Role of ultrasonography in early detection of hip joint infection in neonates

Asmaa M. Ahmed[a], Nisreen A.A. Mohammed[a], Nariman A. Oyoun[b], Hassan I. Meggaly[a]

Departments of [a]Radio-Diagnosis, [b]Orthopedic Surgery, Faculty of Medicine, Assiut University, Assiut, Egypt

Correspondence to Asmaa M. Ahmed, BSC, Department of Radio-Diagnosis, Assiut University Hospitals, Faculty of Medicine, Assiut University, Assiut, Egypt
Fax: 0882341188;
Tel: +20 100 894 4490;
e-mail: asmaamahmoud1989@yahoo.com

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Introduction
Septic arthritis of the hip requires urgent attention because it is not only a medical but also a surgical emergency. Even minimal delay in the diagnosis and treatment causes permanent disability, crippling, and lifelong hip deformity. Neonates are more susceptible to be affected with hip arthritis due to decreased immunity. Neonatal intensive care unit admission is a common risk factor. Not only effusion, but also the status of the intra-articular compartment, articular surface, joint capsule, and adjacent soft tissue can be examined using ultrasonography (US). US also allows for image-guided paracentesis of hip effusion as well as for monitoring the progress of the disease.

Objective
The main objective of this study is to evaluate the role of US as a screerning tool in early diagnosis of hip joint infection in neonates admitted at the neonatal intensive care unit at our center for different neonatal medical and surgical problems.

Results
This study included 260 neonates (520 hips), 67.3% of which were men. Using the US there was evidence of intra-articular infection and complications in only one hip.

Conclusion
Being a nonionizing, easily available, noninvasive, relatively cheap imaging technique, US is of great help in diagnosing early as well as late suspected cases of septic arthritis of the hip with well-defined sonographic signs in sagittal and coronal views. US also helps in differentiating intra-articular from extra-articular abnormalities. It is also helpful in monitoring the progress/resolution of the disease.

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Introduction

Septic arthritis (SA) of the hip joint in neonates is rare but can have devastating complications; presenting signs and symptoms may differ from those seen in older children, which may result in diagnostic challenge or delay [1].

Disruption of the epiphysis leads to arrest of growth of the upper femur with resultant leg length discrepancy. Destruction of the head of the femur leads to lifelong deformity. Early identification of joint sepsis aids early appropriate management, which increases the chance of retaining the anatomy and function of the joint and the limb[2] (Fig. 1).

Patients and methods

This study is an ultrasound (US) screening program of all neonates admitted to the neonatal intensive care unit (NICU) at our center between September 2017 and March 2018 for different types of neonatal medical and surgical problems such as jaundice, respiratory distress, central nervous system anomalies, perinatal asphyxia, prematurity, etc., Those neonates were serially examined by US on the first day of admission as a baseline and to ensure that they were US free from septic hip infection on admission and every 3 days until they were discharged, aiming at early detection of septic infection of the hip joints and the association thereof with any NICU diagnostic or therapeutic procedure. The study was approved by the Ethics Committee of our institution and a written informed consent was obtained from all the patients' parents who participated in the study after explaining the nature and purpose of the study. All enrolled patients were subjected to a full detailed history taking from parents and complete clinical examination before US evaluation.

All cases were examined using TOSHIBA, model UIPS-511A, Minato-Ku, Tokyo, Japan. The linear probe used was 8 MHz.

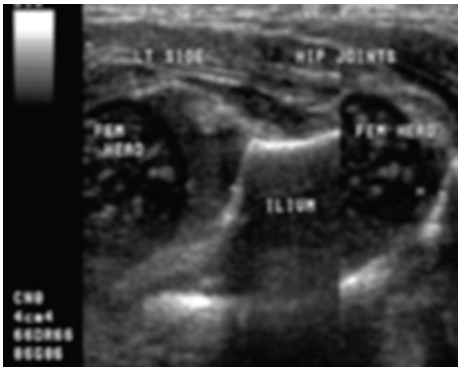
The technique used for the hip sonography was uniform; images were taken in the anterior sagittal view and lateral coronal view.

In the anterior sagittal view, the child was placed supine in neutral position with the hip and the knee kept extended and slightly externally rotated by the attendant. A linear probe was placed along the anterior aspect of the hip paralleling the long axis of the femoral neck, which is lateral to the femoral vessels and nerve (Fig. 2). It is most important to position the two extremities symmetrically and compare the symptomatic and asymptomatic hips [4]. Both hips were examined in every case.

The anterior joint capsule was identified, and the thickness of the capsule was assessed by measuring the maximal distance between the anterior surface of the femoral neck and the posterior surface of the iliopsoas muscle. Moreover, in patients with septic hip, the following parameters were examined: (a) identification and measurement of both layers of the anterior joint capsule in both symptomatic and asymptomatic hips, (b) identification and characterization of the effusion which is seen between the anterior and posterior layers of the anterior joint capsule, and (c) evaluation of the soft tissue and bony changes.

