Magnetic Resonance Imaging Findings in Hematogenous Osteomyelitis of the Hip in Adults

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Abstract Hematogenous hip infections are rare in adults and the extent of infection into the bone or adjacent soft tissues may be underestimated, leading to inadequate surgical débridement. Using MRI, we sought to determine the extent of bone involvement and the presence of adjacent soft tissue abscesses in adults with hip osteomyelitis. We reviewed the records and MRIs in 11 adult patients (12 hips) with hematogenous osteomyelitis of the femoral head in 12 hips. Ten of 11 patients had one or more comorbidities. All patients underwent surgical débridement and received antibiotic therapy for 6 weeks. MRI revealed osteomyelitis distal to the femoral head in seven of 12 hips with extension into the medullary canal in three of these seven. Femoral head erosions were present in 10 hips, acetabulum osteomyelitis in 11, and acetabular erosions in six hips. Infection extended into adjacent soft tissues in eight of 12 hips. MRI demonstrated that the infection may

extend distal to the femoral head or into the adjacent soft tissues. MRI may be useful for preoperative planning so that all regions affected by the infection can be treated.

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

Introduction

Osteomyelitis may result from direct inoculation of pathogens after trauma or surgery, contiguous spread of an infectious process, or hematogenous seeding of the bone during bacteremia [16].

Hematogenous osteomyelitis of the proximal femur and hematogenous septic arthritis of the hip are not infrequent in pediatric patients [8, 13, 22]. Perlman et al. [22] reported the proximal femur was involved in 10 of 66 children (15%) with hematogenous osteomyelitis and the hip was also involved in five of these 10 infections. On the contrary, hematogenous hip infections are uncommon in adult patients [1]. Hip infections in adults usually develop as a complication of surgical procedures, especially hip arthroplasty [2, 9, 20].

Regardless of etiology, surgical débridement is the cornerstone of treatment of the infected hip in adults and excision arthroplasty may be required if osteomyelitis of the femoral head is present [1, 9, 20]. However, the rare occurrence of hematogenous hip infections in adults makes diagnosis and management problematic; the diagnosis may not be considered and may be missed initially, thereby leading to delayed treatment and allowing the infectious process to spread locally [1]. In addition, the extent of bone involvement and the potential extension of infection into the adjacent soft tissues are not apparent by conventional

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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.

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radiographs and may be underestimated, thereby leading to inadequate surgical débridement and persistence or recurrence of infection.

Magnetic resonance imaging (MRI) has high sensitivity for the diagnosis of musculoskeletal infection and also delineates with detail the extent of the osseous and soft tissue involvement [7, 11, 15, 17]. Studies on pediatric pelvic osteomyelitis using MRI demonstrate adjacent muscle abscesses in 20% to 55% of patients [4, 5, 14, 15, 17]. An MRI study on 44 paralyzed adult patients with osteomyelitis of the pelvis or hip demonstrated adjacent abscesses in 15 patients [10]. Knowledge of the extent of bone and soft tissue involvement will be useful for patient management and preoperative planning so that all locations of the infectious process are addressed [6].

Our purposes were to determine (1) the extent of bone involvement, and (2) the presence of adjacent soft tissue abscesses in adult patients with hip osteomyelitis of hematogenous origin.

Materials and Methods

We retrospectively reviewed the medical records of 11 adult patients (12 involved hips) treated for hematogenous hip infections with osteomyelitis of the femoral head from 2003 to 2006. There were nine male and two female patients with a mean age of 47 years (range, 33–59 years). The inclusion criteria were: (1) adult age (18 years or older); (2) hip infection, diagnosed based on clinical picture, laboratory exams, or positive cultures; (3) hematogenous origin of the infection, which was determined by excluding any patients with prior surgery or injury to the hip or pelvis (fractures, penetrating trauma or soft tissue loss over the hip or pelvis) who may have had direct inoculation of bacteria at the area of the hip or at the adjacent soft tissues; and (4) MRI evaluation prior to surgical management demonstrating femoral head edema indicative of osteomyelitis as reflected by decreased signal in T-1 weighted images and increased signal in STIR (short tau inversion recovery) T-2 weighted images (Fig. 1). We obtained prior ethical board approval.

Ten of 11 patients were classified as B hosts according to the Cierny-Mader classification [3] because of one or multiple comorbidities, the most common being intravenous drug abuse and smoking in six patients each (Table 1). Patients presented to the musculoskeletal infection ward of our institution with a considerable delay since the onset of symptoms of the involved hip(s); the mean delay was 42 days (range, 7–89 days).

