

## REVIEW ARTICLE

## ROLE OF BEDSIDE ULTRASOUND IN DETECTION OF BONE FRACTURES IN PEDIATRICS AND ADULTS

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During medical devices evolution many modalities and techniques like Computerized tomography, magnetic resonance imaging, wireless capsule endoscopy and double-balloon endoscopy were applied to provide enough evidences for final detection of diseases. As well as current procedures, sonography is a method that individuals are satisfied with it because of various conditions like non-invasive and cheap. Ultrasound is one of the procedures which can be used in diagnosis of fractures and has its own unique feature including different views at the same time with no radiation effects. It can show bones and plays an important role in initiation of disease, follow up of the patients. The aim of this investigation was to evaluate the Role of bedside ultrasound findings in patients with fractures. We concluded that ultrasound should be used as well as other methods to reach better outcomes.

**Keywords:** Bedside ultrasound; Bone; Fractures; Paediatrics; Adults.

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### INTRODUCTION

Trauma is an injury to body organs (e.g. head, chest, or abdomen and extremities) that may lead to many complications. In fact accurate diagnosis of injuries has the highest priority following admission. Before whole-body multidetector computed tomography (CT) became the imaging procedure of option in the late 1990s<sup>1-6</sup>, ultrasonography (USG) was the only cross-sectional method available for use in cases after major trauma.

There has been High mortality and morbidity rate after fractures of the human body. The prevalence of fractures is increasing because of alterations in socio-economic behaviors.<sup>7</sup> The medical, economic and social impact of fractures are manifold.<sup>8</sup> Disability is a result of continues pain and limited physical mobility. Therefore, the goal of the case beside the treating expert is to return the patient back to the daily activities soon. But sometimes the process of fracture healing is not appropriate enough it will cause complications such as delayed healing, non-healing or even fibrous union. Ultrasonography is a bedside device that comes to the bedside diagnosis of a different of conditions. The methods involve using sonography to diagnose bony fractures, to detect radiolucent soft tissue foreign bodies, to diagnose free fluid in the abdomen cavity of the cases after trauma, and as an aid in obtaining vascular access in the emergency setting. Advantages of sonography in comparison with conventional radiography consist of lack of ionizing radiation, the ability to obtain multiple views or planes in a brief time, and the potential for detecting the presence of coexistent soft tissue injuries.<sup>9</sup>

The history backs to in the aftermath of the Armenian earthquake in 1988, when sonography was applied as a useful and primary screening method at the entry to a hospital in mass casualty patients after trauma. There was an average time of 4 minutes to examine per case. The false-negative rate was calculated for 1%, and there were no false-positive outcomes for trauma-associated injury of the abdomen and retroperitoneal space.<sup>10</sup> Therefore, quick diagnosis of patients in emergency settings is very important and due to high prevalence of trauma and its allied complications including fractures the aim of this review article is to describe the role of ultrasound in bone fractures.

### Ultrasound findings in bone fractures

Sonography shows that the cortex of bone as a homogeneous, strong, bright reflection of echoes with deep acoustic shadowing<sup>11</sup> but, depending on the surface of the bone and the obliquity of the ultrasound beam, reverberation artefacts may also be shown deep to the cortex of the bone.

Harcke *et al.*<sup>12</sup> reported that sonography is capable of revealing opaque and semi opaque foreign bodies in soft tissue of 3–5 mm size with 97% sensitivity. In their investigation, rubber, leather, fabric material, and wood produced strong shadowing. In contrast, plastic material produced images with surface echoes without appreciable shadowing.<sup>12</sup>

Sonographic findings of fractures consist of the disruption of the echogenic cortical line, elevation of the echogenic cortex, an anechoic collection suggestive of adjacent hematoma near the area of cortical disruption, and an echogenic callus in healing fractures.<sup>13</sup>

Ultrasound, also is used for other conditions like knee osteoarthritis. This technique includes that patient would place in a natural standing upright position with knees fully extended and the feet separated enough for good balance. Meniscal tear of medial meniscus for each knee was calculated by longitudinal ultrasound image at the level of the medial collateral ligament using a 10-MHz linear transducer. The medial collateral ligament (MCL) is a broad flat structure approximately 9 cm long that extends from the medial femoral condyle to the medial aspect of the proximal tibia.<sup>14,15</sup> On ultrasound imaging, the MCL seems as a trilaminar structure—two hyperechoic bands divided by a thin hypoechoic zone. The medial meniscus is commonly hyperechoic and its configuration in a longitudinal view is triangular, with its apex pointing toward the centre of the joint. Its base is anchored to the linear hyperechoic deep MCL without any intervening tissue. Meniscal tear of medial meniscus was evaluated as the distance from the outermost edge of the medial meniscus to the border of the tibial plateau. In the presence of marginal osteophytes on the medial border of the tibial plateau, the medial margin of the tibia, instead of the osteophyte projection, was applied to calculate meniscal tear.<sup>14,15</sup>

