

The Role of Real Time Ultrasound in Differentiating between Osteomyelitis and Tumour in Long Bones

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ABSTRACT

Aim: This study was designed to evaluate the use of ultrasound in diagnosis of infection and tumour of long bones.

Methodology: Patients referred from the orthopaedic unit with doubt regarding long bone clinical and/or radiological signs which could be tumour or infection were enrolled in this study. Analysis of ultrasound characteristics included presence of pericortical fluid over normal cortex well away from the primary lesion, wavy contour sign (fluid tracking in and out muscle planes), subperiosteal fluid and soft tissue mass displacing adjacent muscle planes.

Results: Fourteen out of 15 patients with confirmed osteomyelitis were diagnosed by ultrasound examination. Ultrasound as a diagnostic tool has a sensitivity of 93% and specificity of 100%. The most accurate indicator was pericortical fluid noted up to several centimetres from the long bone abnormality seen on plain x-rays.

Conclusion: Ultrasound is a safe, fast, cost-effective imaging modality that can play an important role in diagnosis of osteomyelitis as it then serves as a tool for ultrasound guided aspiration.

Key Words:

Osteomyelitis, Sonographic findings, Pericortical fluid, Wavy contour sign, Subperiosteal fluid

INTRODUCTION

Clinical features of osteomyelitis may be non-specific rendering accurate diagnosis on clinical and plain radiography not possible. Delay in treatment of osteomyelitis may result in complications and morbidity, so early diagnosis is essential to improve outcomes for this infection. Ultrasound has been used to investigate clinically suspected osteomyelitis¹. Skeletal malignancies such as Ewing's sarcoma, osteosarcoma, myeloma or metastatic neuroblastoma can mimic osteomyelitis on plain radiographs^{2,3}. Alternative imaging modalities including

computerized tomography and magnetic resonance imaging have been recommended for this purpose².

Ultrasound is able to detect early stage osteomyelitis and perhaps allow for non-operative treatment in selected advanced cases^{1,4}. However, the specific role of ultrasound in the sequential imaging of osteomyelitis for skeletal infection has yet to be established. This prospective study was therefore undertaken to define the role of ultrasound in the differential diagnosis of osteomyelitis, soft tissue infection, and skeletal tumours.

MATERIALS AND METHODS

Study Sample

Thirty-one consecutive patients referred from the orthopaedic surgery unit of our institution for suspected long bone infection were included in this prospective study. The study took place over two years from 2002-2004. Demographic data and clinical information were collected. Standard anteroposterior and lateral radiographs taken at the time of admission were reviewed by the researchers. Radiographic features observed included bony changes such as periosteal reaction, new bone formation, localized osteoporosis and presence of lytic areas. Investigators also took note of soft tissue changes including swelling near the metaphysis, displacement of muscle planes and obliteration of lucency between muscle planes. The ethics committee of the institution approved this study.

Ultrasonography

Ultrasound examination (using an Advanced Technology Laboratories (ATL) 3000 machine with a high frequency (7.5MHz) linear array) transducer) was performed as soon after presentation as possible, preferably on the day of presentation to the hospital. Scanning included both transverse and sagittal sections and the entire circumference of the extremity was scanned. Patients were positioned in supine and/or prone position for optimal visualization of the involved region. Ultrasound of the contralateral limb was used for comparison.

All scan findings were recorded utilizing the following appearance on ultrasound.

- (i) Hypoechoic periosteal fluid collection (pericortical fluid over normal cortex well away from the primary area of involvement).
- (ii) Fluid tracking in and out of muscle planes from the cloaca (wavy contour sign).
- (iii) Hypoechoic collection away from bone, entirely within the muscular plane - considered as soft tissue abscess
- (iv) Increased subcutaneous tissue thickness without any fluid - considered as cellulitis.
- (v) Periosteal solid mass, different from muscle echogenicity - considered as not osteomyelitis but tumour displacing soft tissues

Magnetic Resonance Imaging (MRI)

MRI was performed in selected patients. T1-weighted, T2-weighted and STIR sequences were conducted and changes recorded, either in sagittal, coronal or axial views depending on the site of disease involvement. Osteomyelitis is revealed at low signal intensity on T1W, and high signal intensity on T2W and STIR sequences⁶. MRI can also confirm subperiosteal fluid collection and the extent of the disease. Comparison and correlation with the ultrasound findings were made.

Bone scan

For some patients had bone scan was performed as an alternative to MRI (i.e., if patients was not able to tolerate MRI procedure due to claustrophobia).

Statistical analysis

Statistical analysis was performed using SPSS. Sensitivity, specificity and accuracy for each of the radiological signs was calculated with the actual confirmation of diagnosis of osteomyelitis by MRI, open debridement or successful therapy with antibiotics.

