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Comparison of arthroscopic and open treatment of septic arthritis of the wrist

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Comparison of Arthroscopic and Open Treatment of Septic Arthritis of the Wrist

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Investigation performed at the Mayo Clinic, Rochester, Minnesota

Background: Open irrigation and débridement is the standard of treatment for septic arthritis of the wrist. Although isolated cases of arthroscopic irrigation and débridement have been reported, a comparison of arthroscopic and open techniques has not been performed, to our knowledge. The purpose of this study was to compare the two methods of management.

Methods: A retrospective comparison of patients with septic arthritis of the wrist initially treated, over an eleven-year period, with open or arthroscopic irrigation and débridement was undertaken at a single institution. The clinical presentation, laboratory and microbiological findings, hospital course, complications, and outcomes were compared between the two groups.

Results: Between 1997 and 2007, thirty-six patients with septic arthritis involving a total of forty wrists were identified. Nineteen wrists (seventeen patients) were initially treated with open irrigation and débridement, and twenty-one wrists (nineteen patients) were initially treated arthroscopically. Eleven wrists in the open-treatment cohort required repeat irrigation and débridement, and eight wrists in the arthroscopy cohort required a repeat procedure. If a repeat irrigation and débridement was required, it was performed in an open fashion in all but two cases. When the comparison included all of the patients in the series, no difference between the two cohorts was found with regard to the number of irrigation and débridement procedures required or the length of the hospital stay. However, when the comparison was limited to the patients with isolated septic arthritis of the wrist, it was found that only one of seven wrists in the open-treatment cohort but all eight wrists in the arthroscopy cohort had been successfully managed with a single irrigation and débridement procedure ($p = 0.001$). No patient in whom isolated septic arthritis of the wrist had been treated with arthroscopic irrigation and débridement required a second operation. The patients in whom isolated septic arthritis of the wrist was treated with the open method stayed in the hospital for an average of sixteen days compared with a six-day stay for those in whom isolated septic arthritis of the wrist was treated with the arthroscopic method ($p = 0.04$). The ninety-day perioperative mortality rate in the series was substantial (18% [three patients] in the open-treatment cohort and 21% [four patients] in the arthroscopy cohort).

Conclusions: Arthroscopic irrigation and débridement is an effective treatment for patients with isolated septic arthritis of the wrist; these patients had fewer operations and a shorter hospital stay than did patients who had received open treatment. However, these benefits were not seen in patients with multiple sites of infection.

Level of Evidence: Therapeutic Level III. See Instructions to Authors for a complete description of levels of evidence.

Septic arthritis is a joint-threatening emergency associated with substantial morbidity and mortality[1,2]. The principles of treatment are emergent irrigation and débridement combined with parenteral antibiotics. Although arthroscopic treatment of septic arthritis of the knee, hip, and shoulder has been well described[3-7], open irrigation and débridement remains the standard of treatment for the wrist[8-10]. However, arthroscopic irrigation and débridement of the wrist has many potential advantages, including smaller incisions (limited disruption of the dorsal wrist ligaments and capsule), less pain, superior visualization of the articular surfaces, and no open wound (with exposed tendons) requiring dressing changes. Although there

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are a few isolated reports of arthroscopic irrigation and débridement for the treatment of septic arthritis of the wrist[8,10-12], we were unable to find studies that critically evaluated the effectiveness of arthroscopic treatment. The purpose of this study was to compare the effectiveness of arthroscopic irrigation and débridement with that of open irrigation and débridement for the treatment of septic arthritis of the wrist.

Materials and Methods

An institutional review board-approved retrospective cohort comparison of all patients in whom septic arthritis of the wrist had been treated with open or arthroscopic irrigation and débridement at a single institution between 1997 and 2007 was undertaken. All adult patients with septic arthritis of the wrist treated with either of these procedures during this time period were included in the study. Patients with suspected septic arthritis of the wrist who were subsequently determined to have crystalline arthropathy or sterile inflammatory arthritis without infection were excluded. Patients who were less than eighteen years of age and those with a postoperative wound infection after wrist surgery were excluded as well.

