ACTA
ORTHOPAEDICA
et
TRAUMATOLOGICA
TURCICA

ORIGINAL ARTICLE

Acta Orthop Traumatol Turc 2011;45(5):342-347
doi:10.3944/AOTT.2011.2469

Graft retaining debridement in patients with septic arthritis after anterior cruciate ligament reconstruction

Burak DEMİRAĞ[1], Ömer Kays ÜNAL[1], Cüneyt ÖZAKIN[2]

[1]Department of Orthopaedics and Traumatology, Faculty of Medicine, Uludağ University, Bursa, Turkey;
[2]Department of Microbiology, Faculty of Medicine, Uludağ University, Bursa, Turkey

Objective: Although septic arthritis following anterior cruciate ligament (ACL) reconstruction is a rare complication, it has a high morbidity deteriorating the clinical outcome. Current treatment options include long-term antibiotic therapy, open or arthroscopic surgical lavage, aspiration, continuous irrigation, graft preservation, and removal of graft and fixation materials with or without reimplantation. The aim of our study was to evaluate the results of long-term antibiotic treatment with arthroscopic debridement without graft and fixation materials removal in the treatment of septic arthritis following ACL reconstructions.

Methods: Seven patients (6 male, 1 female; mean age: 29 years; range: 21 to 40 years) who had septic arthritis following ACL reconstruction at Uludağ University, Department of Orthopaedics and Traumatology were included in this study. Three of the patients were athletes, 1 was a heavy-duty worker, 3 were light-medium-duty workers and 1 was an amateur sportsman. Long-term antibiotic therapy was used for 6 weeks. Rehabilitation was arranged according to the patients' effusion, pain and general condition. Evaluations were made using clinical results, manual Lachman and pivot shift tests, and Tegner activity, Lysholm, and IKDC scores.

Results: Patients had a mean of 6 (range: 0 to 15) degrees of flexion loss and 3 (range: 0 to 5) degrees of extension loss. Manual Lachman test was near normal for all patients. Pivot shift was positive for 3 and negative for 4 patients. Preoperative and postoperative mean Tegner activity scores were 6 (range: 4 to 7) and 5 (range: 4 to 7), respectively. Preoperative and postoperative mean Lysholm scores were 73.2 (range: 67 to 79) and 74.1 (range: 79 to 89), respectively. Preoperative and postoperative mean IKDC scores were 78.0 (range: 70 to 100) and 80.0 (range: 70 to 100), respectively. Mean leg circumference across the quadriceps muscle was 91% (range: 88 to 93) of the contralateral leg. Single-leg longitudinal jumping length was 78% (range: 63 to 100) of the uninvolved leg. Single-leg horizontal jumping was 72% (range: 88 to 93) of the contralateral leg.

Conclusion: Long-term antibiotic therapy and arthroscopic drainage without graft or fixation material removal is effective in patients of regular activity level. Although this procedure is equally successful for treating the infection in competitive athletes and heavy workers, it also results in slight performance loss. Further review is necessary to determine which treatment is suitable for which activity level.

Key words: ACL reconstruction; antibiotic therapy; arthroscopic drainage; graft debridement; septic arthritis.

Correspondence: Burak Demirağ, MD. Uludağ Üniversitesi Tıp Fakültesi, Ortopedi ve Travmatoloji Anabilim Dalı, Bursa, Turkey.
Tel: +90 532 566 98 98 e-mail: burakdemirag@hotmail.com

Submitted: April 26, 2010 **Accepted:** November 3, 2010

Although septic arthritis following ACL reconstruction is a rare complication, it has a high morbidity that negatively affects the clinical outcome. A delay or failure in diagnosis complicates and lengthens the hospitalization period. In recent literature, the incidence rate has been reported between 0.14% and 1.7%.[1-8]

Pathogenesis of this complication is similar to septic arthritis with inflammation of the synovial membrane, caused by bacterial infection, resulting in purulent effusion. Enzymes secreted by or resulting from a break-down of synovial cells, inflammatory cells or microorganisms cause degradation of the cartilage.[2] At the same time, these enzymes may be harmful for the graft and graft fixation, potentially risking the stabilization achieved through the operation.[9] If the course of this complication continues, it may result not only in loss of stability, but also bone destruction, fibrous ankylosis, septicemia, septic shock, and even death.

