THA After Acetabular Fracture Fixation

Is Frozen Section Necessary?

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Abstract

Background Infection is uncommon after THA performed for failed acetabular fracture repair, despite a high reported incidence of culture-positive fixation implants. The use of frozen section analysis at the time of THA after acetabular fracture fixation surgery is unknown.

Questions/purposes We asked whether frozen section analysis predicted occult infection after THA performed after acetabular fracture repair.

Methods We retrospectively reviewed the charts of 43 of 49 patients with prior acetabular fracture fixation who had intraoperative frozen section and culture data from a conversion THA between 2002 and 2010. The average age of patients at fracture was 53 years; conversion was performed after an average of 553 days (median, 369 days; range, 51–2951 days). Five patients had an infection after acetabular fracture surgery (three deep, two superficial). At conversion we obtained an average of three frozen section specimens per patient; 10 specimens in eight patients contained greater than 10 polymorphonuclear

cells/high-power field. The minimum followup was 51 days (median, 256 days; range, 51–2085 days).

Results Five patients had positive intraoperative cultures, three of whom had a positive frozen section. All patients who had prior deep infection developed positive intraoperative cultures. The sensitivity, specificity, positive predictive value, and negative predictive value of frozen section analysis were 0.60, 0.87, 0.38, and 0.94, respectively.

Conclusion Infection complicating THA after acetabular fracture repair is uncommon. A history of deep infection complicating the acetabular fracture surgery was the strongest predictor of infection. Frozen section analysis has a high specificity and negative predictive value.

Level of Evidence Level III, diagnostic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Fractures of the acetabulum typically occur in young patients and are often the result of high-energy trauma. The goal of treatment is anatomic reduction of the articular surfaces with restoration of normal joint biomechanics to prevent the development of posttraumatic arthritis. Hip degeneration can result from articular incongruity, cartilage damage at the time of injury, subtle joint instability, avascular necrosis of the femoral head, or inadvertent intraarticular fixation implant placement. The incidence of posttraumatic arthritis and the potential need for delayed arthroplasty is highly variable and is reportedly between 24% and 57% [11, 12]. Despite meticulous surgical repair, THA is commonly required for treatment of posttraumatic arthritis after acetabular fractures.

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Each author certifies that his or her institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research. This work was performed at the University of Maryland School of Medicine, Baltimore, MD, USA.

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Deep sepsis after THA is a devastating complication. The reported incidence of infection after revision THA is 1.1% to 12% [6, 15, 17, 20] versus 0.2% to 2.2% for primary hip arthroplasty [6, 14, 15, 17]. Joint sepsis can occur as a result of an undetected or untreated occult infection present before arthroplasty. Treatment may consist of single-stage reimplantation or two stages involving removal of components followed by a prolonged course of antibiotics and subsequent component reimplantation. Infection results in substantial morbidity, including multiple operative procedures, prolonged absence from activity and work, and increased risk of subsequent arthroplasty failure. The reported incidence of deep joint infection after open reduction and internal fixation of acetabular fractures is relatively low, ranging from 0% to 6% [21]. However, the incidence of positive cultures during removal of fracture fixation implants in the absence of clinical infection is reportedly as high as 52% [13]. As a result, there is concern about the potential consequences of fixation implant colonization or the presence of occult infection in the tissues at the time of conversion to THA after acetabular fracture repair. This raises the question of the appropriateness of single-stage versus two-stage conversion THA after failure of acetabular fracture repair.

The clinical diagnosis of occult joint infection at the time of revision THA has been well described in the literature [2, 7, 8, 10]. There is currently no universally accepted “gold standard” for the diagnosis of infection. Della Valle et al. [8] defined infection at the time of revision hip arthroplasty as bacterial growth on solid media or permanent histologic sections with acute inflammation, whereas Bori et al. [7] defined infection as growth of the same bacteria from at least two deep cultures or the presence of pus around the prosthesis. The use of preoperative laboratory studies, including C-reactive protein (sensitivity and specificity, 0.96 and 0.92, respectively) and erythrocyte sedimentation rate (sensitivity and specificity, 0.82 and 0.85, respectively), are useful in detecting occult infections [19]. Intraoperative frozen section histologic analysis has been useful in detecting occult infection at the time of operation (sensitivity and specificity, 0.80 to 0.91 and 0.89 to 0.98, respectively) [1, 3, 9]. Although the detection of infection after failed THA has been well documented, it is unclear whether these studies apply to patients who have had prior surgery for acetabular fractures.

We asked whether frozen section analysis could predict occult infection at the time of conversion THA after operative fixation of an acetabular fracture.

