IFAF
International Foot & Ankle Foundation
FOR EDUCATION AND RESEARCH

*The Foot and Ankle Online Journal* *Official Publication of the IFAF*

# The Role of High Resolution Ultrasonography in Detection of Neglected or Missed Radiolucent Foreign Body in Foot and Ankle Region

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**The Foot and Ankle Online Journal 6 (3): 2**

*A prospective case series was undertaken to assess the role of high resolution ultrasonography to detect radiolucent foreign bodies in the foot and ankle region. Out of 30 suspected foreign bodies, ultrasonography was able to detect 28 foreign bodies with 2 false negatives. The overall sensitivity was 93.33%. The false negatives were attributed to the foreign body being obscured by bone.*

**Key words:** foreign body, foot, ankle, ultrasound, exploration

**Accepted:** February, 2012 **Published:** March, 2013



Missed or neglected foreign body and subsequent complications in the extremities is a challenging complaint in the orthopedic outpatient department. Most of these cases present with soft tissue mass, granuloma, abscess, corns, osteomyelitis, fasciitis, cellulitis, chronic discharging sinus, and tendon contracture with or without pain.[1,2,3] The initial investigation is usually done with a plain radiograph, which however, cannot detect radiolucent foreign bodies such as those of wood, plastic and rubber.

Of the other imaging modalities, xeroradiography provides better edge enhancement, but it requires special equipment and is inadequate in detecting radiolucent foreign bodies.[4, 5]

Computerized tomographic (CT) scan has the ability to detect the radiolucent foreign bodies with limitations of ionizing radiation, cost and poor sensitivity in detecting small foreign bodies.[6,7] Magnetic Resonance Imaging (MRI) can detect radiolucent foreign bodies but has the limitations of being inaccessible, expensive, and a concern regarding magnetic foreign bodies as well as time consuming.

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**Conflict of interest statement**: There are is no conflict of interest


**Figure 1 (top) and Figure 2 (bottom)** High-resolution ultrasound of a foot suspected of having a foreign body.

There is an added disadvantage of not detecting foreign bodies with low signal intensity from tissues such as scar tissue, tendon and calcifications.[8, 9] Sonography, on the other hand, is easily accessible, inexpensive and a time saving image modality.

We undertook our study on thirty patients who presented to our outpatient department at two hospitals with a definite history of foreign body injury to the foot and ankle region. Patients presented with varied signs and symptoms which included pain, soft tissue mass, abscess, corn, chronic discharging sinus with duration of symptoms ranging from four months to eight years.

Most of these patients were initially managed by primary care givers and missed or often self treated themselves removing only a part of foreign body and subsequently neglected. Our aim was to assess the role of foreign body detection in these patients with high resolution ultra sonography (USG).

## Materials and Methods

Thirty symptomatic patients who had a definite history of foreign body injury of the foot and ankle region were included in this study. The symptoms of these patients varied from simple pain to chronic discharging sinus and all had a normal plain radiograph. All of them underwent high resolution ultra sonography of the affected part followed by surgical exploration.

Sonography was conducted by four specialist doctors who had a minimum of four years of experience in the radiology department. Sensitivity of USG was determined with respect to that found on surgical exploration.

## Results

Thirty consecutive patients presented to our outpatient departments from May 2008 to May 2012 with history of foreign body injury. Patients presented with persistent pain, soft tissue mass, granuloma, abscess or chronic discharging sinus with a normal radiograph. Nineteen patients were male. Twenty two patients were younger than twenty years of age. Twenty eight patients had symptoms in the foot; two had symptoms in the ankle region. Twenty three patients had a history of nail insertion in the foot through a rubber sole. There was thorn injury in six patients with five having it in the foot and one in the ankle region. One patient had injury to the ankle with a wood. Three patients had multiple surgical interventions for chronic discharging sinuses.

All these patients were sent to radiology for the high resolution ultra sonography of the affected part. In all our cases a frequency of 7.5 MHz to 13 MHz was employed. Foreign bodies were reported as hyperechoic masses with surrounding hypo echoic rim with an acoustic shadow in twenty eight patients (Fig. 1 and Fig. 2).