The coronal view was obtained as recommended by Graf[7] in lateral decubitus position in hip joint flexion. The US transducer is then placed in the anatomic coronal plane. Next, the transducer is moved backwards and forwards from the basic position to identify the most inferior point of the ilium. If a sonogram contains a straight iliac wing contour, triradiate cartilage, and an apparent acetabular labrum, which then indicates that it has a standard plane (Fig. 3).

Figure 1



US image of both hip joints (coronal view) showing echogenic joint effusion in the left hip joint [3]. US, ultrasonography.

Results

In our study, 260 neonates (520 hips) admitted to NICU of our center for different neonatal medical and surgical problems were examined. Their age at examination ranged between 1 and 30 days (mean, 4.49 ± 5.85 days).

As most patients were examined more than once during their stay at the NICU, the total number of examinations amounted to 1350 with an average number of US examinations of 5.19 ± 3.63 for each hip. The average NICU stay was 5.78 ± 5.42 days for each neonate.

Among 520 hips, only one had sonographic features suggestive of septic hip infection as described in detail in Table 1 and Fig. 4.

Discussion

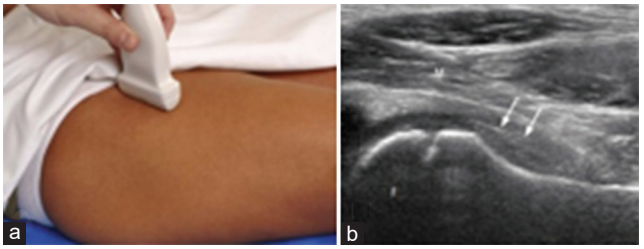
SA of the hip requires urgent attention because it is not only a medical but also a surgical emergency. Minimal delay in diagnosis and treatment causes permanent disability, crippling, and lifelong hip deformity [8].

Neonates and young infants are commonly affected by SA due to impairment of resistance and response to microorganisms more than older infants [9].

NICU admission is a common risk factor as it is frequently possible to induce sepsis through transmission either by femoral blood vessels sampling or umbilical vessel catheterization [10]. Preterm neonates are more likely affected with hip arthritis due to decreased immunity [11].

US can diagnose both intra-articular and extra-articular abnormalities [12], even small collections of fluid (1–2 ml) can be accurately detected [13].

Figure 2



(a) Scanning plane for hip joint effusion detection. The scan plane is oriented along the long axis of the femoral neck. Acetabular brim, femoral head, femoral neck, and the iliofemoral ligament should be included. (b) Sagittal ultrasonography shows the femoral head (f), iliopsoas muscle (m), and both layers of the anterior joint capsule (arrows) [5,6].

US is a beneficial procedure helping in detecting and characterizing joint effusion especially in the hip joint. US helps to follow up the amount and echogenicity of the effusion and guides synovial fluid aspiration for analysis in the diseased joint [14].

Plain radiographs are of limited value for diagnosis in the newborn child because the femoral head and acetabulum are largely cartilaginous [15].

Computed tomography has a serious injurious effect on growing tissues owing to its ionizing radiations, so its value in diagnosing SA is limited in infants [16]. Bone scintigraphy and MRI have the validity to detect osteomyelitis in children with normal US findings of the hip [16], but MRI is more expensive and requires general anesthesia in neonates and infants.

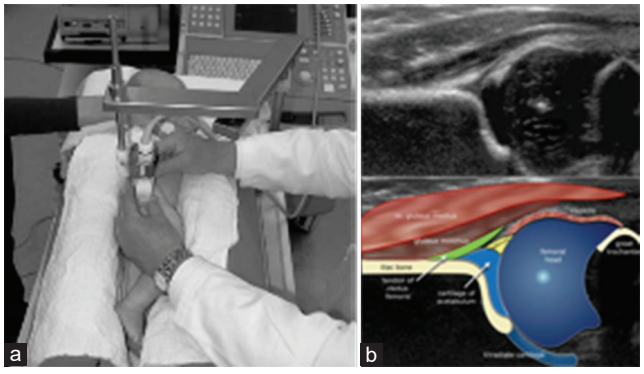
Our study is an US screening program of all neonates admitted to the NICU at our center between September 2017 and March 2018 for different types of neonatal medical and surgical problems.

Table 1 Sonographic findings in the one neonate found to have septic arthritis of the hip

	Sonographic sign
Coronal US view signs	Circular-shaped echogenicity suggestive of effusion surrounding the femoral head
	Pathological dislocation
	Partial head resorption and asphericity
Sagittal US view signs	Capsular thickening
	Convex or flattened anterior capsule
	AP diameter measured from the posterior surface of the psoas muscle to the anterior surface of the femoral neck of more than 4 mm suggestive of effusion
	A difference in AP diameter of more than 2 mm compared with the normal contralateral joint suggestive of effusion in the affected side

This case needed surgical drainage in addition to medical treatment. AP, anteroposterior; US, ultrasonography.

