



## Clinical Notes

# Ultrasound-guided hip arthrocentesis in the ED

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**Abstract** In patients presenting with atraumatic joint pain and swelling, diagnosis is typically made by synovial fluid analysis. Management of an acute suspected hip joint arthritis can present a challenge to the emergency physician (EP). Hip joint effusions are somewhat more difficult to identify and aspirate than effusions in other joints that are commonly managed by EPs. Identification and aspiration of a hip joint effusion under ultrasound guidance is a well-established procedure in the fields of orthopedic surgery and interventional radiology. Here, we report 4 cases of ultrasound-guided hip arthrocentesis at the bedside by EPs; relevant technical details of the procedure are reviewed. These cases demonstrate the feasibility of ultrasound-guided hip arthrocentesis in the emergency department (ED) by EPs. With increasing availability of bedside ultrasound in the ED, suspected hip joint arthritis or infection may be evaluated and managed by the trained EP in a fashion similar to other joint arthritides.

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## 1. Introduction

Acute hip pain may arise from a variety of inflammatory processes involving the hip joint. Of particular concern for the emergency physician (EP) is the patient with a suspected septic hip, an orthopedic emergency because of the potential for rapid and permanent joint destruction. Other possible causes of hip pain in adults include trauma, intraarticular fracture or hematoma, crystal deposition, degenerative arthritis, avascular necrosis, osteomyelitis, bone tumors, and connective tissue disorders. Acute septic arthritis of any joint, including the hip joint, is typically managed with adequate drainage of the infected joint space, administration of antibiotics, and joint rest in a position of stability [1]. While controversy exists over whether open surgical drainage, arthroscopic drainage, or treatment by multiple

aspirations is most advantageous, early arthrocentesis is no longer debated: “Prompt evaluation of purulent joint fluid appears to be crucial both for preservation of articular cartilage and for resolution of the infection [1].”

Evaluation of suspected hip joint sepsis presents a particular problem for the EP because it is inherently more difficult to perform arthrocentesis of the hip than other peripheral joints. Delayed treatment of a septic hip joint may lead to serious sequelae, including avascular necrosis of the femoral head, proximal femoral and/or pelvic osteomyelitis, and systemic sepsis. When the diagnosis of septic hip arthritis is considered, immediate orthopedic surgery consultation is recommended [2]. Typically, the hip joint is aspirated either at the bedside or in the operating room by large-bore needle aspiration, arthroscopy, or open drainage. Ultrasound guidance has been used to assist in arthrocentesis of the hip joint for over 20 years, and its use has been described in the emergency medicine literature [3,4]. However, careful review of the literature review reveals only one reported case documenting ultrasound-guided hip arthrocentesis performed by an EP [5].

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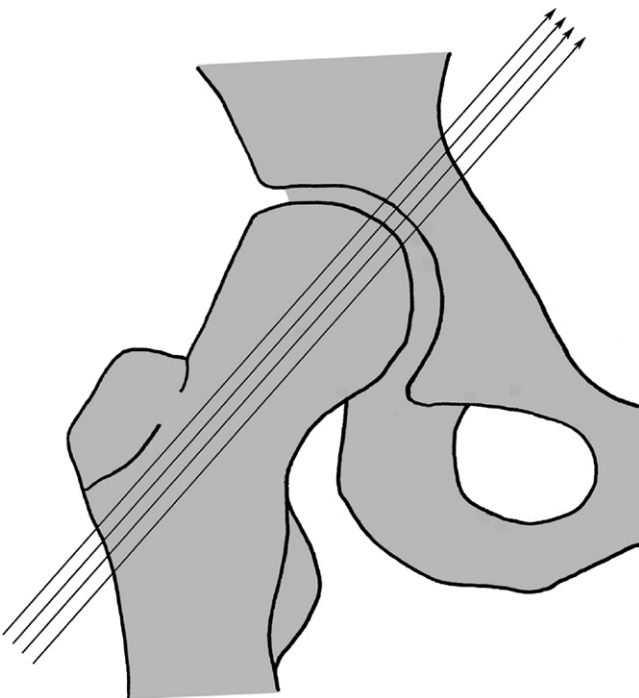


**Fig. 1** Demonstration of ultrasound guided hip arthrocentesis with transducer orientation marker angled superomedially, drape and probe cover omitted for purpose of demonstration.