**Figure 3** Foreign body seen at the time of surgery.

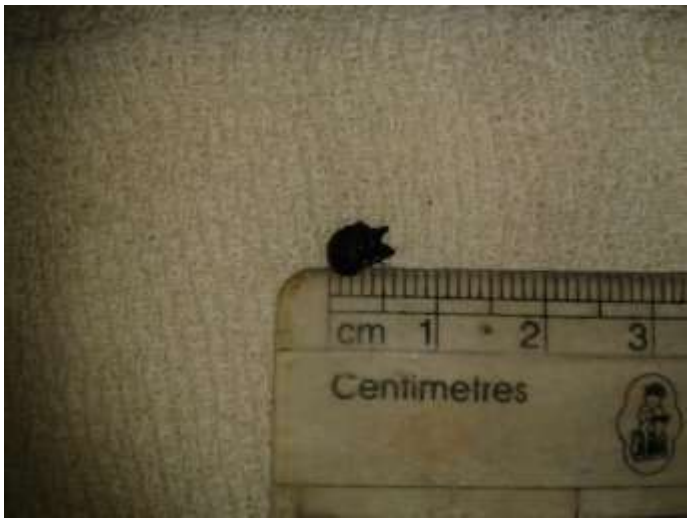


**Figure 4** Foreign body after removal.

Two patients which were reported negative had chronic discharging sinus with one having it on the lateral malleolus and another on the dorsal aspect of the foot. All patients underwent surgical exploration under general or regional anaesthesia with tourniquet control. Preoperative methylene blue injection into the sinus was used in three patients with chronic discharging sinus. Foreign bodies were recovered from all the patients (Fig. 3 and Fig. 4). Two patients who were labeled by the sonologist of not having a foreign body had foreign bodies close to or obscured by the bone. One of the patients had injury to the right lateral malleolar area with a wooden foreign body with persistent sinus discharge, and on exploration the foreign body was found very close to and abutting the cortex. Another patient had a history of nail insertion through the sole of the shoe with persistent sinus discharge on the planter aspect of the foot, and on surgical exploration a piece of rubber was found abutting the second metatarsal shaft cortex on the dorsal aspect. Out of the total thirty suspected radiolucent foreign bodies, high resolution ultra sonography was able to detect the foreign body in 28 patients with two false negatives with an overall sensitivity of 93.33%.

## Discussion

The basic principle of ultra sound is the use of a transducer to penetrate tissues with ultrasonic waves at various frequencies. When the wave strikes the denser component of tissue, they bounce (echo) back to the transducer. The ultrasound can then interpret the speed and intensity of the sound wave to determine the location and composition of the object. Structures are plotted on the screen based on their depth and location relative to the transducer. Superficial structures are plotted at the top and deeper ones at the bottom of the screen. The larger the surface area toward the transducer the greater it will reflect. Sonographic features of the foreign bodies in the soft tissues have three components. Firstly, the appearance of the foreign body; secondly, the changes in the soft tissues surrounding the foreign bodies. Thirdly, the appearance of soft tissues distal to the foreign bodies.

All foreign bodies on ultrasonography appear as hyperechoic foci. The reflectivity depends on acoustic impedance of the foreign body which in turn varies with the density of the object. In general, metal, mineral, glass, wood, and rubber reflect sound, appearing white on the screen. The changes surrounding the foreign bodies are due to inflammatory reaction which may range from edema to abscess formation.

This reaction takes some time to develop and is shown as hypo echoic rim around the foreign body. Distal to the echo rich foreign body acoustic shadowing is noted. This is due to failure of the ultrasound to pass through the foreign body.[10, 11]

Despite their size, foreign bodies are no small matter. When left untreated they cause pain, swelling, infection, nerve and tendon injury.[2, 3, 12] Although USG has been a well-established diagnostic tool for foreign bodies in the soft tissues, it has been underutilized in this part of the world. While evaluating the usefulness of USG in the detection of unsuspected foreign bodies followed by CT, MRI, bone and labeled red cell Scintigraphy, it has been found that the later investigations added no relevant information and were time consuming and costly.[12] The sensitivity of USG in detecting different foreign bodies has been reported to be 70% to 100%. Cases which turned out to be false negatives had either a very deep foreign body, gas around foreign body, or a foreign body too close to the bone,[8,13,14,15] as was the case in two of our patients.

Several studies have demonstrated the effectiveness of USG in detecting non-opaque foreign bodies in the soft tissues. The power of USG is as important as the depth of penetration of wave into soft tissues. The shorter wave length with high frequency penetrates less as most of energy is absorbed by the medium.[15] The authors do not believe that the results could be different if the USG was done by the same radiologists. Differences in the comparative accuracy, sensitivity and specificity of foreign body detection by radiologist and USG technician has not been found to be statistically significant in the previous studies.[16]

## Conclusion

The authors do not recommend replacing plain radiography with ultrasonography in the evaluation of suspected foreign bodies of the foot and ankle region. But Sonography should definitely be considered part of diagnostic work up of patients in whom we strongly suspect the presence of radiolucent foreign bodies based on history and symptomatology.

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