Figure 3



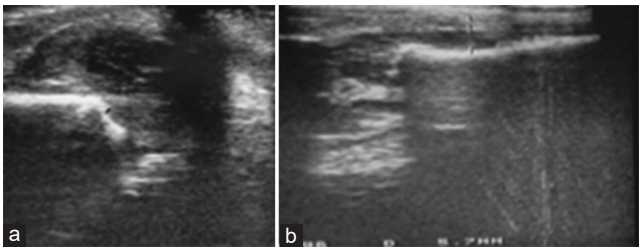
(a) Correct position of the probe (b). Ultrasonography of the infant hip in the coronal plane has three landmarks: 1, a straight iliac line; 2, the tip of the acetabular labrum; and 3, the most inferior point of the ilium [7].

We had male predominance in our study (65.9%). Bennett and Namnyak[17] found male predominance in neonatal SA in their study. This is in disagreement with Yagupsky *et al.* [18], who reported that there is no sex predilection for hip arthritis and Chaudhari *et al.*[19] who had female predominance in their study. Walana *et al.*[20] reported that more male neonates 54.0% were admitted to the NICU compared with female neonates (46.0%), similar to our finding. Ali *et al.* [21], again, reported a similar finding, but suggested it was most likely due to cultural and social factors, whereby male children are more likely to receive medical care compared with women. In our study effusion was seen in one hip, which is not enough to confirm or refute a sex predilection in neonatal SA of the hip.

According to Eich *et al.* [13], the hallmark of septic hip arthritis is unilateral joint effusion. However, Gordon *et al.*[22] reported two (2.5%) cases of false-negative US results for SA of the hip with an absent joint effusion, although both patients had less than 24 h of symptoms. Harcke and Grissom[23] reported that the normal hip joint capsule should demonstrate a concave contour on US, whereas a joint effusion demonstrates a bulging anterior recess with fluid. They reported that the normal anterior capsular distance in children younger than 5 years was 2–4 mm. In our study, the affected hip showed a convex and flattened joint capsule with an anteroposterior (AP) of diameter more than 4 mm, which confirmed the presence of SA in this one hip.

Hip capsule AP diameter on both sides should be symmetric within 2 mm. More than 2 mm of difference between a painful hip and the other hip has been reported to be consistent with an effusion [24]. In our study, the affected hip showed a difference in AP diameter of more than 2 mm compared with the normal contralateral joint.

Figure 4



Hip US (coronal and sagittal views) in a 7-day-old male patient admitted to the NICU at our center by jaundice due to ABO incomptability with fever, swelling at the right hip joint, pseudoparalysis, and crying on passive movement of the joint: (a) coronal view shows circular effusion surrounding the femoral head and pathological dislocation; (b) sagittal view demonstrates distension of the anterior joint space with anterior recess measuring 5.7 mm. NICU, neonatal intensive care unit; US, ultrasonography.

We were able to reproduce the previously described sagittal view signs, for example the thickened joint capsule in agreement with Bureau *et al.*[25] who noted that capsular thickening can only suggest SA, but not a sure diagnostic finding.

In this study, coronal view was helpful in the detection of early intra-articular changes associated with infection, mainly effusion, and was also used to document the known complications of septic hip infection in neonates, for example, pathological dislocation and partial head resorption and loss of sphericity of the femoral head. Chaudhari *et al.*[19] reported that subluxation/dislocation with bony involvement were seen in late presenting cases. US is cost-effective, has no radiation hazards, and can be done repeatedly, which makes it a very useful diagnostic and follow-up tool in early as well as in late cases and those with late complications, and should be done in all suspected cases of SA.

The presence of a solitary case of septic hip infection in the NICU at our center over a period of 7 months, despite heavy loads and rapid turnover, is a positive indicator of the compliance with the rules of infection control including continuous hand wash, antiseptic gel usage, and wearing of sterile shoes. Moreover; the strict supervision of the methods of sterilization of the NICU rooms, the sterile intravenous fluids prepared by the clinical pharmacists, as well as the invasive procedures of cannulation under strict aseptic conditions played an important role in lowering the rate of infection.

Conclusion

Being a nonionizing, easily available, noninvasive, relatively cheap imaging technique, US is of great help in diagnosing early as well as late suspected cases of SA of the hip with well-defined sonographic signs in sagittal and coronal views describing intra-articular abnormalities. Even small amounts of fluid/pus (1–2 ml) can be accurately detected. Along with effusion, the status of the intra-articular compartment, joint capsule, cartilaginous joint components, and adjacent soft tissue can be assessed. US also helps in differentiating intra-articular from extra-articular abnormalities. It not only helps in the diagnosis, but is also helpful in monitoring the progress/resolution of the disease.

Acknowledgements

Asmaa M. Ahmed carried out the collection of patients, filled their complete clinical sheets, and performed US examination. Nisreen A.A. Mohammed guided the work throughout the study. Nariman A. Oyoun carried out full clinical assessment of the patients and performed US examination. Hassan I. Meggaly conceived the study and its design.

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Conflicts of interest

There are no conflicts of interest.

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