All MRI exams were reviewed at the time of patient care by a single experienced musculoskeletal radiologist (TL) to determine the extent of involvement of the proximal femur

Fig. 1 Coronal STIR image demonstrates hip effusion with femoral head and acetabular bone marrow edema, loss of articular cartilage and erosions.

Table 1. Patient comorbidities

Comorbidities	Number of patients
Intravenous drug abuse	6
Smoking	6
Diabetes mellitus	3
Hepatitis B or C without cirrhosis	3
Hepatitis C with cirrhosis	2
Alcohol abuse	2
HIV	1

and acetabulum, as well as the presence of adjacent soft tissue abscesses. A combination of T1-weighted sequences and STIR sequences in three cardinal planes was used. T1-weighted sequences were usually obtained in the axial and coronal plane and STIR sequences in the axial, coronal, and sagittal plane. No intravenous contrast material was used. All patients underwent surgical débridement, which included excision of the femoral head in 10 of 12 hips. Adjacent soft tissue abscesses were managed surgically or with CT-guided aspiration. Intraoperative culture results revealed a monomicrobial infection in nine hips (*Staphylococcus aureus* in five, *Peptostreptococcus anaerobius* in two, *Streptococcus pyogenes* in one, and *Prevotella intermedia* in one hip) and a polymicrobial infection in one hip (*Staphylococcus aureus* and *Klebsiella pneumoniae*). In two hips no organism grew in culture. Both patients were already on antibiotics at the time of surgery, had elevated C-reactive protein and erythrocyte sedimentation rate, and had

previous blood cultures positive for *Staphylococcus aureus*. *Staphylococcus aureus* was the most common organism, present in six hips (three pathogens were oxacillin-sensitive and three were oxacillin-resistant). Antibiotic therapy was administered for 6 weeks postoperatively.

Results

Osseous involvement extended distal to the femoral head in seven of 12 hips; there were MRI changes consistent with osteomyelitis in the intertrochanteric area in seven hips (Fig. 2), and in three of these the infection extended into the medullary canal up to 10 cm distal to the lesser trochanter (Fig. 3). Other imaging findings included femoral head erosions in 10 hips (Figs. 1, 2), osteomyelitis of the acetabulum in 11 hips with acetabular erosions in six hips (Figs. 1, 2, 3), and involvement of the sacroiliac joint and symphysis pubis in one patient each. This information was useful in guiding surgical débridement. When osteomyelitis extended to the intertrochanteric area, the cancellous bone of that area was débrided following excision of the femoral head and neck. When the MRI demonstrated medullary canal involvement, the canal was opened and reamed or curetted. Otherwise, if there was no evidence of intramedullary extension of infection, the medullary canal was not opened to avoid introducing bacteria into this area. When the acetabulum was involved, reaming of the acetabulum was performed.

Fig. 2A–B Coronal STIR (A) and T1-weighted (B) images demonstrate femoral head erosions and collapse. There is extensive bone marrow edema signal change present in the acetabulum and also in the femoral head extending distally into the intertrochanteric area.

Fig. 3 Coronal STIR image demonstrates extensive bone marrow edema of the left hip extending distally into the femoral shaft. There is also extensive bone marrow edema signal change of the acetabulum extending proximally towards the sacroiliac joint. Note marked soft tissue edema involving the subcutaneous tissues and musculature. Abscess formation is present in the adductor musculature and the greater trochanteric bursa.

Table 2. MRI findings in hematogenous osteomyelitis of 12 hips

MRI findings	Number
Osseous and articular findings	
Femoral head osteomyelitis	12
Hip effusion	12
Femoral head erosions	10
Osteomyelitis of the acetabulum	11
Acetabular erosions	6
Sacroiliac joint infection	1
Symphysis pubis infection	1
Soft tissue findings	
Iliopsoas abscess	4
Subiliacus abscess	4
Subgluteal abscess	3
Subadductus abscess	3
Greater trochanter septic bursitis	2
Subiliopsoas abscess	1

Fig. 4 Coronal STIR image demonstrates an abscess (white arrow) medial to the iliopsoas tendon (black arrow) as it inserts onto the lesser trochanter. Also note the presence of fluid in the hip and the involvement of the acetabulum.

The infection extended into the adjacent soft tissues in the form of fluid collections (abscesses) in eight of 12 hips (Table 2). In six hips there were multiple soft tissue abscesses present (Fig. 3) and in two hips there was a

single abscess (Fig. 4). Iliopsoas and subiliacus abscesses were the most common, present in four hips each.