The clinical presentation and patient comorbidity status were reviewed. Preoperative radiographs and laboratory values including a preoperative white blood-cell count, erythrocyte sedimentation rate, results of arthrocentesis, and culture results were reviewed. The postoperative course including any subsequent irrigation and débridement procedures, the length of the hospital stay, and the duration of administration of antibiotics was reviewed as well. Perioperative mortality was recorded. The primary outcome measures were the number of irrigation and débridement procedures and the length of the hospital stay.

The Student t test was used to compare mean values for parametric data, and the Fisher exact test was used to compare nonparametric data. Significance was set at $p < 0.05$. Because significance was found in the analyses of the two primary outcome measurements (the number of irrigation and débridement procedures and the length of the hospital stay), a power analysis was not performed.

Diagnosis of Septic Arthritis and Decision Regarding the Type of Surgery

The diagnosis of septic arthritis was made on the basis of the history and physical examination and was supported by laboratory findings. A history of swelling, pain, and redness of the wrist was typical. On examination, patients had severe pain with an active or passive range of motion and with axial loading of the wrist. Other findings consistent with infection included fever, leukocytosis, or an elevated erythrocyte sedimentation rate.

Because other inflammatory conditions can mimic septic arthritis, arthrocentesis was routinely performed in patients who presented with suspected isolated septic arthritis of the wrist. However, wrist arthrocentesis was not performed in some patients with multiple sites of infection who had already undergone arthrocentesis of another joint. A white blood-cell count (nucleated cell count) of $>50.0 \times 10^9$ cells/L in a specimen obtained with arthrocentesis was considered to represent infection. A Gram stain that was positive for organisms followed by a positive culture was considered conclusive evidence of septic arthritis. Blood cultures were also performed for some patients. In most cases, however, the decision regarding surgery was made before the results of cultures of blood or arthrocentesis specimens were available and was based on the history, findings of the physical examination, and supporting laboratory results.

Ten surgeons performed the irrigation and débridement procedures. Six of these surgeons were trained in wrist arthroscopy. The decision to treat the patient with open or arthroscopic surgery was made by the individual surgeon. There were no predetermined criteria for this decision-making, but there was a trend toward increased use of arthroscopy later in the study period.

Open Surgical Technique

With the patient under general anesthesia, a longitudinal midline incision was made over the dorsum of the wrist. The third extensor compartment was opened, and the extensor pollicis longus was transposed radially. Retinacular flaps were raised radially to the second extensor compartment and ulnarly to the fifth extensor compartment, exposing the wrist capsule. A variety of arthrotomies were used. These included a ligament-preserving capsulotomy (along the course of the dorsal radiocarpal ligament and the dorsal intercarpal ligament), a longitudinal arthrotomy, and separate transverse midcarpal and radiocarpal arthrotomies. The radiocarpal and midcarpal joints were opened in all cases. Fluid was typically sent for culture and sensitivity testing as well as crystal studies. The radiocarpal and midcarpal joints were inspected, débrided of proliferated synovial tissue, and typically irrigated with 3 L of normal saline solution. The incision was left open without drains and was packed with a saline solution-soaked dressing. The wrist was immobilized in a plaster splint.

Arthroscopic Surgical Technique

With the patient under general anesthesia, the hand was suspended in finger traps with 10 to 12 lb (4.5 to 5.4 kg) of traction to distract the wrist. The 3-4 and 4-5 radiocarpal portals were established. A 30° 2.7-mm arthroscope was generally used. The articular surfaces, triangular fibrocartilage complex, intercarpal ligaments, and extrinsic ligaments were inspected. When necessary, the motorized shaver was used to débride fibrinous debris and proliferated synovial tissue. After inspection and débridement, irrigation was performed. Three liters of normal saline solution was typically used, and irrigation was performed until there was no evidence of purulent drainage. Next, the radial midcarpal and ulnar midcarpal portals were established, and the process of inspection, débridement, and irrigation was repeated for the midcarpal joint. The distal radioulnar joint was not routinely irrigated unless there were clinical signs of involvement. The small skin incisions were left open or were loosely approximated with a single suture.