#### Adults and childhood fractures

Current investigations have studied the reliability of USG for the detection of bone fractures in adults and children. These studies indicated that USG can be advised in routine use in the emergency departments. Patel *et al.* showed that bedside USG of long bones is a rapid, effective, and non-invasive procedure of examining patients with suspected orthopaedic trauma, with an agreement of 96% with radiography.<sup>16</sup> Another study by Atighechi *et al.* revealed that USG can replace radiography in the early diagnosis of nasal bone fractures, because of significantly better results of USG compared with radiography ( $P=0.004$ ).<sup>17</sup> Warkentine *et al.* indicated that the use of USG for diagnosis and assessment of occult or unsuspected fractures in case of child abuse.<sup>18</sup> Hubner *et al.* have revealed in expert hands, an accurate diagnosis of long bone fractures could be made in 86% of patients. But, these articles were less enthusiastic in case of comminuted fractures due to lack of sensitivity.<sup>19</sup>

Based on the studies by Hedelin *et al.*, Ekinci *et al.*, and Rabiner *et al.*, limited and standardized training in adults and children is enough to permit USG-guided triage for bone fractures with a highly sensitive technique (100%) with a 99% specificity in adults.<sup>20-22</sup> But in contrast with previous studies, Bolandparvaz *et al.* revealed that bedside USG (with 1 month of training) is not a reliable

technique for detection of upper and lower extremities fractures, compared with radiography.<sup>23</sup>

Based on investigations in Patients with normal X-ray with suspected occult fracture in both paediatrics and adults, USG had a specificity to diagnose radiographically undiagnosed fractures, especially in adults, with 30% more diagnostic data in cases for bone and soft tissue.<sup>24,25</sup>

Previous articles and studies defined the use of sonography in the detection of fractures, mainly in child's and in longer bone fractures.<sup>26-28</sup>

Williamson *et al.*<sup>29</sup> indicated that 100% sensitivity and specificity for childhood forearm fractures in 18 paediatrics patients. Marshburn *et al.*<sup>27</sup> revealed that doctors with limited training could diagnose long bone fractures with bedside ultrasound in 58 cases. Hubner *et al.*<sup>19</sup> revealed valued outcomes with long bone fracture diagnosis and indicated that diagnosis of fractures in the hand, among other sites, was more difficult.

#### Rib and costal cartilage

Some articles showed descriptions of the usage of USG in the detection of rib and costal cartilage fractures.<sup>30-32</sup> Investigations revealed that USG was superior to radiography in the diagnosis of acute rib<sup>33,30,31</sup> and costal cartilage<sup>32</sup>. At USG, rib injuries might show a disruption of the normally continuous echogenic cortex of the rib, disruption of the costochondral junction, or fracture of the costal cartilage.<sup>33</sup> Griffith *et al.* USG showed that 10 times as many fractures in 6 times as many patients as radiography and 11% of those fractures were located in the costal cartilage or at the costochondral junction.<sup>33</sup> Turk *et al.* detected rib fractures by USG in 18 of 20 cases who revealed negative radiography, but persistent pain. They indicated that USG had a sensitivity of 78% when compared to 12% for radiography in the diagnosis of rib fractures, including costal cartilage fractures.<sup>30</sup> A fracture of the costal cartilage is not radiographically detectable unless it includes a densely calcified cartilage.<sup>32</sup> Due to these considerable reasons fractures of the costal cartilage may happen with greater frequency than is currently detected and therefore sometimes become undetected.<sup>32</sup>

Physicians in Emergency medicine departments have used bedside ultrasound for examination of patients from 1980s.<sup>34-37</sup> When ultrasound is advised in the diagnostic evaluation of multiple-trauma patients, it will improve patient care.<sup>38-39</sup>

There is high sensitivity and specificity for Ultrasonography to accurately diagnose many diseases and allied conditions at the bedside in Emergency medicine departments.<sup>40-43</sup>

Advances in ultrasound technology, and improvements in clinical experience with ultrasonography, has led to its common use in conditions including thoracoabdominal trauma, ectopic pregnancy, abdominal aortic aneurysm, pericardial effusion, cardiac arrest, biliary disease, renal tract disease, and small bowel obstruction, and in procedures including lumbar puncture, arthrocentesis and central venous access.<sup>43-45</sup>

#### Central nervous system

Different articles have indicated that unconscious trauma cases may have concomitant cervical spine injury with estimates differing from 18–26%.<sup>46-54</sup> Moreover, it has been revealed that injury at one level of the spine elevates chances of simultaneous injury at other stages manifold.<sup>46</sup>

It seems that ultrasound may not be useful to examine the spine, a previous investigation on horses has revealed the normal ultrasonographic appearance of the cervical anatomy.<sup>55</sup> Different papers have tried to take use of ultrasound for pedicle screw insertion,<sup>56</sup> and facet injections<sup>57,58</sup> with notable outcomes.

### CONCLUSION

Many modalities in these decades were performed to establish the exact diagnosis of fractures including magnetic resonance imaging (MRI), sonography and radiograph but each of them has their own limitation for instance MRI and radiograph has radiation but ultrasound does not have radiation but is operator dependent. Therefore, the combination of these methods can provide useful information for diagnosis of the cases, today's ultrasonography is on hand in most therapeutic and diagnostic sections for both diagnosis and disease management. Advantages of ultrasonography are that it's portable and can be advised in patient's bedside.

#### Competing interests

The authors declare that they have no competing interests.

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