectomy together with ACL reconstruction was undertaken in the second and the third patient. We do not believe this to be the cause of post-operative infection. However, most studies reported an increased infection rate if concurrent meniscal repair was carried out.^{1,3,7,9} The proposed causes of the increased infection rate were longer operative time, additional or longer incisions and the use of sawing implant material (foreign body) if simultaneous meniscal repair was performed at the time of ACL reconstruction.

Arthroscopic ACL reconstructions were carried out in strict aseptic conditions. Patients with post-operative septic arthritis were operated in different time periods. As no increases in infection rate were detected at the time of operative procedures, epidemiologic workups were not performed. A few studies reported on cases with post-operative septic arthritis occurring in relatively narrow timeframes. Instruments used for arthroscopy have been implicated as a potential source of contamination. Viola et al. reported 10 infections in 70 ACL reconstructions over a 4-month period.²⁸ They found 2 prepackaged "sterile" sets of inflow catheters to be infected with coagulase-negative *Staphylococci*. In the study by Schollin-Borg et al., the high post-operative infection rate (1.7%) was linked to the growth of coagulase-negative *Staphylococcus* on the graft boards.⁸ They concluded that the gap between the metal part and the rubber membranes on the graft board could not be satisfactorily sterilized, despite the use of certified autoclaves.

In our study group, septic arthritis developed in the early post-operative period in all patients. Swelling and knee pain were universally present, local erythema and incisional drainage were additionally present in the sec-

ond patient. The first patient returned to our institution one day after development of clinical symptoms, whereas the second patient returned after five days. ESR and CRP were elevated in all patients. Peripheral white blood cell count was elevated only in the second and the third patient. Gram's stains were reliable guides to the correct diagnosis of infection in 2 patients. The appropriate antibiotic and operative treatments were initiated within a few hours. *Staphylococcus*, the most common cause of post-operative infection^{3,5,7,9} was isolated in both cultures within a few days. All microbiological surveys remained sterile in the third patient. The diagnosis of aseptic arthritis in the third patient was established through clinical examination, a laboratory workup and an elevated white blood cell count in the aspirate.

In our group, the wounds from the previous procedure were opened, the necrotic tissue around them was removed and cleansed with an iodine solution. Initial arthroscopic irrigation of the joint was then performed and the knee thoroughly examined. The grafts were firm, without areas of necrosis and were retained in all cases. Additional arthroscopic partial synovectomy, with removal of intra-articular adhesions, was performed in the patient with stage II septic arthritis. Drains were placed, and a continuous perfusion was maintained for the ensuing three days. With an additional antibiotic treatment the signs of infection disappeared within a few days, and no further surgery was required. According to the studies where continuous irrigation was not used, several operative procedures (repeated debridement and lavage) were needed in the therapeutic process. In some cases of persistent infection, the graft had eventually to be removed. Williams et al. reported on the results of 7 patients (out of 2,500 reconstructions – a 0.3% incidence) with post-operative septic arthritis.⁹ *Staphylococcus aureus* was isolated in 6 patients and *Peptostreptococcus* in one patient. In 4 patients, two or more operative procedures had to be performed following the initial irrigation and debridement. The graft was removed in all 4 patients. One patient, who was treated with several procedures, graft removal and four weeks of antibiotics, developed osteomyelitis. McAllister et al. presented 4 cases (out of 831 reconstructions - a 0.48%

Table 3. Treatment results of post-operative infections following anterior cruciate ligament reconstruction.

Patient	Follow-up (months)	Pre-injury Tegner score	Post-operative Tegner score	Pre-operative Lysholm score	Post-operative Lysholm score	Function
1	34	8	8	35	96	1 Normal
2	61	6	5	42	84	3 Nearly normal
3	4	7	7	50	93	1 Normal

incidence) of post-operative septic arthritis in which the graft was retained.⁷ *Staphylococcus aureus* was isolated in all patients. Clinical signs of infection appeared after an average of 11 days (within a range of 8-18 days) following the ACL reconstruction. In all cases the diagnosis of septic arthritis was made within 24 hours of the initial presentation of symptoms. On average, 2.75 arthroscopic procedures (within a range of 2-4 procedures) were required before eradication of the infection. Indelli *et al.* had 5 patients (incidence 0.14%) with septic arthritis following ACL reconstruction, where the patellar graft was used as an autograft in 40% of instances, and as an allograft in 60% of cases.⁵ Again, *Staphylococcus aureus* was the most commonly isolated organism (3 patients), *Staphylococcus epidermidis* was encountered in 2 patients and *Peptostreptococcus* was found in one patient. Treatment began with an average delay of 7.5 days (within the range of 2-20 days) from the onset of symptoms. Several procedures were necessary in all patients, and the graft was removed in 2 patients. At follow-up, one patient (a 51-year-old man) with mild to moderate pre-operative degenerative changes had been converted to a total knee replacement.

A different approach is needed in patients with advanced stages of infection. Schulz *et al.* presented 24 patients who were treated for knee infections on an average of 91 days after ACL reconstruction.²⁹ Prior to referral to their center, 15 patients had already been unsuccessfully surgically treated elsewhere. In 12 patients the causative pathogen was *Staphylococcus aureus*, in 5 patients *Staphylococcus epidermidis*, while in 4 patients the cultures remained sterile, and in 2 patients streptococci were responsible for the infection. Sixteen patients had stage III or stage IV septic arthritis. Open surgery with necrectomy and total synovectomy was performed, and gentamicin-containing beads were implanted. The beads were removed after 7-10 days during a repeated surgery. They concluded that a more radical approach is favorable in cases of advanced or chronic infection; however, results in these cases are generally worse than those with treatment in the early stage of infection.

The infection was managed with graft retention and without additional surgery in all our patients. The literature favors graft removal if the graft tissue appears to be affected by the infection, or if there is any difficulty in treating the infection. The fixation material has to be removed together with the graft, and the drilling canals cleared. When the knee has returned to a normal appearance and the laboratory values have returned to normal, the possibility of a reimplantation should be considered in young and active patients.^{3,10}

All our patients had a full range of motion at the follow-up. The average Lysholm score was

91. Even the patient with the lowest score still works as a ski instructor. Clinical examination and KT-2000 measurements showed excellent knee stability in all patients. Contrary to our results, most studies reported on a poorer clinical outcome in patients who had a post-operative septic arthritis.^{3-7,9,29} Arthrofibrosis and cartilage destruction are claimed to be responsible for a less favorable outcome in these patients.

Conclusions

Post-operative septic arthritis of the knee is a rare complication following ACL reconstruction. It carries a high morbidity that usually leads to prolonged hospitalization and high costs. The goals of treatment are to protect the articular cartilage and to protect the graft. Timely recognition of the condition and the correct approach are essential for the successful treatment. A full range of motion and good clinical stability can be achieved through a combination of arthroscopic surgery and specific antibiotics in early cases of septic arthritis.

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