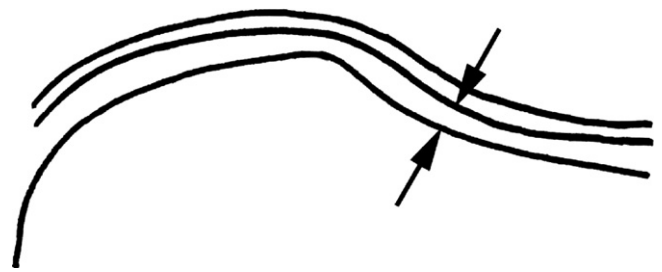
This report reviews 4 cases of ultrasound-guided hip arthrocentesis performed by EPs in our emergency department (ED) and includes a brief discussion of the technical aspects of the procedure and its use in the ED evaluation and management of the patient with atraumatic hip pain.

## 2. Methods

Sonographic evaluation of the hip may be successfully accomplished with a variety of transducers, including linear

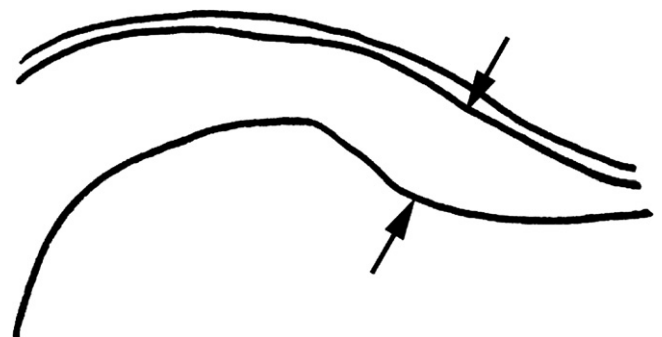


**Fig. 2** Anterior view of hip; parallel lines represent the ultrasound plane, perpendicular to the long axis of the femoral neck with arrows indicating probe orientation.