TABLE I Clinical Presentation

	Open-Treatment Cohort	Arthroscopy Cohort	P Value*
No. of patients (wrists)	17 (19)	19 (21)	
Mean age (range) *(yr)*	62 (25 to 80)	64 (33 to 89)	0.65
No. of men	10	13	0.73
No. of immunosuppressed patients	13	14	1.0
No. with hematogenous spread	15	14	0.41
No. with local spread	2	5	0.41
No. with multiple sites of infection	10	11	1.0
No. with bilateral wrist involvement	2	2	1.0

*The Student t test was used to compare the mean ages, and the Fisher exact test was used for all other comparisons.

Postoperative Management

If clinical examination did not demonstrate substantial improvement within twenty-four to forty-eight hours, or if there was evidence of purulent drainage or necrotic tissue, the irrigation and débridement was repeated. In all but two wrists, the repeat surgery was done in an open fashion regardless of how the initial irrigation and débridement had been performed. Broad-spectrum intravenous antibiotics tailored to the culture results were administered postoperatively. In most cases, an infectious disease consultation was obtained to assist with determining the appropriate antibiotic(s) and duration of treatment.

Source of Funding

There was no external or internal funding source for this study.

Results

From 1997 through 2007, sixty-seven adult patients with suspected septic arthritis of the wrist underwent open or arthroscopic irrigation and débridement. Fourteen patients were subsequently determined to have sterile inflammatory arthritis (i.e., rheumatoid arthritis) or crystalline arthropathy without infection and were excluded from the study. Thirteen patients had undergone irrigation and débridement of the wrist for treatment of a postoperative infection (not primary septic arthritis of the wrist) and were also excluded. Three patients were excluded because prior wrist irrigation and débridement procedures had been performed at an outside hospital before transfer to our institution. One patient was excluded because of insufficient documentation of the history and the operations that had been performed. The remaining thirty-six patients (forty wrists) with septic arthritis of the wrist were included. Seventeen patients (nineteen wrists) were treated with open irrigation and débridement, and nineteen patients (twenty-one wrists) were treated with arthroscopic irrigation and débridement.

Clinical Presentation

Tables I and II summarize the clinical presentation, demographics, and comorbidities of the patients in the two cohorts. The mean age at presentation was sixty-two years in the open-treatment cohort and sixty-four years in the arthroscopy cohort. There were ten men and seven women in the open-treatment cohort and thirteen men and six women in the arthroscopy cohort. There was some degree of immunosuppression at the time of presentation in a large proportion of both cohorts (thirteen patients in the open-treatment cohort and fourteen patients in the arthroscopy cohort). The most common causes of immunosuppression included medications, such as corticosteroids or chemotherapy, and comorbidities, such as poorly controlled diabetes or chronic renal failure. It should be noted that only four of the seventeen patients in the open-treatment cohort and five of the nineteen in the arthroscopy cohort were considered healthy. Hematogenous spread was the most common route of infection, occurring in fifteen patients in the open-treatment cohort and fourteen in the arthroscopy cohort. In two patients in the open-treatment cohort and five patients in the arthroscopy cohort, the septic arthritis developed through spread of overlying cellulitis. In one patient in the open-treatment cohort and two patients in the arthroscopy cohort, the cellulitis was related to an intravenous catheter site. There were no direct joint inoculations by penetrating injury. Ten patients in the open-treatment cohort and eleven patients in the arthroscopy cohort had multiple sites of infection, with most having another infected joint. Two patients in each cohort presented with bilateral septic arthritis of the wrist. Information on symptoms and their duration prior to presentation was not available for most patients.

