Host Factors Affect the Outcome of Arthroscopic Lavage Treatment of Septic Arthritis of the Knee

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abstract

The purpose of this study was to determine the prognostic factors related to the outcome of lavage surgery in patients with septic arthritis of the knee. A total of 55 patients with acute septic arthritis who underwent arthroscopic lavage were enrolled in the study. Host factors, including age, medical comorbidities, and medication use, were evaluated according to the Musculoskeletal Infection Society staging system, and patients were then stratified into 3 types: type A, no compromising factors; type B, 1 to 2 compromising factors; and type C, more than 2 compromising factors. Routes of infection were classified. Causative organisms were classified as gram positive, gram negative, mixed, or culture negative. Multivariable analysis confirmed that type C hosts showed more than 16 times the risk for failure of a single arthroscopic lavage than type A hosts. Type B hosts showed no significant differences from either type A or type C hosts. Patients with gram-positive cultures had more than 13 times the risk for failure than patients who were culture negative. Patients with gram-negative and mixed cultures showed no significant differences from the other groups. The sex of the patient and the route of infection were not related to the success of a single arthroscopic lavage surgery. Patients in poor health (ie, very medically ill) and with gram-positive cultures should be counselled regarding potential failure after a single arthroscopic debridement procedure. [Orthopedics. 2018; 41(2):e184-e188.]

Septic arthritis of a joint is an emergent condition that can result in irreversible joint destruction or even death if not managed in a timely fashion. Therefore, early diagnosis and effective treatment are essential. Septic arthritis most commonly affects the knee joint, which accounts for approximately half of all infected joints. The incidence of septic arthritis appears to have increased during the past few decades as a result of the general aging of the population, widespread use of more potent immunosuppressive drugs, and increased use of intra-articular procedures. Although a definitive diagnosis of septic arthritis is only possible with direct growth of bacteria in cultures from aspirated synovial fluid, diagnosis is often aided by careful history taking, hematologic evaluation, and joint synovial fluid analysis. Arthroscopic lavage has been established as the most successful treatment for septic arthritis of the knee. However, few studies have focused on outcomes related to prognostic factors, so evidence is lacking regarding the impact of prognostic factors related to arthroscopic lavage for septic arthritis of the knee.

The purpose of this study was to determine the prognostic factors for lavage surgery in patients with septic arthritis of the knee. The authors sought to determine (1) whether patients with worse host grades have lower success rates with a single arthroscopic lavage and (2) whether patients with known iatrogenic infections (ie, after...
MATERIALS AND METHODS
Population and Criteria

The medical charts and records of 69 consecutive patients who underwent arthroscopic lavage of the knee joint for acute septic arthritis at the authors’ hospital between March 2013 and May 2016 and who were followed for a minimum of 12 months were retrospectively reviewed for their potential inclusion in the study.

Six patients with positive crystals on polarizing microscopic analysis, 4 patients with obscure onset of symptoms or delayed treatment of more than 7 days, 2 patients with multiple joint involvement (knees and shoulders), and 2 patients with infections after anterior cruciate ligament reconstructions were excluded. Data from the remaining 55 patients were compiled and assessed. Pediatric patients with an open physis were cared for in other divisions of the hospital and not included in this study.

Procedures

At initial presentation, all patients had blood tests, blood cultures, and synovial fluid cultures and routine analyses. The indications for arthroscopic lavage were the presence of grossly purulent pus and a white blood cell count of greater than 50,000/mm³ in the joint aspirate. Initial intravenous antibiotics (a first-generation cephalosporin) were given after diagnostic knee joint aspiration to cover the most common pathogens (Staphylococcus aureus and Streptococcus species). Arthroscopic lavage was performed within 24 hours of initial presentation. Postoperative drainage was kept in place for all patients until drainage was less than 30 mL/d for 2 consecutive days. Antibiotic treatment was modified or adjusted based on the culture and antibiotic sensitivity results. Antibiotic therapy usually lasted for 2 to 3 weeks and was monitored by blood erythrocyte sedimentation rate and C-reactive protein. Sudden aggravation of pain and swelling of the knee, combined with steady elevation of erythrocyte sedimentation rate and C-reactive protein on repeated blood tests, was an indication for additional arthroscopic lavage.

Outcomes and Variables

Host factors, including age (≥80 years), medical comorbidities (ie, diabetes, hepatic insufficiency, malignancies, pulmonary insufficiency, renal failure requiring dialysis, systemic inflammatory disease including rheumatoid arthritis and systemic lupus erythematous, and systemic immunosuppression from infection or disease), and use of medications such as insulin or immunosuppressive drugs, were evaluated according to the Musculoskeletal Infection Society staging system. Patients were then stratified into 3 types: type A, no compromising factors; type B, 1 or 2 compromising factors; and type C, more than 2 compromising factors (Table 1). Routes of infection were classified as “iatrogenic” (intra-articular injection or acupuncture history) or “unknown” (may include hematogenous spread). causative organisms were classified as gram positive, gram negative, mixed, or culture negative.