Patients and Methods

From January 2002 through December 2009, 49 patients with prior operative repair of an acetabular fracture were

treated with conversion THA. Forty-three patients had frozen section analysis and intraoperative cultures performed at the time of their first surgery (either THA or staged hardware removal). Of these 43 patients, there were 14 women and 29 men. Information from the initial injury was available for 41 patients; the remaining two did not have complete information available regarding their initial injury as a result of the remoteness of the injury or initial treatment outside of our institution. The average age at the time of initial injury was 49 years (range, 26–81 years). The minimum followup was 51 days (median, 256 days; range, 51–2085 days). We obtained prior approval from the Institutional Review Board to review the charts of these patients.

Of the 43 patients, five patients had a postoperative wound infection (three deep and two superficial to the fascia) requiring additional surgery and antibiotic treatment after the acetabular fracture fixation surgery. Before conversion surgery, patients underwent routine preoperative clearance and laboratory evaluation, including a white blood cell count. No additional workup for evaluation of infection was routinely performed. Eleven patients were further evaluated with erythrocyte sedimentation rate, C-reactive protein, and hip aspiration as a result of a higher index of suspicion for infection.

The average interval between injury and reconstructive surgery was 594 days (range, 22 days to more than 10 years). The mean age at return to the operating room was 54.3 years (range, 26.9–82.6 years). Patients received preoperative antibiotics (cephalosporin or vancomycin if there was a history of methicillin-resistant bacterial infection).

Surgery was performed through either a posterior or anterolateral approach to the hip, based on surgeon preference, with exposure and removal of fixation implants as needed to insert the acetabular component. Two patients underwent a planned staged reconstruction for treatment of posttraumatic arthritis as a result of a high degree of suspicion for quiescent infection based on history of infection or rapid joint destruction. One went on to successful reimplantation, whereas the second elected not to undergo further surgery. Two patients underwent resection arthroplasty based on intraoperative frozen section findings. One of these patients underwent second-stage implantation of a THA, whereas the second remained with a resection arthroplasty resulting from persistent deep infection at the time of planned reimplantation. The remaining patients in the series were treated with a single-stage conversion to a THA.

At the time of surgery, tissue from the synovial membrane adjacent to the fixation implants and/or any other suspicious tissue were sent for frozen section analysis, permanent pathology, and culture. We defined infection as

any patient who met one of the following two criteria: (1) bacterial growth on solid culture medium; or (2) any bacterial growth associated with acute inflammation on permanent histologic analysis of tissue.

Postoperatively, patients received continued antibiotic coverage until operative cultures were finalized. Patients diagnosed with an infection were treated with 6 weeks of intravenous antibiotics based on sensitivities from intraoperative culture and recommendations from an infectious disease consultant.

After discharge, followup was scheduled at 6 weeks, 3 months, 6 months, 1 year, and yearly thereafter. Radiographs were obtained immediately after surgery, at 6 weeks, 1 year, and yearly thereafter. No patient presented with clinical signs or symptoms of active infection.

Sensitivity, specificity, and positive and negative predictive values for the frozen sections were calculated (SAS 9.1 for Windows [computer program]; SAS Institute, Inc, Cary, NC).

Results

An average of three frozen section specimens was sent per patient (range, 1–11 specimens). Using the criteria established by Athanasou et al. [2], a positive frozen section was a sample with an average of one polymorphonuclear lymphocyte per high-powered field after examination of at least 10 high-powered fields. A total of 10 samples from eight patients had greater than 10 polymorphonuclear leukocytes in at least one high-powered field. Of these eight patients, three had at least one positive intraoperative culture. Two additional patients had positive intraoperative cultures with negative frozen section analysis (Table 1). The sensitivity, specificity, positive predictive value, and

negative predictive value for the detection of infection by frozen section analysis were 0.60 (95% CI, 0.15–0.95), 0.87 (95% CI, .72–.96), 0.38, and 0.94, respectively. Of the five patients with prior infection, the three who had a deep infection developed positive intraoperative cultures, whereas the two patients with superficial infection developed positive intraoperative cultures. One of the patients with a prior deep infection had a positive frozen section analysis, and a second had a negative frozen section analysis but a positive permanent histologic section for acute inflammation.