Incidence of this complication has been published in multiple retrospective studies. Statistical analyses of these data have been used to investigate the risk factors and the effectiveness of the diagnostic and therapeutic methods. Current treatment options include long-term antibiotic therapy, open or arthroscopic surgical lavage, aspiration, continuous irrigation, graft preservation, and removal of graft and fixation materials with or without reimplantation. However, the effectiveness of each option has not yet been clearly established. Additionally, it is not clear which treatment is most appropriate for people with different activity level.

We hypothesized that if diagnosed early, good results can be achieved by long-term antibiotic use combined with arthroscopic debridement without removal of the graft and fixation materials in patients with septic arthritis following ACL reconstruction.

The aim of our study was to evaluate the results of long-term antibiotic treatment with arthroscopic debridement without graft and fixation materials removal in the treatment of septic arthritis following ACL reconstructions.

Patients and methods

In our study, we included 7 patients (6 male, 1 female; mean age: 29 years; range: 21 to 40 years) who had septic arthritis following ACL reconstruction at Uludağ University Faculty of Medicine, Department of Orthopaedics and Traumatology. In two patients, for whom patellar tendon autograft was used, the Mitek RIGIDFIX BTB System (DePuy Mitek, Inc., Raynham, MA, USA) and metal interference screw (BIOCRYL Interference Screw; DePuy Mitek Inc., Raynham, MA, USA) methods were used for femoral and tibial fixation, respectively. For the remaining 5 patients, hamstring autograft was used and fixed on the femur with a cortical cancellous slingshot system (SLINGSHOT Cross Pin System; DePuy Mitek Inc., Raynham, MA, USA) and on the tibia using metal interference screw and staple. Mean time from surgery to septic arthritis was 5 (range: 1 to 12) weeks. Postoperative infections were classified as either acute (<2 weeks), subacute (between 2 weeks and 2 months), or late (>2 months).[5] One infection was acute, 1 was chronic and the remaining 5 were subacute (Table 1). The

Table 1. Research results.

	Sex	Age	Graft	Agent	Time	Follow-up (Month)	Sed. (/mm)	WBC	IKDC		Tegner		Lysholm		Pivot shift	Lachman	Satisfying	Tourniquet time (min)
1	M	26	Hamstring	*Staph. epidermidis*	Subacute	60	45	9,600	70	70	7	7	79	89	(+)	(+1)	7	125
2	M	40	Hamstring	*Staph. epidermidis*	Subacute	72	45	17,000	72	76	7	6	67	81	(-)	(+1)	7	105
3	M	30	Hamstring	*Staph. capitis*	Subacute	33	32	13,600	90	84	6	4	78	89				135
4	M	37	Bone Patellar Bone	*Staph. epidermidis*	Subacute	17	120	10,100	100	100	5	5	71	81	(-)	(+1)	7	120
5	K	37	Hamstring	*Staph. aureus*	Chronic	60	120	8,800	72	70	7	5	71	81	(-)	(-)	6	85
6	M	37	Bone Patellar Bone	*Staph. epidermidis*	Acute	21	120	10,900	70	76	4	4	68	79	(+)	(+1)	6	112
7	M	21	Hamstring	*Staph. epidermidis*	Subacute	60	40	12,400	72	84	6	5	79	89	(-)	(+1)	7	75

presenting symptoms and the results of laboratory tests were recorded (Table 2). Knee aspiration was performed for patients who had the symptoms of septic arthritis before antibiotherapy.