Preoperative Laboratory Investigations

Table III summarizes the results of the preoperative laboratory studies. One patient in the arthroscopy cohort had leukopenia, whereas no patient in the open-treatment cohort had leukopenia. The mean preoperative white blood-cell count was elevated in both cohorts (to 15×10^9/L in the open-treatment cohort and to 12×10^9/L in the arthroscopy cohort, $p = 0.15$). The mean preoperative erythrocyte sedimentation rate was also elevated in both cohorts, but it was significantly higher in the open-treatment cohort (75 mm/hr as compared with 38 mm/hr in

TABLE II Comorbidities and Immunosuppression

Comorbidity	Open-Treatment Cohort	Arthroscopy Cohort
No. of healthy patients	4	5
No. with immunosuppressive comorbidity or medication	13	14
Recent chemotherapy	1	3
Cancer	3	5
Renal failure	2	2
Chronic alcoholism	0	1
Prednisone or other immune modulator	8	7
Diabetes	5	6
Rheumatoid arthritis	4	0
Other connective-tissue disorder	2	2
Immunoglobulin deficiency	0	1

the arthroscopy cohort, $p < 0.01$). Eight patients in the open-treatment cohort and thirteen patients in the arthroscopy cohort underwent preoperative arthrocentesis of the wrist. The mean nucleated cell count in the specimen obtained with the arthrocentesis was in the range indicating infection in both cohorts, but the count was significantly higher in the arthroscopy cohort (105.2×10^9/L as compared with 56.3×10^9/L in the open-treatment cohort, $p = 0.04$). The percentage of neutrophils in arthrocentesis specimens averaged 79 in the open-treatment cohort and 83 in the arthroscopy cohort ($p = 0.56$).

Preoperative Radiographs

The preoperative radiographs of sixteen patients (seventeen of twenty-one wrists) in the arthroscopy cohort and of eleven patients (twelve of nineteen wrists) in the open-treatment cohort were available for review. The most common findings were degenerative changes at the radiocarpal joint (ten wrists in the arthroscopy cohort and nine wrists in the open-treatment cohort), arthritis of the first carpometacarpal joint (six wrists in each cohort), and marked soft-tissue swelling (four wrists in each cohort). No radiographs were suggestive of osteomyelitis of the distal part of the radius or the wrist bones.

Number of Irrigation and Débridement Procedures Required

Eight of the nineteen wrists in the open-treatment cohort were successfully treated with a single irrigation and débridement procedure, and eleven wrists required more than one irrigation and débridement procedure; all of the procedures were performed in an open fashion. In the arthroscopy cohort, thirteen of the twenty-one wrists were successfully treated with a single irrigation and débridement procedure and eight wrists required more than one irrigation and débridement procedure. In this cohort, six of the wrists (29% of the cohort) that required repeat irrigation and débridement underwent open surgery for this procedure and two (10% of the cohort) underwent repeat arthroscopy. With the numbers studied, the difference between the two cohorts with regard to the number of wrists that required more than one irrigation and débridement procedure was not significant. The average number of irrigation and débridement procedures per wrist was two (range, one to four) in the arthroscopy cohort and two (range, one to five) in the open-treatment cohort.

When patients with multiple sites of infection were excluded—i.e., only patients with isolated septic arthritis of one wrist were evaluated—the analysis showed a significant difference between treatment groups with regard to the number of irrigation and débridement procedures required ($p = 0.001$). In the open-treatment cohort, one wrist was successfully treated with a single irrigation and débridement procedure and six wrists required more than one irrigation and débridement procedure. All eight wrists with isolated septic arthritis in the arthroscopy cohort were treated with a single irrigation and débridement procedure; no patient required a second operation. The average number of irrigation and débridement procedures per wrist was three (range, one to five) in the open-treatment cohort and one in the arthroscopy cohort.

Length of Hospital Stay

The average inpatient length of the hospital stay was twenty-four days (range, seven to sixty-three days) for the patients initially treated with open irrigation and débridement and

TABLE III Preoperative Laboratory Results

	Open-Treatment Cohort*	Arthroscopy Cohort*	P Value†
White blood-cell count *(× 10^9/L)*	15 ± 7	12 ± 5	0.15
Erythrocyte sedimentation rate *(mm/hr)*	75 ± 33	38 ± 33	<0.01
Arthrocentesis			
White blood-cell count *(× 10^9/L)*	56.3 ± 41.7	105.2 ± 38.2	0.04
Polymorphonuclear cells *(%)*	79 ± 12	83 ± 21	0.56

*The values are given as the mean per patient and the standard deviation. †Derived with the Student t test.

