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Ultrasound in Emergency Medicine

POINT-OF-CARE ULTRASOUND IN A CHILD WITH CHEST WALL PAIN AND RIB OSTEOMYELITIS

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☐ **Abstract—Background: Diagnosis of acute osteomyelitis in young children can be challenging due to the lack of specific clinical signs and symptoms. Prompt diagnosis and treatment is essential to prevent complications and to improve long-term prognosis and reduce the need for operative intervention. Point-of-care ultrasound (POCUS) may be a useful tool to detect early changes associated with osteomyelitis. Case Report: A 26-month-old boy presented with 6 days of fever and 3 days of focal pain over the right anterior lower ribs without swelling, erythema, or bony deformity, and negative chest x-ray study. A POCUS was performed by the ultrasound fellows and revealed deep soft tissue swelling, periosteal elevation, and increased vascular flow with color Doppler. The patient was admitted to the pediatric service with infectious disease consultation and started on antibiotics. Magnetic resonance imaging confirmed the diagnosis of a right seventh anterior rib osteomyelitis, and the patient subsequently improved and was discharged home. Why Should an Emergency Physician Be Aware of This?: In this case, the use of POCUS in the emergency department heightened the suspicion for acute osteomyelitis in a rare location and guided early diagnosis and treatment.**

☐ **Keywords—ultrasound; osteomyelitis; rib; imaging; infectious disease**

INTRODUCTION

Osteomyelitis is one of the most common invasive infections in children (1,2). Most cases result from hematogenous spread, typically occurring in the long bones such as the femur and tibia (3). Diagnosis of acute osteomyelitis in childhood may be challenging due to the lack of specific clinical signs and symptoms. Ultrasound can identify signs of acute osteomyelitis, including deep soft tissue swelling, periosteal elevation, and increased vascular flow with color Doppler (4,5). We present the case of a 26-month-old child with fever and chest wall pain and point-of-care ultrasound (POCUS) demonstrating findings suggestive of acute rib osteomyelitis, guiding early diagnosis and treatment.

CASE REPORT

A previously healthy 26-month old boy presented to the Emergency Department (ED) with fever and right chest wall pain. He was in his usual state of health until 7 days prior to presentation, when he developed loose stools. The next day he developed fevers up to 40°C with rhinorrhea and nasal congestion. Four days prior to presentation, he presented to an outside hospital ED where a chest x-ray study was obtained and was negative, as was a nasal swab for influenza. A catheterized urine analysis was positive for leukocyte esterase and few bacteria. He was started on a 5-day course of cefdinir (completed 4 days), and the urine culture subsequently grew < 10,000 units of *Staphylococcus simulans*. Three days prior to presentation, the mother described pain over the right lower ribs/upper abdomen whenever she would pick him up, and he was noted to cry whenever the area was touched. This pain

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remained consistent over the ensuing 2 days. She denied any swelling, redness, or trauma. The mother was the sole caretaker and there was no travel history, vomiting, or diarrhea. The next day he was seen again at the outside ED with continued fevers and worsening pain. A chest and abdominal x-ray study were negative. An abdominal ultrasound was unable to visualize the appendix, however, there was no hydronephrosis or renal abscess visualized. Laboratory results were remarkable for a white blood cell count of 16,000/mm^3, and he was transferred to our ED for further evaluation.

In the ED, the patient was alert and well appearing. Vital signs were within normal limits for age: temperature of 36.8°C (unknown when last antipyretic was given); heart rate 120 beats/min; respiratory rate 26 breaths/min; blood pressure 84/56 mm Hg; oxygen saturation of 98% on room air, and weight 13 kg. The examination was normal, including a soft abdomen with no tenderness. However, his musculoskeletal examination over the right lower anterior ribs elicited tenderness to touch, and the patient would cry and push the examiners hand away during palpation. No swelling, mass, erythema, or bone abnormality was palpated. A complete blood count was normal, with a white blood cell count of 11,000/mm^3 (5–15.5/mm^3), with 64% segmented neutrophils and an elevated C-reactive protein (CRP; 148 mg/L). His creatine kinase was normal (68 U/L) and respiratory syncytial virus (RSV) polymerase chain reaction (PCR) was positive. A repeat chest x-ray study and comprehensive abdominal ultrasound were negative, as were dedicated right lower rib x-ray studies. POCUS was performed in the ED using a high-frequency linear probe, and revealed soft tissue swelling surrounding the right lower anterior ribs. The intercostal and external oblique abdominal muscles were distended and hypoechoic compared with the unaffected left side (Figure 1A, B). Color Doppler revealed increased flow on the affected side in the described muscular structures (Figure 1C). The periosteum appeared elevated, but no subperiosteal abscess or discontinuity of the bone cortex was seen in the long- or short-axis views. No soft tissue abscess was found to be present.