Diagnosis was based on patient history, physical examination, laboratory and radiological findings and microscopy and culture of joint aspirate. Patients who were diagnosed with septic arthritis were admitted to hospital. Intravenous cefazolin sodium and gentamicin sulfate therapy was begun. If necessary, the antibiotherapy was changed according to the organism isolated from the aspirate. Long-term antibiotic therapy was used for 6 weeks. Three to 4 weeks of intravenous administration was followed by oral amoxicillin and clavulanate potassium, according to the patient's symptoms, sedimentation and CRP values. Arthroscopic lavage and debridement were performed after aspiration and 2 to 3 days of intravenous antibiotic treatment. Hyperemic and hypertrophic synovium, fibrinous linings and villous fibrinous tissues were removed using arthroscopic shavers and laser probes (VAPR Radiofrequency System; DePuy Mitek, Inc., Raynham, MA, USA). If found to be intact and mechanically stable, the graft was retained and any fibrinous exudates and irregularities on the graft surface were removed. A second arthroscopic debridement was performed for persistent or recurring effusion. One of our 7 patients required a second arthroscopic lavage and debridement. For the first postoperative week a physical therapy and rehabilitation program was begun. Rehabilitation was arranged according to the patients' effusion, pain and general condition. After discharge from the hospital, patient follow-ups were done at the orthopaedics policlinic. Manual Lachman and pivot shift tests were used to examine instability. Atrophy of quadriceps and loss of flexion or extension were determined by comparison with the contralateral leg. Patient satisfaction, Tegner activity, Lysholm and IKDC scores, and single leg longitudinal and horizontal jumping performances were assessed. Patients' activity levels were determined using the Tegner activity score. X-rays were used to determine if there was a widening of the tunnels.

Results

Three subjects were operated on the 4th week following the trauma or after a 4-week period of rehabilitation, because of recurring knee instability. The remaining 4 cases were patients with chronic complaints. Mean operation and tourniquet time of patients were 125 (range: 95 to 155) and 108 (range: 75 to 135) minutes, respectively. An average of 5 (range: 4 to 6) 3000 cc 0.9% NaCl solution bags were used during the operation. Two patients underwent diagnostic arthroscopy prior to ACL reconstruction. Another 2 underwent concomitant partial meniscectomy. Subtotal meniscectomy was performed on one of these patients because of the inability to repair a complicated longitudinal degenerative tear. Synovial aspirate cultures of all patients were positive (Table 3). Isolated bacteria were *Staphylococcus epidermidis* in 5 cases, *Staphylococcus aureus* in one case and *Staphylococcus capitis* in one case. All 7 patients underwent arthroscopic debridement with one patient needing a second debridement. Mean follow-up time was 48 (range: 17 to 72) months.

Table 2. Patients' symptoms.

	n (patients)
General symptoms	7
Swelling	7
Joint pain	7
Stiffness	7
Rash	6
Sunk eyes	7
Fever (37.8˚-39.4˚C)	5

Table 3. Laboratory findings.

	n (patients)
WBC >10,000/mm^3	5
Sedimentation >40 mm/hr	6
CRP >100 mg/L	5
WBC at synovial fluid >50,000/mm^3	5
Culture	7

Patients experienced 6 (range: 0 to 15) degrees of flexion loss and 3 (range: 0 to 5) degrees of extension loss. A manual Lachman test performed at 25 degrees of flexion was near normal for all patients. Pivot shift was positive for 3 patients and negative for 4 patients. Preoperative and postoperative mean Tegner activity scores were 6 (range: 4 to 7) and 5 (range: 4 to 7), respectively. Preoperative and postoperative mean Lysholm scores were 73.2 (range: 67

to 79) and 74.1 (range: 79 to 89), respectively. Preoperative and postoperative mean IKDC scores were 78.0 (range: 70 to 100) and 80.0 (range: 70 to 100), respectively. Mean leg circumference across the quadriceps muscle was 91% (range: 88 to 93) of the contralateral leg. Single-leg longitudinal jumping length was 78% (range: 63 to 100) of the uninvolved leg. Single-leg horizontal jumping was 72% (range: 88 to 93) of the contralateral leg. Based on Tegner activity scores, 3 of the patients were athletes, 1 was a heavy-duty worker, 3 were light-medium-duty workers and 1 was an amateur sportsman.

