# EFSUMB Course Book, 2nd Edition

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# Bone fracture ultrasound

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## Introduction

Fracture sonography is an object of research since 1975 (1). There are numerous studies about the feasability of ultrasound in fracture diagnosis which point out the potential of this method (2, 3), but do not compare sensitivity and specifity with radiologic imaging. Therefore the clinical usage of the method was recently limited to highly specialized examiners.

Since 2006 a structured research with comparison to x-ray allowed the definition of indications, safeness and the development of clinical standards which can easily be adopted to any clinical circumstances (4).

## Remarks to technique and indication

### Technique

#### *Ultrasound technique*

For fracture sonography regular ultrasound devices with 4-12 MHz linear transducers are used. No special equipment is needed. The opportunity for electronic angle measurement is advantageous but not mandatory.

Due to the high impedance difference between bone and soft tissues, a total reflection of ultrasound waves occurs at the cortical surface. This results in an excellent visualization of the corticales while deeper structures like cancellous bone cannot be examined.

#### *Visualization*

Sonography reveals alterations of the bone surface. The advantages in comparison to x-rays are the opportunity of multiple angles and planes with no overlying and the visualization of soft tissues like joint effusion, haematoma and blood vessels; the disadvantage is that deeper structures and intraarticular fractures cannot be adequately diagnosed.

Cartilage is not well visualized by ultrasound, while soft tissues like muscle, fat and blood vessels can be examined easily. These have no relevant impact on the fracture diagnosis, because any severe soft tissue damage deserves x-ray evaluation of the bone.

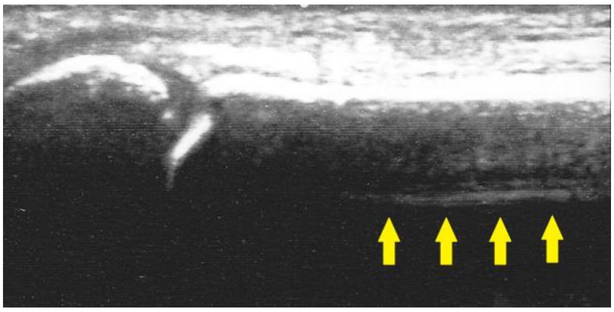
Sonographic measurement of bone deformities is precise with a mean difference of 2° (4, 5); only extreme deformities which are clinically apparent and doubtless deserve surgical repositioning, cannot be assessed well (6).

However, the gold standard of x-ray is in doubt (7). Studies showed that minor fractures which are not radiologically diagnosed can be seen in the ultrasound examination (5, 8). If a fracture is clearly seen in the x-ray images, the assessment is based on 2 planes which are not always in correct projection (9); ultrasound allows the assessment with multiple planes so that the complete deformity can be visualized (9).

Most linear transducers show a section of 4-6 cm length, longer structures can be documented sequentially. This may be necessary in case of a bowing fracture or a shaft fracture.

Bone tissue is displayed as a sharp line with full ultrasound wave reflection. Echoes behind the corticalis are artificial [Figure 1].

**Figure 1** **The tissue behind the cortical bonne cannot be pictured. The echoes in this projection are artificial (*)**

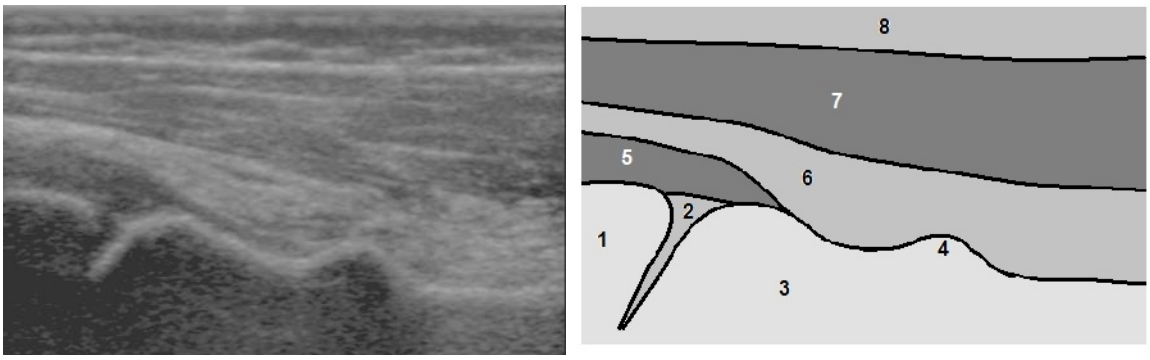


Muscle tissue, fat and nerves are well visualized and show the typical echoes similar to other locations. Haematomas and muscle tears can also be diagnosed.

The joint capsule of the wrist appears as a sharp line covering the dark joint cavum.

The epiphyseal plate is not pictured itself but can be assessed by the position of meta- and epiphysis. Cartilage is not well visualized [Figure 2].

**Figure 2 While bone and soft tissue is well visualized, cartilage and the epiphyseal plate are not echogenic structures; 1=epiphysis, 2=epiphyseal plate, 3=metaphysis, 4=fracture bump, 5=joint capsule, 6=deep fat, 7=muscle, 8=cutis and subcutaneous fat (*)**




## Application fields

### *Patient age*

Sonographic fracture diagnosis is feasable for patients from 0-12 years. In this population nearly all fractures cause cortical alterations and intraarticular fractures are rare. Also the thin soft tissue cover of the extremities is advantageous.

Due to the high sensitivity of growing tissue to radiation, these patients profit from the ultrasound diagnosis in a particular way.

An additional advantage is the high correction potential of these patients, which makes the ultrasound-guided treatment safe.

### *Fracture localisation*

Ultrasound cannot be ubiquitarily utilized. In respect of the special implications of every fracture entity focussed research is necessary for every location. Ultrasound is only advantagous if a) radiation exposure can be avoided or b) diagnosis quality is improved.

Actually 3 localizations where fracture sonography is feasible have been identified by prospective studies with direct comparison with x-ray imaging (10-13):

1. wrist fractures; in this location diagnosis and treatment is completely ultrasound-based. X-ray imaging is limited to special indications. The high frequency of these fractures results in a relevant reduction of radiation exposure for the patient population.
2. elbow fractures; in this location ultrasound serves as a screening method to rule out an intraarticular lesion. If a fracture is suspected (30% of the cases), x-ray diagnosis in 2 planes is mandatory, otherwise x-ray is dispensable.
3. proximal humerus fractures; in this location ultrasound can rule out a fracture and avoid radiation exposure. In case of a fracture, sonography allows a better visualization of the deformity in comparison to x-ray imaging.