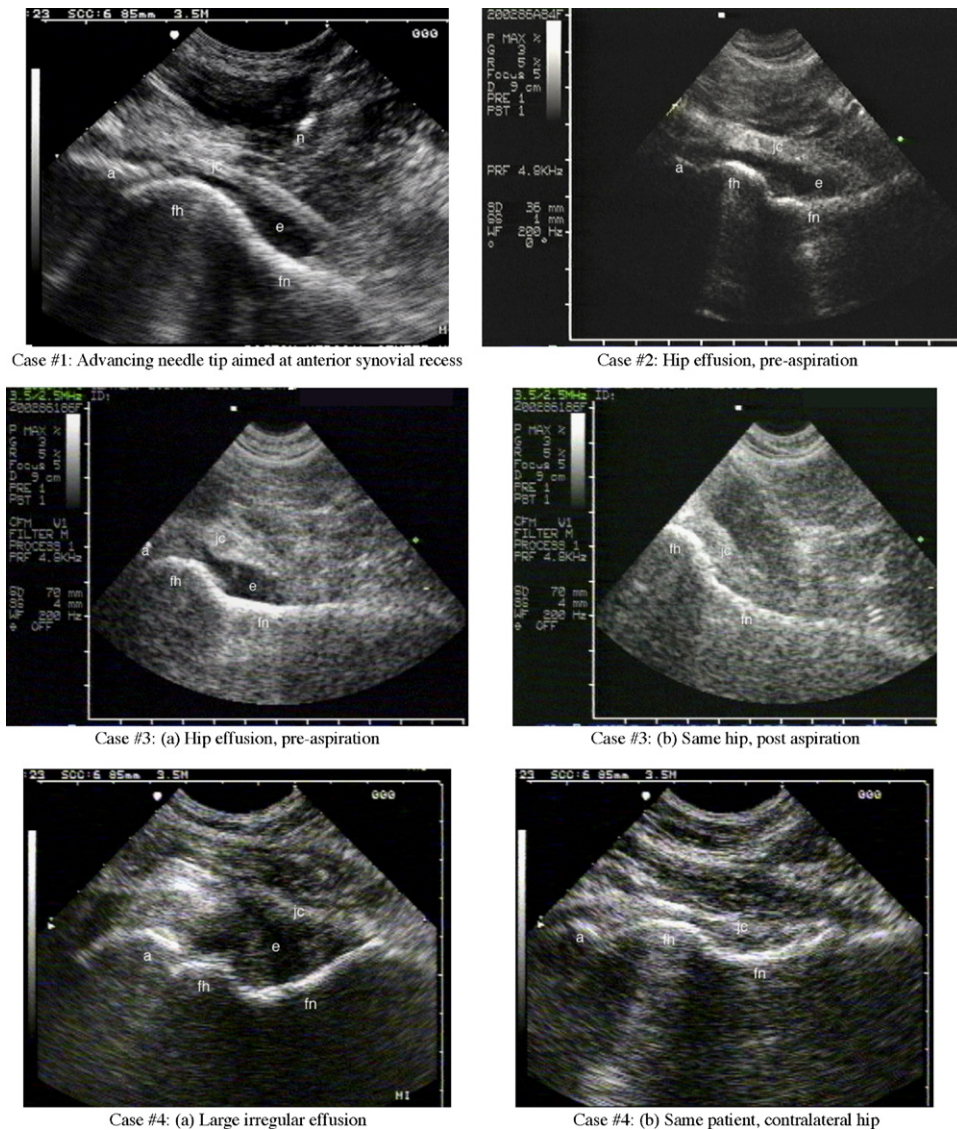


**Fig. 3** Line diagram of image obtained when scanning as described in Figure 1; femoral head, and femoral neck, with joint capsule in close opposition. Space between arrows indicates anterior synovial recess.

array and sector transducers. The patient should be placed in a supine position, with the ultrasound transducer located just below the inguinal ligament, lateral to the femoral vessels, with the transducer orientation marker angled superomedially at an approximately 45° angle, aiming toward the umbilicus (Fig. 1). This scanning position places the transducer such that the long axis of the ultrasound beam is aligned with the long axis of the femoral neck (Fig. 2). The acetabular labrum, femoral head, and neck (collum) provide strong echo reflections that are readily identified on the ultrasound monitor at about 3 to 5 cm below the skin surface. As per usual scanning convention, the curved echo of the bony femoral head will be located on the left side of the sonogram. The articular capsule of the hip joint is a moderately reflective fibrous structure extending from the acetabular labrum to its point of fixation on the lower femoral neck. Synovial fluid cannot typically be seen in a normal hip joint (Fig. 3). When a hip effusion is present, it will appear as an anechoic or hypoechoic collection that elevates the joint capsule. The most prominent area of fluid accumulation occurs in the area termed the *anterior synovial recess*, a potential space located just anterior to the femoral neck and immediately posterior to the articular capsule (Fig. 4). This is the area that should always be visualized in order to confirm or exclude a hip effusion. Small effusions are more easily identified with the knee in slight flexion and the hip in slight internal rotation; this is the recommended patient



**Fig. 4** Space between arrows indicates joint effusion in anterior synovial recess, with displacement of anterior joint capsule from the femoral neck.