Mean patient satisfaction was 6.6 (range: 6–7). None of the patients had tunnel widening on their X-rays.

Discussion

Because of the low number and heterogenity of patients involved in the previous studies, there are no clear cut answers to questions regarding risk factors, the important methods of diagnosis, and the effectiveness of treatment methods of this complication. Matawa et al. tried to consolidate data gathered through questionnaires given to doctors who had come across this complication.[10] In their study, they demonstrated that this complication is rare and that the first treatment must be surgical drainage and retaining the graft along with long-term intravenous antibiotic therapy. They suggested removing the graft and fixation material when the allograft is infected or the infection is shown to be resistant to this initial treatment.

In our series, all patients were operated by the same surgeon using patellar or hamstring tendon grafts and the same fixation methods. In this study we especially tried to research previously observed and neglected factors.

The treatment method we used can result in slight stretching of the graft, as can be understood from the results of the final follow-ups. Considering the basic purpose of operation is to fix the knee instability and lack of patient confidence, our treatment cannot be considered successful for patients who are heavy-duty workers or competitive athletes. This treatment is more suitable for patients engaging in light to mild activity. However, this limitation may more likely be caused by the complication itself, rather than the treatment method. Occurrence of such a complication is frustrating for both the patient and the rehabilitation crew and causes the lengthening of treatment period to regain muscle forces and proprioception. When these factors are considered, the effectiveness of the alternative treatment methods is controversial.

The existence of studies in the literature enables the diagnosis of this complication and makes treatment possible by understanding the pathophysiology. However, diagnosis is difficult. It may easily be confused with early symptoms of other complications that appear at the postoperative 2nd and 3rd weeks.[2,7,11] The most common symptoms of septic arthritis are fever, swelling, severe pain, tenderness, and restricted motion. These symptoms can occur in cases of arthrofibrosis, when the knees with diminished proprioception stand for a long time in the early postoperative stages or with unmonitored and excessive early rehabilitation.[2] Septic arthritis may present with non-specific symptoms of an infection. Differential diagnosis must be then made by anamnesis, physical examination and laboratory tests. It is important to note that sedimentation is generally high after a normal ACL procedure and becomes normal at a later period.[12] CRP is more suitable for diagnosis and treatment. Fibrinogen amount (FIB) has been used recently for diagnosis and follow-up.

Joint destruction and severity of the symptoms depend on the virulence of the etiological microorganism, which sometimes cannot be isolated easily.[13] Arthrosynthesis is important for differential diagnosis and chylous effusions following trauma have also been described in the literature. Its pathophysiology has been attributed to the post-traumatic release of lipid tissue from bone marrow and intraarticular fat pads.[14] We came across this post-traumatic reaction during joint aspiration of patients who stood for an extended period before full proprioception recovery, patients with lesion area infection, and patients with difficulties at rehabilitation. In this situation, biochemical features and culture contribute to the differential diagnosis.

Through animal research, the importance of early antibiotic therapy in the first 8 hours of knee infections caused by *Staphylococcus genus* to prevent cartilage destruction was established. In addition, delaying the surgical decompression more than one week may result in glycosaminoglycan and collagen loss which may lead to future degenerative osteoarthritis.[15] Cohen et al. determined that using adenosine A2A as an agonist to antibiotic therapy

reduces cartilage destruction and inflammation. They concluded that this agent is effective for conserving cartilage and preventing arthrosis.[16] Two cases in the literature proved that if this complication is not treated appropriately, it can result in severe problems, such as massive bone loss and total destruction of the condyles. Contamination from surgical incisions and portals may be the most important factor for the development of septic arthritis.[8] The contamination of joint space tracts or graft site incisions may cause inoculation of the joint space. This risk increases with each additional number of incisions. Using fluid in arthroscopic surgery decreases the risk of infection. This situation can be explained as the fluid removes the debris and microorganisms in the surgical area. We normally use an average of five 3-liter serum physiologic bags for our ACL reconstruction operations (range: 4 to 6). The number of bags used for the operations in this study did not differ from the general mean.