Discussion

Infection after THA is a devastating complication. The reported incidence of infection after conversion from prior acetabular fracture surgery varies widely (range, 0%–17.5%) [4, 5, 16, 18] and is comparable to revision THA (range, 1.1%–12%) [6, 15, 17, 20]. Because of the high rate of bacterial growth reported after simple fixation implant removal, there is concern when performing any THA in a previously operated bed with retained fixation implants that will need to be exposed or removed [13]. Additionally, after posterior wall acetabular fractures, there may be a segment of ununited, avascular bone that may serve as an additional nidus for infection. Although frozen section analysis is a useful study for the detection of infection after total joint arthroplasty, it is unknown whether it would be useful during conversion to arthroplasty after prior fracture fixation. We asked whether frozen section analysis predicted occult infection after THA performed for posttraumatic arthritis after acetabular fracture repair.

Our study has several limitations. First, as a result of the relatively small number of patients and infrequency of

Table 1. Summary data of patients with positive frozen section or positive intraoperative culture

Patient number	Age at conversion (years)	Interval to conversion (days)	Prior infection	Number of positive frozen sections	Number of frozen sections reviewed	Culture result
1	26.5	591	No	2	2	Staphylococcus aureus
2	80.2	223	No	2	3	Light Enterococcus, S. aureus in anaerobic broth
3	38.8	316	Yes	1	5	Rare S. aureus
4	49.7	611	No	1	3	No growth
5	66.7	179	No	1	4	No growth
6	70.1	546	No	1	5	No growth
7	56.8	378	No	1	4	No growth
8	44.6	729	No	1	4	No growth
9	34.4	450	Yes	0	5	S. aureus in anaerobic broth
10	26.2	257	Yes	0	3	Light growth S. aureus

clinical infection, the study may be underpowered and the diagnostic accuracy of frozen section may be less than reported in our study. However, the sensitivity and negative predictive values reported in our study are comparable to those reported for revision THA [3, 7]. Second, patients did not have a standard or minimum number of frozen section specimens sent at the time of the surgery. This lack of standardization may have resulted in sampling errors or fewer positive results than if each patient had a standard sampling protocol. Additionally, there was no standard approach to fixation implants; fixation implants were not exposed in every case, and in some cases, fixation implants were exposed and not removed because the implant did not interfere with placement of the arthroplasty components. Furthermore, removed implants did not undergo sonication or other specialized methods for bacterial detection, which limits the conclusions that can be drawn about occult infection specifically as it relates to the fixation implants. Finally, there is no universally accepted definition of what constitutes a true occult infection; the application of our data may be limited if using different criteria to define an occult infection found at the time of surgery. We also cannot ensure some of the patients not diagnosed with a postoperative infection might not have an occult infection, which might alter the findings.

Although the incidence of occult infection of fixation implants has been reported at 52%, we found a lower incidence of occult infection of previously placed fixation implants or within the hip itself at the time of planned conversion THA (five of 43 cases [11.6%]), and the risk of unsuccessful conversion to THA resulting from deep infection was only 4.7% (two of 43 cases). We found a specificity of 0.87, which is comparable to 0.89 reported by Fehring and McAlister [9] and 1.00 reported by Bori et al. [7]. Our sensitivity result of 0.6 is higher than that reported by these authors (18.2 and 28.5, respectively) [7, 9]; however, our 95% confidence interval has a wide range resulting from the number of patients and infrequency of infection. When infection was defined as bacterial growth on intraoperative culture, Feldman et al. [10] reported specificity of 0.96 and sensitivity of 1.00 in 33 revision THA cases. The experience of the pathologist is critical when using frozen section analysis, and a clear and open dialogue between the surgeon and the pathologist is essential for proper interpretation of the histologic findings. Because of the consequences of an infection, we recommend hardware removal and resection arthroplasty in cases pending final culture and permanent histologic analysis.

Our observations suggest a history of deep infection after acetabular fracture surgery is a risk factor for the development of a positive intraoperative culture, and surgeons should maintain a high index of suspicion for quiescent infection in such patients. Of the five patients

with prior infection, only one patient had a positive frozen section analysis, whereas the three with prior deep infection had positive intraoperative cultures (including the one with a positive frozen section analysis). Ranawat et al. [16] reported a 16% incidence of infection in 37 patients undergoing THA for posttraumatic arthritis after acetabular fracture. Each of these patients had a known infectious complication related to their initial trauma or acetabular fracture; however, the total number of patients in the series who had a known infectious complication before THA was not reported. Other series of THA for treatment of post-traumatic arthritis after acetabular fracture have not reported on prior infection [4, 5, 21].

Our data suggest frozen section analysis, using the criteria we describe, provides a reliable predictor of the absence of infection at the time of conversion THA and underscores the importance of a history of clinical deep infection as a risk factor for occult infection, which can compromise the likelihood of successful arthroplasty conversion.

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