Eradication of infection after a single arthroscopic procedure was regarded as “successful,” whereas the need for 2 or more procedures was regarded as “unsuccessful.”

Statistical Analyses

SPSS version 23 software (IBM, Armonk, New York) was used for the statistical analyses. Continuous variables were compared with the independent-samples t test. Categorical variables were compared with the Fisher exact test. Multivariable logistic and linear regression analyses were used to assess factors related to the success of a single arthroscopic lavage.

RESULTS

Data from a total of 17 men and 38 women (mean age, 65.8 years; range, 26-86 years) were compiled for the study. Twenty-three (42%) of the patients were classified as medically healthy (type A hosts), 21 (38%) as medically compromised (type B hosts), and 11 (20%), as very medically ill (type C hosts) (Table 2). Thirty-nine (71%) had successful eradication of infection after a single arthroscopic lavage, whereas 16 (29%) required 2 or more arthroscopic treatments. None of the patients had recurrent infections during a minimum follow-up of 12 months (range, 12-50 months) after the final arthroscopic lavage. The infecting microbe was identified in 38 patients (69%). Gram-positive bacteria (27 patients, 49%) were the most common pathogens identified, followed by gram-negative (8 patients, 15%) and mixed (3 patients, 6%) bacteria. At initial presentation, the mean erythrocyte sedi-
mentation rate was 68.9 mm/h (range, 17-145 mm/h; normal, 0-20 mm/h) and the mean C-reactive protein was 12.7 mg/dL (range, 3.2-35.5 mg/L; normal, <0.8 mg/dL). Thirty-three patients (60%) had a known iatrogenic cause of infection (either acupuncture or intra-articular injections). The remaining 22 patients (40%) had no clear source of infection.

Host status was found to be a significant ($P = .022$) risk factor for failure of a single arthroscopic lavage, with a linear association between host status and the outcome of treatment ($P = .018$). Microorganism type was also found to be a significant ($P = .002$) risk factor for treatment failure, with higher rates for gram-positive and mixed pathogen groups compared with gram-negative and culture-negative groups. Multivariable logistic and linear regression analysis with adjustment of possible confounding factors confirmed that type C hosts had more than 16 times (odds ratio, 16.017, $P = .032$) the risk of failure of a single arthroscopic lavage than type A hosts (Table 3). However, type B hosts showed no significant differences from either type A or type C hosts. In addition, patients with gram-positive cultures were at higher risk of failure (odds ratio, 13.795, $P = .033$) than culture-negative patients ($P = .141$). However, the gram-negative and mixed culture groups showed no significant differences from the other groups. The sex of the patient and the route of infection were not related to the success of a single arthroscopic lavage surgery.

**DISCUSSION**

Septic arthritis of the knee is a serious problem, having potentially significant morbidity and possibly leading to death. Irreversible joint destruction can occur if these infections are not managed in a timely way. However, septic arthritis may be difficult to diagnose in certain situations or certain populations, such as the elderly with preexisting joint destruction or patients with systemic inflammatory diseases (eg, rheumatoid arthritis or systemic lupus erythematosus). Reported mortality rates for septic arthritis have varied. Deaths from septic arthritis are
typically reported to represent 2% to 10% of the deaths occurring in general hospitals.\textsuperscript{11,12} Despite advances in diagnostic techniques and the availability of new antibiotics, the incidence of septic arthritis of the knee appears to have increased as a result of the growing elderly population, widespread use of more potent immunosuppressive drugs (eg, anti-tumor necrosis factor agents), and increased use of invasive procedures, such as intra-articular injections and acupuncture, especially in some Asian countries.\textsuperscript{10,13,14} Increasing rates of resistance to conventional antibiotics have also been suggested as a factor in the higher incidence of septic arthritis.\textsuperscript{10}

The mainstay of treatment for septic arthritis of the knee involves early administration of appropriate antibiotics and removal of purulent material from the joint space. Arthroscopic lavage has become the preferred intervention, as it leads to satisfactory clinical outcomes with rapid postoperative recovery compared with traditional open arthroscopy.\textsuperscript{5,5} It has been argued that arthroscopic surgery offers significant advantages because it is less invasive and leads to less blood loss and postoperative scarring, thus allowing earlier functional recovery. Moreover, arthroscopic surgery reduces exposure of hyaline cartilage to air and allows better visualization of anatomic gutters and joint areas compared with open arthroscopy.\textsuperscript{15,16} A study by Chung et al,\textsuperscript{17} which included 9 cases of septic arthritis of the hip in children, reported that after arthroscopic drainage and debridement, the need for reoperations was less than that observed after open arthroscopy. Shukla et al\textsuperscript{18} conducted a study of acute septic arthritis in hip and knee joints. They reported successful eradication of infection in 18 patients after arthroscopic drainage and debridement with continuous suction irrigation. In a larger study by Vispo Seara et al\textsuperscript{1} including 78 cases of septic arthritis of the knee treated with arthroscopic lavage, the infection was eradicated after a single arthroscopic procedure in 54 cases, whereas a second decompression or drainage procedure was required in 24 patients and a third lavage in 8 patients. These outcomes are similar to the results of the current study.