The high number of implants used during ACL repair procedures, especially those in narrow areas such as the tibial side tunnel, also increases the risk of infection.[5,11] When the patellar tendon is used, the graft is fixed with 2 implants at the femoral area and 2 at the tibial tunnel entry. When hamstring tendon grafts are used, the graft is fixed with 1 implant at the femoral tunnel and 2 at the tibial tunnel entry. If the graft is short, the suture materials tied to the hamstring tendon's ends are left in the tunnel and can cause foreign material reaction. We think that residues from these different materials (polyethylene suture materials, titanium or alloyed steel staple, absorbable or non-absorbable screws) and polyglactine sutures can cause foreign material reaction and disrupt functions of the immune system.[9]

Hemarthrosis, following an acute ACL rupture and surgical intervention before the healing of synovitis, may be a cause for infection. Three of our cases were operated at the 4th post-traumatic week or following 4 weeks of rehabilitation after recurrent giving out of the knee. Currently, there is a debate on the optimal timing for anterior cruciate ligament reconstruction. The same trauma which causes ACL rupture also results in bone bruise or cartilage lesions, which predisposes to synovitis. In these situations, synovial architecture is disrupted by hemarthrosis. Barrier function of the synovium is impaired which predisposes to infection.

In our cases, the mean operation time was 125 minutes, which was a bit over the average, due to some unexpected complications during surgeries. In two patients, while locating the guide of cortical cancellous suspension system, the screw gut guide could not be caught and the procedure was repeated. In our series, there was no concomitant surgical procedure to prolong operative time. Septic arthritis did not occur in cases in which ACL reconstruction was performed with a concomitant surgery, such as meniscal repair or mosaicoplasty.

Post-tourniquet syndrome, which was addressed by Bunnel, is a reaction occurring because of long-term ischemia and is characterized by swelling, pallor, joint stiffness, paresis and paresthesia.[17] Sapega et al. showed that increased capillary permeability may result in micro vascular congestion. These situations begin in the first 2 to 3 hours and last for the first week post surgery.[18] Consequently, the first week is a critical period for postoperative infection, in which the extremity and surgical area are likely to be infected. Average tourniquet application length was 108 minutes. This period is in line with other studies and we did not find any correlation between tourniquet time and septic arthritis.

Bony debris produced while drilling the tunnel spreads throughout the joint and adheres to lasting ACL residues and the PCL, especially in supporting surgeries. Drilling with a drill sleeve can produce metallic debris material. These bone and metal debris can cause foreign material reaction or disrupt the host's immune system against infection by causing Type 4 hypersensitivity reaction.[19]

According to the study of Williams et al., the graft was seen as a nidus for infection and removal was suggested.[4] McAllister et al. reported that their ACL reconstruction was intact in 4 patients at the second-look arthroscopy, performed following the eradication of septic arthritis.[8] Burks et al. compared 4 patients who received irrigation, debridement and antibiotic therapy and whose grafts were removed, and one patient for whom the same treatment protocol was performed, but whose graft was retained. They found that the patient whose graft was retained had bad postoperative results.[2]

The aim is to preserve the graft's morphological and mechanical integrity during arthroscopic debridement. At an average of 2 months after the

ACL reconstruction, the graft is expected to heal within the tunnel. During arthroscopic lavage, collection of the lavage fluid beneath the tibial incision is a sign of failure of healing of the tendon-bone within the tunnel. In this case, the removal of the partially healed graft would not affect the clinical result.

In our study, we observed that long-term antibiotic therapy and arthroscopic drainage without graft or fixation material removal is effective in patients of regular activity level. Although this procedure is equally successful for treating the infection in competitive athletes and heavy workers, it also results in slight performance loss. Further review of the literature, metaanalyses and studies with a more uniform patient group are necessary to determine which treatment is suitable for which activity levels. Animal research may be useful to monitor and establish a method to prevent long term results of this complication, such as secondary osteoarthritis, graft destruction and arthrofibrosis.