TABLE IV Microbiological Findings*

	Open-Treatment Cohort	Arthroscopy Cohort
Single organism	12	11
Polymicrobial	3	4
Staphylococcus aureus†	11	7
Coagulase-negative Staphylococcus‡	2	5
Group-B Streptococcus	4	2
Group-G Streptococcus	1	2
Other	1	3

*The values are given as the number of patients with the given type of infection (n = 15 patients for both cohorts). †Two organisms in the open-treatment cohort and no organisms in the arthroscopy cohort were methicillin-resistant. ‡No organisms in the open-treatment cohort and three organisms in the arthroscopy cohort were methicillin-resistant.

sixteen days (range, two to ninety-four days) for those initially treated with arthroscopic irrigation and débridement. This difference was not significant ($p = 0.24$). However, the difference was significant when only the patients with isolated septic arthritis of the wrist were compared: those initially treated with arthroscopic irrigation and débridement had an average hospital stay of six days (range, two to twelve days), whereas those initially treated with open irrigation and débridement had an average stay of sixteen days (range, seven to thirty-four days) ($p = 0.04$).

Microbiological Findings

A causative organism was identified for the infection in fifteen of the seventeen patients in the open-treatment cohort and fifteen of the nineteen in the arthroscopy cohort. For the remaining patients, the diagnosis of septic arthritis was determined by both the orthopaedic surgeon and the consulting infectious disease specialist on the basis of the clinical presentation, gross purulence on arthroscopy, leukocytosis with a left shift in the aspirated joint fluid, a favorable response to antibiotics, and a lack of crystals on polarized light microscopic examination of the joint fluid. Table IV summarizes the culture results. In both cohorts, the majority of the patients had an infection with a single organism. *Staphylococcus aureus* was the most common causative organism. The duration of treatment with intravenous antibiotics averaged five weeks in the open-treatment cohort and four weeks in the arthroscopy cohort.

Complications

Perioperative mortality was substantial in both cohorts. The ninety-day perioperative mortality rate was 18% (three patients) in the open-treatment cohort and 21% (four patients) in the arthroscopy cohort. For six of the seven patients who died, the cause of death was overwhelming sepsis and multisystem organ failure. One patient in the arthroscopy cohort died of pneumonia and renal failure during a subsequent stay in the hospital after successful treatment of the septic arthritis.

Discussion

Septic arthritis is a common problem that causes substantial morbidity and is associated with a relatively high mortality rate[2,9]. The yearly incidence of septic arthritis is estimated to be two to five per 100,000 in the general population and is even higher in certain groups (twenty-eight to thirty-eight per 100,000 individuals with rheumatoid arthritis and forty to sixty-eight per 100,000 individuals with a prosthetic joint)[13]. There is permanent impairment of joint movement in 10% to 73% of patients and an associated mortality rate of 5% to 20%[2].

The incidence of septic arthritis of the wrist is not known, but the disease occurs less frequently in the wrist than it does in other large joints. The largest percentage of cases (approximately 50%) occur in the knee, and lower-extremity joints as a group are affected in up to 79% of patients[14]. Approximately 25% of the cases that occur in the upper extremity affect the wrist[1]. Perhaps because of the relatively low incidence of septic arthritis of the wrist, its management has not been extensively studied. Although there have been multiple studies of arthroscopic irrigation and débridement for the treatment of septic arthritis of the knee, hip, and shoulder[3,4,6,7,15-24], there are few case reports or textbook descriptions of arthroscopic irrigation and débridement for septic arthritis of the wrist[10-12,18] and we are not aware of any studies evaluating the effectiveness of that treatment.