Discussion

Information on the extent of bone and soft tissue involvement in patients with osteomyelitis may be helpful to guide patient management and surgical débridement so that all locations of the infectious process are addressed. We aimed to determine the extent of bone involvement and the presence of adjacent soft tissue abscesses in adults patients with hematogenous hip osteomyelitis.

Our findings are limited to a specific patient group of compromised hosts with delayed presentation for treatment; the impaired host response to infection and the prolonged time interval from onset of symptoms to treatment may have contributed to the observed frequent spread of the infection beyond the hip. These findings may not be applicable to healthy patients who present for treatment without delay after developing a hematogenous hip infection. Nevertheless, the findings underscore the potential for underestimating the true extent of infection in cases of osteomyelitis involving the hip without the additional information obtained by MRI. Our MRI exams were not independently reviewed by at least two radiologists to reach a consensus on the diagnostic findings and there might be some variability in identifying the extent of the infections.

Intravenous contrast material, such as gadolinium, facilitates differentiating fluid collections/abscesses from edema of the surrounding soft tissues [5, 6]. However, intravenous contrast is not routinely used at our institution for the work-up of musculoskeletal infections. This is similar to suggestions by other authors [18, 19], who reported that bone inflammatory changes were similar in extent on contrast-enhanced T1-weighted sequences and on fast fat-suppressed T2-weighted sequences, such as STIR. In our experience, abscesses are also clearly demonstrated on STIR sequences, but if there is difficulty distinguishing phlegmon from abscess, then contrast is used. We prefer to use contrast only in select cases because of the added cost, the increased time necessary to inject and obtain additional sequences, and because of concerns for nephrotoxicity and nephrogenic systemic fibrosis in patients with renal insufficiency [21, 23].

Studies on pediatric patients with osteomyelitis of the pelvis have demonstrated MRI often detects associated soft tissue abscesses [4, 5, 14, 15, 17]. Muscle abscesses were present in four of 20 children with osteomyelitis of the pelvis in the series by McPhee et al. [17], and in 55% (21/38) of children in the series by Connolly et al. [5]. Using MRI, Huang et al. evaluated 44 adult patients with osteomyelitis of the pelvis or hip and found adjacent abscesses

in 15 patients [10]. However, all patients in that study were paralyzed and many had decubitus ulcers so the origin of osteomyelitis is uncertain; moreover the authors did not provide data on the number of patients with hip osteomyelitis and the presence of associated abscesses in this subgroup [10].

In contrast, we evaluated patients with hip osteomyelitis comprising a homogeneous group regarding the etiology of infection. The absence of prior trauma, surgery, or soft tissue loss at the hip or pelvis assured the hematogenous origin of the infections and also prevented the confounding effects of postoperative or posttraumatic soft tissue changes on MRI imaging.

MRI has high sensitivity and specificity for the diagnosis of both osteomyelitis and soft tissue infections [7, 11]. MRI accurately depicts edematous, diseased bone and differentiates diseased bone from normal bone. However, differentiating reactive bone marrow edema from osteomyelitis is difficult as they have similar signal characteristics. Therefore, it should be noted that the extent of osteomyelitis could be overestimated because of reactive marrow edema and hyperemia adjacent to osteomyelitis.

Other imaging modalities may also be helpful in the evaluation of osteomyelitis. Bone scintigraphy can evaluate the whole skeleton for other areas of osteomyelitis, which can be useful in young children with diffuse symptoms, but does not provide anatomic detail and exact localization of the infectious process [4, 24]. Ultrasound can diagnose fluid collections but cannot provide data on bone involvement [19]. Computerized tomography can delineate sequestra and diagnose fluid collections but does not provide the detail that MRI does on early marrow changes [12, 17].

MRI can delineate the extent of involvement of the bone marrow and the surrounding soft tissues and has been described as imaging modality of choice for the evaluation of osteomyelitis of the pelvis in children [5, 15, 17]. We believe that MRI is a valuable diagnostic tool in osteomyelitis of the hip as well. The information provided may be useful for patient management and preoperative planning so that all locations of the infectious process are addressed.

MRI in adult patients with osteomyelitis of the hip demonstrates the infection may extend distal to the femoral head into the intertrochanteric area and medullary canal of the femur or into adjacent soft tissues.