Conflicts of Interest: No conflicts declared.

References

1. Judd D, Bottoni C, Kim D, Burke M, Hooker S. Infections following anterior cruciate ligament reconstruction. Arthroscopy 2006;22:375-84.
2. Burks RT, Friederichs MG, Fink B, Luker MG, West HS, Greis PE. Treatment of postoperative anterior cruciate ligament infections with graft removal and early re-implantation. Am J Sports Med 2003;31:414-8.
3. Wang C, Ao Y, Wang J, Hu Y, Cui G, Yu J. Septic arthritis after arthroscopic anterior cruciate ligament reconstruction: a retrospective analysis of incidence, presentation, treatment, and cause. Arthroscopy 2009;25:243-9.
4. Williams RJ, Laurencin CT, Warren RF, Speciale AC, Brause BD, O'Brien S. Septic arthritis after arthroscopic anterior cruciate ligament reconstruction: diagnosis and management. Am J Sports Med 1997;25:261-7.
5. Van Tongel A, Stuyck J, Bellemans J, Vandenneucker H. Septic arthritis afterarthroscopic anterior cruciate ligament reconstruction: a retrospective analysis of incidence, management and outcome. Am J Sports Med 2007;35:1059-63.
6. Armstrong RW, Bolding F, Joseph R. Septic arthritis following arthroscopy: clinical syndromes and analysis of risk factors. Arthroscopy 1992;8:213-23.
7. Indelli P, Dillingham M, Fanton G, Schuman DJ. Septic arthritis in postoperative anterior cruciate ligament reconstruction. Clin Orthop Relat Res 2002;(398):182-8.
8. McAllister DR, Parker RD, Cooper AE, Recht MP, Abate J. Outcomes of postoperative septic arthritis after anterior cruciate ligament reconstruction. Am J Sports Med 1999;27:562-70.
9. Binnet MS, Başarır K. Risk and outcome of infection after different arthroscopic anterior cruciate ligament reconstruction techniques. Arthroscopy 2007;23:862-8.
10. Matawa MJ, Evans TA, Wright RW, Shively RA. Septic arthritis of the knee following anterior cruciate ligament reconstruction: results of a survey of sports medicine fellowship directors. Arthroscopy 1998;14:717-25.
11. Fong SY, Tan JL. Septic arthritis after arthroscopic anterior cruciate ligament reconstruction. Ann Acad Med 2004;33:228-34.
12. Margheritini F, Camillieri G, Mancini L, Mariani PP. C-reactive protein and erythrocyte sedimentation rate changes following arthroscopically assisted anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc 2001;9:343-5.
13. Mouzopoulos G, Fotopoulos VC, Tzurbakis M. Septic knee arthritis following ACL reconstruction: a systematic review. Knee Surg Sports Traumatol Arthrosc 2009;17:1033-42.
14. Reginato AJ, Feldman E, Rabinowitz JL. Traumatic chylous knee effusion. Ann Rheum Dis 1985;44:793-7.
15. Smith RL, Schurman DJ, Kajiyama G, Mell M, Gilkerson E. The effect of antibiotics on the destruction of cartilage in experimental infectious arthritis. J Bone Joint Surg Am 1987;69:1063-8.
16. Cohen SB, Gill SS, Baer GS, Leo BM, Scheld WM, Diduch DR. Reducing joint destruction due to septic arthrosis using an adenosine2A receptor agonist. J Orthop Res 2004;22:427-35.
17. Bunnell S. Ischaemic contracture, local, in the hand. J Bone Joint Surg Am 1953;35:88-101.
18. Sapega AA, Heppenstall RB, Chance B, Park YS, Sokolow D. Optimizing tourniquet application and release times in extremity surgery. A biochemical and ultrastructural study. J Bone Joint Surg Am 1985;67:303-14.
19. Maletis GB, Samuelson TS, Drez D Jr. Synovial response to intra-articular metal debris: implications for anterior cruciate ligament reconstruction. Arthroscopy 2002;18:61-3.