**Fig. 5** See above for details. Key: a, acetabular labrum; fh, femoral head; fn, femoral neck; e, effusion; jc, joint capsule; n, needle tip.

position for scanning usually suggested in the literature [6]. Extension of the knee and external rotation of the leg, in contrast, will tighten the articular capsule and displace synovial fluid posteriorly [6]. One report suggested placing the hip in extension and abduction improved ultrasound-guided visualization of the joint, but this positioning was compared to neutral position rather than the more frequently described flexion with internal rotation [7].

The inflamed hip joint should always be examined in conjunction with a sonogram of the contralateral hip. Diagnosis of a hip effusion is based upon measurement of the widest distance of the anechoic or hypoechoic fluid strip located between the anterior surface of the femoral neck and the echogenic joint capsule [8]. Criteria for defining an effusion include a convex bulging joint capsule with a fluid strip of greater than 5 mm or greater than 2 mm of fluid strip asymmetry, compared to the contralateral hip [9]. An important caveat to this standard measurement

technique occurs in the patient with chronic rheumatic disease, where ultrasound measurement of the anterior collum to capsule distance may not distinguish a thickened capsule from thickened synovium [10]. Once an effusion has been identified, it may be aspirated with ultrasound guidance or mapping. The transducer should first be placed just below the inguinal ligament in a transverse orientation, with the probe marker oriented to the left. The goal is to clearly identify the location of the medially located common femoral vein, artery, and nerve in relation to the joint space in order that these structures may be avoided during the aspiration. The hip should then be prepped and draped for sterile needle aspiration. The ultrasound transducer may be placed in a sterile glove or covered with a commercially available sterile sheath; aspiration can then be performed with an 18-gauge spinal needle and a 20-mL syringe under direct visualization. The procedure is generally performed with topical or local anesthesia. With

the transducer orientation marker now aimed superomedially along the long axis of the femoral neck, and while directly visualizing the hip effusion, the spinal needle is advanced within the long axis of the ultrasound beam from its skin entry site at the inferior border of the transducer. The characteristic reverberation artifact of the advancing spinal needle can be used to guide the needle tip directly into the largest region of fluid accumulation at the level of the anterior synovial recess. The synovial fluid is then aspirated and sent for analysis.

Four cases of patients who had arthrocentesis of a hip joint in the ED, performed by an EP under ultrasound guidance and recorded on SVHS videotape or digital format, were identified. Cases where an effusion of the hip joint was identified by ultrasound but not aspirated by the EP were not included. Ultrasound examination of the hips was performed with either a Biosound 3000D equipped with a 5-MHz linear array probe (Biosound Esaote, Indianapolis, Ind) or a Hitachi EUB 525 equipped with a 3.5 MHz curvilinear probe (Hitachi Medical Systems America, Twinsburg, Ohio). In each case, the patient was placed in a supine position, and both hips were assessed by ultrasound to identify the presence of an effusion. Where a fluid collection in the affected joint space was visualized, the appropriate hip was prepped and draped, local anesthesia was administered, and an 18-gauge spinal needle was used for arthrocentesis under real-time ultrasound guidance, as previously described [6,11,12]. Fig. 5 demonstrates representative findings from each of the described cases. Cases without recorded ultrasound images of the hip joint were not included.

### 3. Illustrative cases

#### 3.1. Case 1

A 28 year-old male presented to the ED complaining of 2 days of worsening pain in the right thigh. The pain started upon awakening, extended throughout the proximal femur, and was associated with a "tight" feeling in the hip joint. There had been no recent trauma or repetitive activities. He reported abdominal bloating, diarrhea, and fever on the day before the onset of pain, but the associated symptoms had resolved. He had no other medical history. He was afebrile, and physical examination was significant only for marked pain with even slight range of motion of the right hip joint. Plain radiography of the right hip was normal, as were the complete blood count and serum glucose.