The patient was admitted to the pediatric service for concern of possible rib osteomyelitis, with infectious disease and orthopedic consultation. A computed tomography (CT) scan of the abdomen and pelvis on day 1 of admission revealed asymmetric focal soft tissue thickening of the right lower anterolateral chest wall measuring 9 mm in thickness, compared with 2 mm on the left side. A focal lucency of the underlying anterolateral right seventh rib was noted near the costochondral junction. Due to concern for osteomyelitis, the pediatric infectious disease service recommended starting

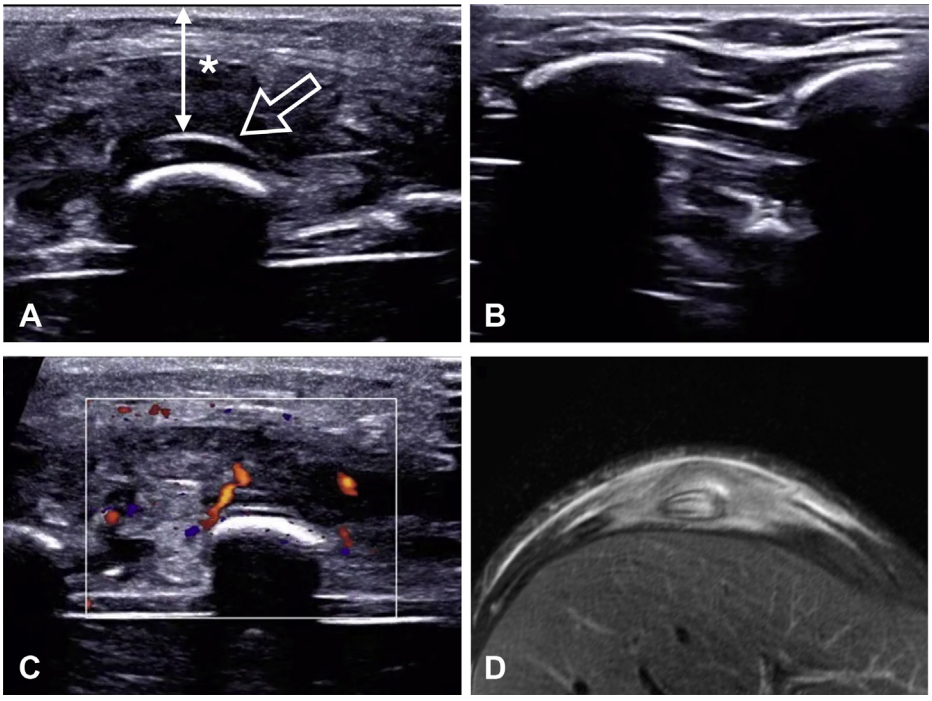

Figure 1. (A) Point-of-care ultrasound at location of pain over the affected rib in B-mode and short axis. The * marks soft tissue swelling measuring 1.5 cm and the arrow delineates periosteal elevation. (B) For comparison, unaffected corresponding ribs on the left side. (C) Color Doppler revealing hyperemia of the affected side. (D) Magnetic resonance imaging demonstrating increased T2 signal in the bone marrow of the anterior end of the seventh rib, with associated periosteal elevation and soft tissue swelling consistent with osteomyelitis.

cefazolin and vancomycin for continued spiking fevers up to 39.4°C, as well as a sedated magnetic resonance imaging (MRI) scan for further delineation of the CT findings. However, due to the patient's RSV infection, anesthesia opted for a delay and MRI was obtained on day 3 of admission. The MRI (Figure 1D) revealed extensive soft tissue swelling surrounding several ribs, centered on the anterior end of the right seventh rib. Abnormally increased T2 signal in the bone marrow of the anterior end of the right seventh rib with associated periosteal elevation was noted, findings most consistent with osteomyelitis. Blood cultures, purified protein derivative, and echocardiogram performed during the hospital course were negative. The patient defervesced on day 6 of admission (total of 12 days of fevers), and CRP was 11 mg/L upon discharge on day 8. Given the clinical course, and CT and MRI findings, the clinical impression was osteomyelitis of the seventh rib and the patient was discharged for completion of antibiotic therapy.