It has been reported that there is a risk of permanent loss of joint function in nearly 40% of patients with septic arthritis, particularly in those with delayed diagnoses, advanced age, or underlying joint diseases.\textsuperscript{1} Furthermore, the mortality rate for septic arthritis is as high as 33% in elderly patients with comorbidities such as diabetes, other joint diseases, and compromised immune systems.\textsuperscript{19} However, the prognostic factors for eradication of septic arthritis of the knee by arthroscopic techniques have been scarcely addressed in the literature.\textsuperscript{4} McPherson et al\textsuperscript{4} previously described a Musculoskeletal Infection Society staging system that focused on individual status in the assessment of patients with periprosthetic joint infections. In the current study, the authors adopted their host status staging system to stratify patients on the basis of host medical and immune status. Host status was found to be a significant risk factor for the failure of a single arthroscopic lavage, with a linear association between host status and the outcome of treatment. Furthermore, multivariable analysis with adjustment of possible confounding factors confirmed that type C (very medically ill) hosts were at more than 16 times (odds ratio, 16.017) the risk of failure of a single arthroscopic lavage than type A (medically healthy) hosts. However, type B (medically compromised) hosts showed no significant differences from type A or type C hosts.

The causative organisms for septic arthritis vary with age and immune status. In general, the most common organism is \textit{Staphylococcus aureus} followed by \textit{Streptococcus} species in the adult population.\textsuperscript{7} Gram-negative cocci infections are responsible for at least 20% of septic arthritis cases, and bacillus infections are responsible for 10% to 20% of cases.\textsuperscript{20} In the current study, gram-positive cocci were identified in 27 cases (49%); among them, only 1 showed methicillin resistance. In addition, 8 cases (15%) were positive for gram-negative organisms and 3 (6%) were positive for mixed organisms. Patients with gram-positive cultures were at higher risk of failure (odds ratio, 13.795) than culture-negative patients ($P=0.033$). Patients with gram-negative and mixed cultures showed no significant differences compared with the other groups. However, because the culture-negative cases might have included some patients with nonseptic arthritis, these results should be carefully interpreted and reevaluated after a larger study of only culture-positive cases.

The main routes by which pathogens accumulate in the knee joint are as follows: (1) hematogenous spread; (2) infected contiguous foci; (3) neighboring soft tissue sepsis; and (4) iatrogenic by direct inoculation through arthrocentesis.\textsuperscript{10} Theoretically, hematogenous spread occurs as synovium in a well-vascularized structure without a basement plate, which allows easy access by pathogens.\textsuperscript{19} However, in the clinical setting, it is difficult to confirm whether the infectious agent entered the joint through a blood vessel. Therefore, in the current study, those patients with unclear origins for their infections were defined as unknown and were compared with iatrogenic inoculation cases. Among the iatrogenic cases, 16 had intra-articular steroid injection, 10 had been treated with acupuncture, and 7 had diagnostic aspiration. However, given the relatively small number of septic arthritis cases in this study, the route of infection could not be shown to be related to the success of a single arthroscopic lavage surgery. Thus, the authors’ second hypothesis was rejected.

This study had several limitations. First, the number of patients was small. Second, culture-negative cases were included and may represent some nonseptic arthritis cases. However, in the clinical
setting, culture-negative cases do occur, and treatment modality, including arthroscopic lavage, may not differ. When other diagnostic clues indicate that the diagnosis is septic arthritis but a culture result is not available, timely decompression may be crucial for successful treatment outcomes. Third, the exact onset and route of infection were not known because the data were obtained by a retrospective medical chart review. However, because the authors adopted strict inclusion and exclusion criteria, enrolling only acute cases with typical symptoms that had undergone arthroscopic lavage, the difference in the prognosis because of the timing of treatment should have been minimized. Finally, the exact course of antibiotics was not evaluated and antibiotic treatments were not compared.

**Conclusion**

This study showed that type C (very medically ill) patients were at higher risk for failure of a single arthroscopic lavage than type A (medically healthy) patients. In addition, patients with gram-positive cultures were at higher risk of failure than culture-negative patients. The route of infection was not related to the success of a single arthroscopic lavage surgery. Patients in poor health (ie, very medically ill) and with gram-positive cultures should be counselled regarding potential failure after a single arthroscopic debridement procedure.

**References**