Sonography revealed a hip joint effusion and a thickened joint capsule, and arthrocentesis yielded approximately 20-mL of cloudy, straw-colored fluid. Synovial fluid analysis revealed a white blood cell (WBC) count of 42 000/mm<sup>3</sup>, with 90% neutrophils, 1% lymphocytes and 9% monocytes, a joint fluid glucose of 65 mg/dL, lactate dehydrogenase of 548 IU/L, and a protein of 5.2 g/dL. No

crystals were seen. Gram stain was negative for organisms. The patient reported decreased pain and improved range of motion after arthrocentesis. He was started on intravenous antibiotics, treated with analgesics and admitted to the hospital. Rheumatology recommended continued antibiotics, and further workup included an erythrocyte sedimentation rate of 14 mm/h, a C-reactive protein of less than 0.5 mg/dL, and a negative Lyme titer. Final culture results were negative, and the patient was comfortable and ambulatory on a regimen of nonsteroidal anti-inflammatory medication. He was presumed to have had reactive monoarticular arthritis, likely secondary to a viral gastroenteritis, and was discharged from the hospital.

#### 3.2. Case 2

A 42-year-old man was referred from a community health center with a chief complaint of left hip pain. His pain began 3 days before arrival and was associated with subjective fever. There was no associated trauma. His medical history was significant for type I diabetes, hypertension, chronic renal insufficiency, and chronic anemia. He had been evaluated by his primary care provider 3 months before for bilateral hand pain and swelling and had been prescribed acetaminophen with codeine. Temperature in the ED was 98.9°F. Physical examination was significant for tenderness over the hip joint as well as pain with range of motion. Plain radiography of the left hip was normal. His complete blood count and serum glucose were normal; the BUN and creatinine were elevated at 56 and 8.4 mg/dL, respectively. The erythrocyte sedimentation rate was elevated at 116 mm/h.

Bedside ultrasound demonstrated a hip effusion with a thickened joint capsule, and 8 mL of cloudy fluid was obtained on arthrocentesis. Synovial fluid analysis revealed a WBC of 78 000/mm<sup>3</sup>. No crystals were seen, and Gram stain was negative for organisms. The patient was treated with cefazolin and ketorolac and admitted to the hospital for further workup. Antinuclear antibody titer was mildly positive at a ratio of 1:80, and rheumatoid factor was elevated at 63 IU/mL (normal <20 IU/mL). Lyme serology was negative. He remained afebrile; his pain and ambulation improved with narcotics and nonsteroidal anti-inflammatory medication. Final synovial fluid culture results were negative, and he was presumed to have had a reactive monoarthropathy. He was discharged to follow-up with the rheumatology service.

#### 3.3. Case 3

A 42-year-old female was transferred by ambulance from a local community health center complaining of right lower quadrant abdominal pain that had begun upon awakening that day. She pointed to her right inguinal region, and the referring physician was concerned about a possible inguinal hernia or ovarian torsion. Her pain was sharp, radiated to the mid thigh, and was worse with ambulation. She was unable to sit or stand comfortably, but

the pain was somewhat lessened by a stooped posture. She denied fever, nausea, trauma, or prior episodes of similar discomfort. Her medical history was significant only for a cesarean section. On physical examination, she had normal vital signs but appeared tearful and uncomfortable. Her abdomen was soft and nontender. She had pain on palpation of the right inguinal region and significant discomfort with right hip flexion or internal rotation. Pulses were symmetric in both lower extremities, and reflexes, sensation, and motor function were intact. Pelvic examination was normal. The patient had minimal relief with multiple doses of morphine. A complete blood count was performed and demonstrated a peripheral white blood cell count of  $11.8 \times 10^3/\mu\text{L}$ , hemoglobin level of 13.2 g/dL, hematocrit of 38.3%, and a platelet count of  $390 \times 10^3/\mu\text{L}$ . Serum glucose was 96 mg/dL. Plain films of the hip and lumbar spine were normal. A computed tomographic scan of the abdomen/pelvis was remarkable only for the presence of a right hip effusion.