DISCUSSION

Osteomyelitis is one of the most common invasive infections in children and most frequently results from hematogenous spread (1). Most cases occur in the metaphysis of long bones such as the femur or tibia, however, because any bone can be affected, patients can present with a wide variety of symptoms and signs, including fever, localized bone pain, impaired bone function, and redness or swelling (2,3). Early diagnosis and initiation of antibiotic treatment are critical in preventing complications. Plain radiography has traditionally been the initial diagnostic modality, and although useful in excluding other diagnostic considerations, has a low sensitivity and specificity for detecting acute osteomyelitis, and early findings are not usually visible until days 10–14 (4). Compared with CT, MRI is the preferred imaging modality for diagnosing osteomyelitis due to its excellent anatomic detail, superior soft tissue resolution, high sensitivity for detecting early infection, and lack of ionizing radiation (5). However, MRI can be time consuming, often requires sedation in children, and may not be readily available. Ultrasound can be an important adjunct in the evaluation of suspicious cases of acute osteomyelitis, and assists in guiding further imaging and treatment (6). The scanning technique used in our patient included longitudinal and transverse sections covering the full circumference of the relevant area, and was examined with the high-frequency, linear array probe (5–13 MHz) to better image superficial structures. The unaffected contralateral side was also examined to obtain equivalent views for comparison.

Although bone is a strong reflector of ultrasound sound waves, recognition of indirect and soft tissue changes can aide in diagnosis. Several small case series and reports have documented the potential utility of ultrasound in acute osteomyelitis of the long bones in children (7,8). In a study of 25 confirmed pediatric cases of acute osteomyelitis, sonographic findings of deep soft tissue swelling and increased flow with color Doppler were the earliest changes seen within the first 4 days of symptom onset. Fluid adjacent to infected bone and cortical erosion were additionally identified within 1–2 weeks of onset of symptoms (9). In a study of 38 children with acute osteomyelitis, a continuum of ultrasound changes was similarly found, with deep soft tissue swelling most commonly identifed within the first 1–3 days of symptoms followed by early periostial elevation at 4–6 days, and subperiosteal fluid and cortical erosion identified within 7–14 days (10). Importantly, although ultrasound examination may show features of osteomyelitis several days earlier than radiographs, reported sensitivities supporting ultrasound in the diagnosis of osteomyelitis range from 55% to 90% (8,11,12).

Rib osteomyelitis is extremely rare and accounts for < 1% of all hematogenous osteomyelitis (3). A review of the literature over 48 years (1963–2011) identified 57 cases of rib osteomyelitis in children (13). A recent case report of a 48-year-old woman with chest wall pain described the first use of bedside ultrasound in the diagnosis of acute hematogenous osteomyelitis of a rib (14). In this report, ultrasound identified a periostial fluid collection concerning for abscess that was confirmed with MRI. Risk factors for rib osteomyelitis in children include trauma, contiguous infection (cellulitis or abscess), pneumonia, and immunosuppression (15). As none of these were present in our patient, the etiology for this child's osteomyelitis was presumed to be of hematogenous origin secondary to bacteremia (1).

In our patient, POCUS in the ED identified deep soft tissue swelling, periostial elevation, and increased vascular flow with color Doppler, heightening the suspicion for acute osteomyelitis in a rare location and guiding early diagnosis and treatment.

WHY SHOULD AN EMERGENCY PHYSICIAN BE AWARE OF THIS?

Diagnosis of acute osteomyelitis in young children may be challenging due to the lack of specific clinical signs and symptoms. In this case, we demonstrated that POCUS can identify signs of acute osteomyelitis including deep soft tissue swelling, periosteal elevation, and increased vascular flow with color Doppler, leading to early recognition, treatment, and diagnosis. When children present with concern for acute osteomyelitis, we suggest scanning the involved area to evaluate for early signs of osteomyelitis.

Pearls

Ultrasound may detect features of osteomyelitis prior to radiographic changes, and deep soft tissue swelling is the earliest finding. Scanning the uninvolved contralateral side for comparison is recommended.

Pitfalls and Limitations

If no changes on ultrasound are seen, the diagnosis of osteomyelitis cannot be excluded, as the supporting literature involves small-scale, single-institution studies with variable sensitivities. Further randomized controlled studies in pediatrics are warranted to determine the accuracy of POCUS in the diagnosis of acute osteomyelitis.

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