The clinical presentation of the patients in this study was similar to that described in other studies of septic arthritis of the wrist[1]. Our patients were, on the average, older than sixty years of age, and there was a high incidence of comorbidity and immunosuppression, all of which are known risk factors[2,13,14]. The most common route of spread (hematogenous), the presence of systemic leukocytosis, and the results of the arthrocentesis in both cohorts were typical for septic arthritis[1,9,13,14]. The most common causative organism in this study, *Staphylococcus aureus,* has also been generally reported as the most common organism isolated from sites of septic arthritis[1,10,13,14]. A causative organism was not isolated in six cases. However, that is also in keeping with the findings in other studies of septic arthritis, in which the prevalence of no growth on culture has ranged from 0% to 40%[1,8,19,22].

There were two significant differences between the two cohorts in terms of preoperative presentation: the preoperative erythrocyte sedimentation rate was significantly higher in the open-treatment cohort and the nucleated white blood-cell count in the specimens obtained with arthrocentesis was significantly higher in the arthroscopy cohort. It is possible that the higher erythrocyte sedimentation rate in the open-treatment cohort was due to the greater number of patients with rheumatoid arthritis in that cohort (four patients compared with no patients in the arthroscopy cohort). The mean erythrocyte sedimentation rate for rheumatoid patients was 85 mm/hr, which was higher than the average in either cohort. It is not

clear why the nucleated cell count of the arthrocentesis specimens was higher in the arthroscopy cohort. It is possible that the infections were more severe in the arthroscopy cohort, although there are no other data to support this possibility. It should be noted that, because of the small number of patients in each cohort, real differences between the two cohorts may not have been detected. Our failure to detect significant differences when we compared certain preoperative characteristics does not signify equivalence of the two cohorts.

When the comparison involved all patients, including those with multiple sites of surgical infection, no difference between groups was found in the number of irrigation and débridement procedures performed or the length of the hospital stay. However, when only patients with isolated septic arthritis of the wrist were compared, there was a significant difference in both the number of irrigation and débridement procedures and the length of the hospital stay. We believe that studying only patients with isolated septic arthritis of the wrist provides more useful information with regard to those two variables because of the likelihood that patients, in both cohorts, who had multiple sites of infection underwent an additional irrigation and débridement of the wrist when they returned to the operating room for irrigation and débridement of other sites.

It is not clear why, in the group with isolated septic arthritis of the wrist, patients treated with open irrigation and débridement tended to undergo multiple surgical procedures whereas those in the arthroscopy cohort were successfully treated with a single irrigation and débridement procedure. A possible explanation is that the open wounds resulting from open irrigation and débridement may have required repeat débridement because of the accumulation of fibrinous debris or the presence of necrotic tissue. Another possibility is that these patients were simply taken to the operating room for a final débridement and wound closure as a matter of protocol. Although this may account for a second operation, it does not explain the average of three irrigation and débridement procedures in the open-treatment cohort. In addition, because this was a retrospective nonrandomized study, selection bias may have affected the outcomes. It is possible that patients with more severe or chronic infections were treated preferentially with open irrigation and débridement. Although this possibility cannot be ruled out, we believe that the two cohorts were relatively similar with regard to their clinical presentation.

Another factor may have influenced the length of the hospital stay. Arthroscopy of the wrist has become more common over the last decade, and arthroscopic irrigation and débridement was performed more frequently in the later portion of the study whereas open irrigation and débridement was done more often in the early portion of the study. Because the trend toward more arthroscopies in more recent years coincided with a national trend toward shorter hospital stays, that may have affected our findings with regard to this variable.

The substantial perioperative mortality rate in both cohorts is consistent with published mortality rates of 5% to 20% in association with septic arthritis[2,25,26]. The high mortality rate is likely due to the severity of the disease process as well as the high rate of comorbidities in this population.

Other limitations of this study should be noted. Because of the retrospective nature of the investigation, detailed clinical evaluations of postoperative wrist pain and range of motion were not available for many patients. Likewise, the duration of symptoms prior to presentation was not known for most of the patients. In addition, the number of patients in this study was small, and the follow-up was short.

In conclusion, arthroscopic irrigation and débridement was effective in all cases of isolated septic arthritis of the wrist and in 62% of the cases overall. Compared with open irrigation and débridement, it resulted in fewer operations and shorter hospital stays for patients with isolated septic arthritis of the wrist. These benefits were not seen in patients with multiple sites of infection. ■

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