Bedside ultrasound was then used to localize the effusion and approximately 10-mL of turbid, yellow-colored fluid was obtained under ultrasound guidance. Synovial fluid analysis revealed a WBC count of 43 600/ $\text{mm}^3$  with 85% neutrophils, 0% lymphocytes, and 15% monocytes; a joint fluid glucose of 34 mg/dL; lactate dehydrogenase of 854 IU/L; and protein of 4.2 g/dL. No crystals were seen, and Gram stain was negative for organisms. The patient received an initial dose of intravenous antibiotics and was admitted to the hospital. Antinuclear antibody (ANA) screen and Lyme disease serology were negative. She remained afebrile, and final synovial fluid culture results were negative. She was believed to have had reactive monoarticular arthritis, and her antibiotics were discontinued. By hospital day 3, she was ambulatory without pain, and she was discharged on ibuprofen to follow-up with rheumatology.

### 3.4. Case 4

A 51-year-old man with a history of hypertension, asthma, and alcoholism presented to the ED complaining of left knee pain. He reported sustaining an injury during a collision with a bicyclist approximately 6 months before, which had resulted in intermittent discomfort in his left knee. During the week before his presentation, his knee pain had returned, with radiation of the pain to his left hip and back. The patient reported that the pain had gradually progressed to the point where he could only get around his apartment by crawling on the floor. His pain was constant, exacerbated by movement, and extended from the knee to his lower back. He denied fever, nausea, weakness, paresthesias, or incontinence. He last used his inhaled albuterol 1 day before arrival and had not been taking his antihypertensive medications. On physical examination, he was afebrile, with a pulse of 83 and blood pressure of 173/102 mm Hg. He was in no acute distress and had ethanol on his breath. His left knee, femur, and lateral hip

were tender to palpation. Left knee extension, hip flexion, and internal rotation were limited by pain. Sensation and reflexes were intact. Pulses were easily palpable and symmetrical. His complete blood count was notable for a WBC of  $12.1 \times 10^3/\mu\text{L}$  with a normal differential. Plain radiographs of the left knee, hip, and pelvis showed sclerosis and deformity of the left femoral head without fracture or dislocation. A bedside ultrasound of the left hip joint revealed a large effusion, and bedside arthrocentesis yielded approximately 20 mL of dark yellow fluid. Synovial fluid analysis revealed a WBC count of 48 500/ $\text{mm}^3$  with 95% neutrophils, 0% lymphocytes, and 5% monocytes; a joint fluid glucose of 45 mg/dL; a lactate dehydrogenase of 864 IU/L; and a protein of 5.5 g/dL. His erythrocyte sedimentation rate was 49 mm/h. The patient received an initial dose of IV antibiotics and was admitted to the hospital. Although plasma cells were not seen on the peripheral blood smear, multiple myeloma was considered as a possible diagnosis. The orthopedic surgery service was consulted and felt that the radiographic images and clinical picture were most consistent with avascular necrosis of the femoral head. The patient's pain was controlled with nonsteroidal anti-inflammatory medications, and his final synovial fluid cultures were negative. His peripheral white blood cell count decreased to  $4.7 \times 10^3/\mu\text{L}$ , and he was soon ambulating comfortably with the assistance of a cane. He was discharged with a diagnosis of avascular necrosis of the left femoral head and possible multiple myeloma. He was started on metoprolol and scheduled to follow-up with both the orthopedic surgery and internal medicine services.