RESULTS

Of the 31 study participants, 22 (71%) were male and 9 (29%) were female. Ethnicity of the study is as follows: 12 Malays (39%), 10 Chinese (32%) and 9 Indians (29%). The age of study subjects ranged from 3 to 64y, with a mean of 27 y. More than half of the patients (55%) were children or young adults between 1 to 20 y (Table I). Osteomyelitis was confirmed in 15 cases based on clinical findings, supplemented with MRI in 6 patients, biopsy and surgical drainage in 8 patients and bone scan in one patient. All osteomyelitis patients responded to antibiotic treatment.

From the 31 sets of early plain radiographs, 9 (29%) were reported as normal and 22 (71%) were considered abnormal. On the final evaluation of these 9 patients, 2 had osteomyelitis, 5 had cellulitis and 2 had soft tissue

abscesses. For the remaining 22 patients with abnormal plain radiographs, 13 were later confirmed to have osteomyelitis.

Ultrasound examinations (Table II) of the 31 patients revealed diagnoses of 14 (45%) cases of osteomyelitis, 6 (19%) with cellulitis, 2 (6%) soft tissue abscesses and 9 (29%) periosteal solid masses (not osteomyelitis). For the 6 patients reported to have cellulitis, 3 were further examined using MRI. MRI confirmed that one of the three was found to have osteomyelitis, and so had demonstrated a false negative for ultrasound. Due to technical difficulties, MRI was not available for the remaining 3 patients. All osteomyelitis patients were treated with antibiotics and recovered without complication. The 2 patients with soft tissue abscesses diagnosed by ultrasound had MRI confirmation of the diagnosis. For the other 9 patients with periosteal solid masses, biopsy confirmation confirmed that these masses were not osteomyelitis.

During ultrasound examination, we also observed other sonographic features described earlier and analyzed them in relation to the final diagnosis. Figures 1 and 2 show two such examples, Figure 1 shows subperiosteal fluid and Figure 2 fluid extending over normal cortex well away from the original site of the lesion. Table III summarizes the statistical analysis of these sonographic features in relation to the osteomyelitis.

Statistical analysis

Ultrasound diagnosed osteomyelitis of long bones with 93% sensitivity and 100% specificity. Positive predictive value (PPV) reaches 100% with a negative predictive value (NPV) of 94%. Accuracy of diagnosis of osteomyelitis by ultrasound is 97%.

DISCUSSION

Although early diagnosis of osteomyelitis is crucial, its clinical features may be confusing; thus a simple, safe and easily available diagnostic tool would be valuable adjunct. CT scans and MRI are sensitive in detecting early osteomyelitis, but they are relatively expensive and not as readily available in some areas of the world²⁰. The current study demonstrates that ultrasound is able to diagnose osteomyelitis with 97% accuracy. The 2 cases of osteomyelitis that went undetected via normal radiography were indeed detected by ultrasound.

In addition to early detection of osteomyelitis, this study indicates that ultrasound is valuable in differentiating an infective from a non-infective lesion. The 9 cases in which ultrasound excluded osteomyelitis were eventually confirmed to be free from infective pathology.

Table I: Age distribution of study participants and for those with the confirmed diagnosis of osteomyelitis. (Abbreviation: OM, osteomyelitis)

Age in Years	Number of Study Participants	Number of Patients with Confirmed OM
<1y	0	0
1-12y	12	7
13-20y	5	3
<21y	14	5
Total	31	15

Table II: Comparison of osteomyelitis detected by ultrasound to confirmed diagnosis (93% sensitivity and 100% specificity for ultrasound. (Abbreviation: OM, osteomyelitis)

Osteomyelitis Detection	Confirmed Positive OM	Confirmed Negative OM	TOTAL
Positive osteomyelitis on ultrasound	14	0	14
Negative osteomyelitis on ultrasound	1	16	17
Total	15	16	31

Table III: Statistical analysis of the sonographic features in relation with osteomyelitis. (Abbreviations: PPV, positive predictive value; NPV, negative predictive value; ACC, accuracy)

Sonographic Features	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	ACC (%)
Periosseous fluid collection adjacent to normal cortex with osteomyelitis	93	100	100	94	97
Subperiosteal fluid with osteomyelitis	73	100	100	80	87
Periosseous wavy fluid collection with osteomyelitis	87	100	100	89	94
Cortical break with fluid in and out with of cloaca.	40	100	100	64	71
Periosseous solid mass, not osteomyelitis(in our study)	100	100	100	100	100