References

1. Bulmer JH. Septic arthritis of the hip in adults. *J Bone Joint Surg Br.* 1966;48:289–298.
2. Castellanos J, Flores X, Llusa M, Chiriboga C, Navarro A. The Girdlestone pseudarthrosis in the treatment of infected hip replacements. *Int Orthop.* 1998;22:178–181.
3. Cierny G, Mader JT, Pennick H. A clinical staging system for adult osteomyelitis. *Contemp Orthop.* 1985;10:17–37.
4. Connolly LP, Connolly SA, Drubach LA, Jaramillo D, Treves ST. Acute hematogenous osteomyelitis of children: assessment of skeletal scintigraphy-based diagnosis in the era of MRI. *J Nucl Med.* 2002;43:1310–1316.
5. Connolly SA, Connolly LP, Drubach LA, Zurakowski D, Jaramillo D. MRI for detection of abscess in acute osteomyelitis of the pelvis in children. *AJR Am J Roentgenol.* 2007;189:867–872.
6. Dangman BC, Hoffer FA, Rand FF, O'Rourke EJ. Osteomyelitis in children: gadolinium-enhanced MR imaging. *Radiology.* 1992;182:743–747.
7. Erdman WA, Tamburro F, Jayson HT, Weatherall PT, Ferry KB, Peshock RM. Osteomyelitis: characteristics and pitfalls of diagnosis with MR imaging. *Radiology.* 1991;180:533–539.
8. Frank G, Mahoney HM, Eppes SC. Musculoskeletal infections in children. *Pediatr Clin North Am.* 2005;52:1083–1106, ix.
9. Grauer JD, Amstutz HC, O'Carroll PF, Dorey FJ. Resection arthroplasty of the hip. *J Bone Joint Surg Am.* 1989;71:669–678.
10. Huang AB, Schweitzer ME, Hume E, Batte WG. Osteomyelitis of the pelvis/hips in paralyzed patients: accuracy and clinical utility of MRI. *J Comput Assist Tomogr.* 1998;22:437–443.
11. Jaramillo D, Treves ST, Kasser JR, Harper M, Sundel R, Laor T. Osteomyelitis and septic arthritis in children: appropriate use of imaging to guide treatment. *AJR Am J Roentgenol.* 1995;165:399–403.
12. Kanal E, Burk DL, Jr, Brunberg JA, Johnson ND, Wood BP, Flom L. Pediatric musculoskeletal magnetic resonance imaging. *Radiol Clin North Am.* 1988;26:211–239.
13. Kaplan SL. Osteomyelitis in children. *Infect Dis Clin North Am.* 2005;19:787–797, vii.
14. Karmazyn B, Kleiman MB, Buckwalter K, Loder RT, Siddiqui A, Applegate KE. Acute pyomyositis of the pelvis: the spectrum of clinical presentations and MR findings. *Pediatr Radiol.* 2006;36:338–343.
15. Karmazyn B, Loder RT, Kleiman MB, Buckwalter KA, Siddiqui A, Ying J, Applegate KE. The role of pelvic magnetic resonance in evaluating nonhip sources of infection in children with acute nontraumatic hip pain. *J Pediatr Orthop.* 2007;27:158–164.
16. Lazzarini L, Mader JT, Calhoun JH. Osteomyelitis in long bones. *J Bone Joint Surg Am.* 2004;86:2305–2318.
17. McPhee E, Eskander JP, Eskander MS, Mahan ST, Mortimer E. Imaging in pelvic osteomyelitis: support for early magnetic resonance imaging. *J Pediatr Orthop.* 2007;27:903–909.
18. Miller TT, Randolph DA, Jr, Staron RB, Feldman F, Cushin S. Fat-suppressed MRI of musculoskeletal infection: fast T2-weighted techniques versus gadolinium-enhanced T1-weighted images. *Skeletal Radiol.* 1997;26:654–658.
19. Palestro CJ, Love C, Miller TT. Diagnostic imaging tests and microbial infections. *Cell Microbiol.* 2007;9:2323–2333.
20. Parr PL, Croft C, Enneking WF. Resection of the head and neck of the femur with and without angulation osteotomy. A follow-up study of thirty-eight patients. *J Bone Joint Surg Am.* 1971;53:935–944.
21. Penfield JG, Reilly RF, Jr. What nephrologists need to know about gadolinium. *Nat Clin Pract Nephrol.* 2007;3:654–668.
22. Perlman MH, Patzakis MJ, Kumar PJ, Holtom P. The incidence of joint involvement with adjacent osteomyelitis in pediatric patients. *J Pediatr Orthop.* 2000;20:40–43.
23. Sam AD, 2nd, Morasch MD, Collins J, Song G, Chen R, Perelles FS. Safety of gadolinium contrast angiography in patients with chronic renal insufficiency. *J Vasc Med.* 2003;38:313–318.
24. Weber-Chrysochoou C, Corti N, Goetschel P, Altermatt S, Huisman TA, Berger C. Pelvic osteomyelitis: a diagnostic challenge in children. *J Pediatr Surg.* 2007;42:553–557.