## 4. Discussion

Prior to this manuscript, there has been only 1 published case report of hip arthrocentesis performed by an EP [5]. The case involved a patient with acute hip pain and fever. Orthopedic surgery was consulted, and after several unsuccessful attempts at blind aspiration, hip arthrotomy and irrigation in the operating room was planned. The operation was avoided by needle aspiration of the hip effusion under direct ultrasound guidance by the EP, and synovial fluid analysis subsequently revealed calcium pyrophosphate crystals consistent with a diagnosis of pseudogout. Another published report documents the use of bedside ultrasound by an EP to detect the presence of a hip effusion; subsequent arthrocentesis on this patient was performed under fluoroscopic guidance, however, and the patient was taken to the operating room for open drainage [13]. Review of the medical literature yielded no other published cases of hip ultrasound by EPs, although the diagnosis of hip effusion by ultrasound and ultrasound-guided arthrocentesis of the hip joint has previously been discussed in the emergency medicine literature [4] as well as in an ultrasound textbook written for EPs [3].

In the cases reported here, each of the 4 patients had historical or physical examination features concerning for possible acute septic arthritis. Emergency physician-performed ultrasound revealed an effusion of the affected hip joint in each case, and bedside arthrocentesis was successfully performed under direct sonographic visualization by 2 of the authors (WB, cases 1 and 2; AD, cases 3 and 4). There were no complications. In each case, synovial fluid analysis demonstrated evidence of inflammation, with polymorphonuclear leukocytes seen on microscopy, but without organisms on gram stain. All 4 patients were admitted, and final culture results were uniformly negative. Three patients were discharged with the diagnosis of reactive synovitis of unknown etiology, and the fourth was felt to have had avascular necrosis of the femoral head and a secondary reactive hip effusion. All 4 patients showed clinical improvement within 2 to 3 days, without operative intervention.

These 4 cases demonstrate the feasibility of ultrasound-guided hip arthrocentesis in the ED. The safety and tolerability of this procedure in the hands of radiologists has previously been well-documented [6,14]. Visualization of a hip joint effusion by ultrasound was first reported in 1980 [15]. Although ultrasound-guided arthrocenteses of the hip were initially performed under general anesthesia or conscious sedation, by 1990, a case series of ultrasound-guided hip aspirations in children under local anesthesia was published [14]. Since then, published series of as many as 800 aspirations have been described by radiologists, without a single complication, including iatrogenic infection [6]. The potential risk of damage to the femoral neurovascular complex is small, and with careful visualization of the relationship between of the joint space and the femoral artery, vein and nerve this risk is negligible. Although there is a risk of pain from the arthrocentesis, multiple reports suggest that the procedure is well tolerated, with only topical anesthesia or local anesthetic infiltration used before the aspiration [6,14,16]. Other risks are bleeding, vasovagal reaction, and failure to obtain fluid.

Emergency physician-performed ultrasound of the painful hip at the bedside can expedite early diagnosis and treatment. Ultrasound of the hip is the preferred modality for demonstration of fluid collections around the hip joint, and early detection of an effusion in the evaluation of a patient with atraumatic hip pain may direct the differential diagnosis [4]. Making a timely diagnosis of possible septic arthritis is most important, however, because irreversible hip destruction begins within 2 to 4 days [1,16]. In cases of acute hip pain with an effusion, clinical prediction algorithms are inadequate to predict infection, and arthrocentesis is clinically indicated. Although on-call orthopedics or interventional radiology consultants are capable of performing hip arthrocentesis, their availability may be limited and may delay the diagnosis, especially during "off-hours". Timely diagnosis and antibiotic administration are critical to outcome in septic arthritis, and the ability of EPs to perform bedside

arthrocentesis of the hip can contribute to this goal. As with other acutely inflamed, painful monoarthropathies, arthrocentesis of the hip is important, first, to rule out septic arthritis [17]. Second, if a septic arthritis is present, adequate drainage through arthrocentesis may be therapeutic, and if clinical improvement occurs on antibiotics, further intervention may not be necessary [1]. Third, regardless of cause, effusions are painful because of pressure exerted on the synovial capsule; release of this pressure by arthrocentesis often provides immediate pain relief and improvement in range of motion. This has been well documented in cases of hip effusions [6,14]. Fourth, synovial fluid analysis may lead to alternative diagnoses, such as crystal arthropathies, rheumatoid arthritis, or reactive arthritis [5].