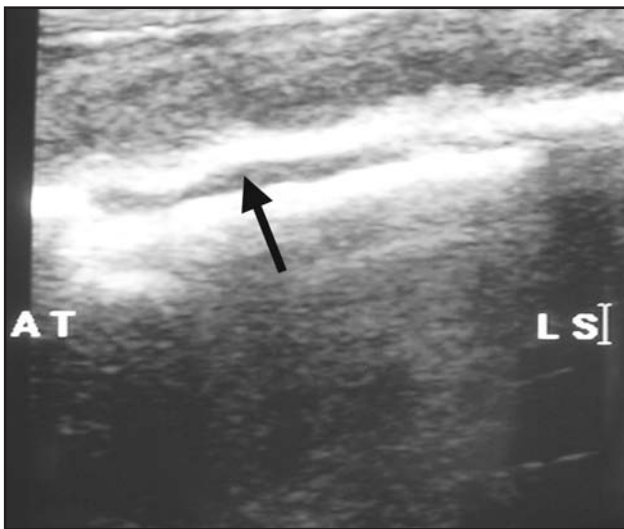


Fig. 1: Arrow points to the presence of subperiosteal fluid on ultrasound as evidenced by a hypoechoic line under the periosteum on real time ultrasound.

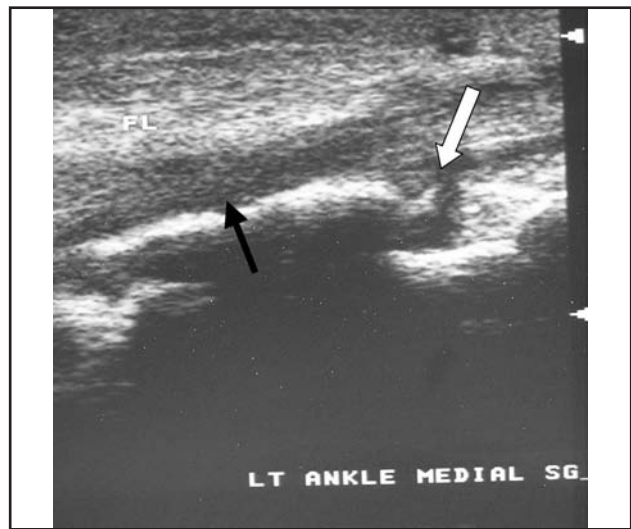


Fig. 2: Arrow shows fluid over normal cortex that stretches over several cm along the bone away from the cloaca (white arrow) in the long bone. This is shown by the presence of hypoechoic line over the cortex stretching over the normal hyperechoic cortex which appears as a hyperechoic band.

Ultrasound is an also excellent investigative tool to differentiate between cystic and solid masses^{21,22}. This differentiation is very important to the clinician, as immediate management is different in both conditions. In rural areas where CT scan, MRI or nuclear medicine imaging is not available, ultrasound is an ideal alternative imaging device after plain radiography because it provides economic and noninvasive imaging of the tissue. Early diagnosis of osteomyelitis enables the clinician to initiate treatment before extensive bone and tissue injury occur. Additionally, ultrasound can also be used to guide the placement of the needle tip during diagnostic or therapeutic aspiration for osteomyelitis.

The presence of periosteal (pericortical) fluid collection over normal bone away from the primary lesion appears to be the best sonographic indicator for diagnosis osteomyelitis by ultrasound. A demonstration of fluid collection contiguous to bone surface is essential for accurate sonographic diagnosis of acute osteomyelitis¹. Our results revealed 93% sensitivity, 100% specificity and 97% accuracy for this sonographic feature in diagnosing osteomyelitis. In one patient where the diagnosis of osteomyelitis was missed by ultrasound, the patient had been treated with a complete course of antibiotic prior to presentation and examination.

The medical therapy may have altered the tissue condition. Subperiosteal fluid collection is a specific (100%) sonographic feature for osteomyelitis but not sensitive enough (73%) for definitive diagnosis as not all the osteomyelitis cases had this feature. Subperiosteal abscess is more commonly found in children as loose attachment of the periosteum to the cortex in children enables infection to extend into the subperiosteal region¹⁰. Although periosteal wavy fluid collection and cortical break with surrounding fluid are not sufficiently sensitive indicators to diagnose osteomyelitis, these features were observed in some cases of confirmed osteomyelitis in this study.

CONCLUSION

Ultrasound is a valuable imaging tool in diagnosis of osteomyelitis in that it carries high sensitivity and specificity for accurate diagnosis. Additionally, ultrasonography provides further information on condition of the surrounding soft tissue, differentiating osteomyelitis from soft tissue infections and other non-infective bone lesions. Ultrasound has the advantage of being simple, inexpensive and freely available in most hospitals and can be performed without undue delay.

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