Although children and the elderly are the patient groups who will most commonly present with atraumatic hip pain, acute septic arthritis in the pediatric population carries a higher risk of severe complications. Because of the developing femoral head circulation, the pediatric septic hip is at high risk for avascular necrosis, and epiphyseal involvement with potential separation and pathologic dislocation may occur. Although transient synovitis is the most common final diagnosis in pediatric hip pain, the early presentation of this childhood diagnosis is nearly identical to early septic arthritis: spontaneous, progressive pain in the hip, groin, or thigh; difficulty with weight-bearing or ambulation; fever; and irritability. Clinical prediction algorithms for differentiation between the diagnosis of transient synovitis and acute septic arthritis of the hip have not been supported when parameters such as the temperature, leukocyte count, erythrocyte sedimentation rate (ESR), and weight-bearing status are relied upon [17]. To definitively diagnose septic arthritis of the hip, analysis and culture of synovial fluid is necessary. Hip ultrasonography and arthrocentesis are generally advocated as adjunctive diagnostic modalities in the assessment of pediatric hip pain [16-18].

Protocols for evaluation of acute hip pain with ultrasound assistance have been established in the pediatric population. Ultrasound-guided evaluation of the irritable pediatric hip allows for early diagnosis of septic arthritis and other serious pathology, avoids unnecessary hospital admissions, and helps relieve pain by joint decompression [16]. In a prospective study of 50 pediatric patients presenting with acute hip pain, a pelvic radiograph and initial blood work including a complete blood count with differential, as well as an erythrocyte sedimentation rate, were obtained for each patient [16]. One fracture was identified. Bilateral hip ultrasound was subsequently performed, and in 36 patients, an effusion was identified, and immediate ultrasound-guided aspiration was performed. Patients with significant systemic symptoms, with or without an effusion present, were admitted for further evaluation. In one case, Gram stain was positive, and the patient was admitted for parenteral antibiotics and monitoring. When the immediate Gram stain was negative, and there were no systemic symptoms,

the patient was discharged, provided that provision could be made for urgent recall, should cultures later prove positive. Patients without an effusion on ultrasound imaging or without significant systemic symptoms were also discharged. In either case, follow-up was scheduled in 1 week for repeat ultrasound and for bone scintigraphy if pain persisted. With the increasing availability and use of ED bedside ultrasound, a similar protocol might logically be extended to the evaluation of adult patients in the ED. Clinical validation of such protocols should be the subject of future investigation.

The 4 cases presented here demonstrate how bedside ultrasound can be incorporated as part of a rational approach to the ED management of atraumatic hip pain and how detection and aspiration of hip effusions may be included among the armamentarium of bedside procedures performed by the trained EP.

After the preparation of this manuscript, an additional case of atraumatic hip pain presented in our emergency department. The patient was a 42 year-old male with 2 days of progressive hip pain, worse with motion, without associated fever or nausea. Ultrasonography revealed a hip joint effusion (not shown), and arthrocentesis was performed by the emergency physician. The synovial fluid was found to have greater than 95,000 white blood cells, antibiotics were started, and orthopedic surgery was consulted. The patient underwent operative debridement and irrigation of the infected hip joint. Culture of the synovial fluid later revealed *Streptococcus pneumoniae*. The patient recovered uneventfully. This case, along with the 4 described in the report, show the feasibility of using ultrasound-guided hip arthrocentesis in the ED to evaluate possible septic arthritis of the hip.

## 5. Summary

Ultrasound-guided arthrocentesis of the hip joint is a well-established procedure, and the cases reported here illustrate its feasibility in the hands of trained EPs. In a fashion similar to the workup of other painful monoarthropathies, this procedure allows for timely diagnosis and management of the patient with of atraumatic hip pain.

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