

Soft Tissue Foreign Body: Utility of High Resolution Ultrasonography

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ABSTRACT

Introduction: Minor percentage of wooden foreign bodies is radio-opaque. High Resolution Ultrasonography (HRUSG) though existing is sparsely used as a primary imaging modality for diagnosis and localization of retained foreign body.

Aim: To evaluate the diagnostic accuracy of High Resolution Ultrasonography (HRUSG) in diagnoses and localization of retained foreign body.

Materials and Methods: A prospective study with registered 46 patients with history of foreign body injury which were initially imaged with conventional radiography was enrolled. Later patients were subjected for high resolution USG of the diseased part with a linear transducer. Surface marking was done for all subjects to assist the surgical exploration. Ultrasound findings

were correlated with surgical exploration and histopathological findings.

Results: Out of 46 patients, forty one showed foreign body with foreign body inflammatory reaction in the form of abscess and/or granulation tissue on high resolution ultrasonography. No foreign body was detected in five patients but they showed focal hypoechogenicity which represented abscess and/or haematoma. On surgical exploration, two out of 41 patients did not reveal foreign body where as rest were found to have foreign body with foreign body inflammatory reaction. Sensitivity and negative predictive value of the current study is 100%.

Conclusion: High resolution USG is not only an efficient modality in diagnosing and localizing the foreign body in soft tissue, but can also be utilized for guiding the foreign body removal.

Keywords: Foreign body reaction, Foreign body granuloma, Ultrasonography, Wooden foreign body, Abscess

INTRODUCTION

Biological tissues respond to any foreign material in the tissue with the formation of foreign body granuloma [1]. This foreign body reaction compels the subjects to reach emergency departments and outpatient departments of orthopaedics of hospitals for further treatment. Walking barefoot in rural India is a common practice. Agriculture being the major occupation in rural regions, people working in the fields, farms and plantations with barefoot and without any protective measures for hands, could be the greater reason for more number of foreign body injuries with foreign body reactions in rural areas.

Penetration of foreign body into the soft tissues may be accidental or self inflicted [2]. Most of the individuals try to help themselves by removing the foreign body which is accessible outside the skin. However, majority of foreign bodies get retained within the soft tissues and later lead to complications. Foreign bodies may be in the form of wooden pieces, glass, metal, plastic or stone/mud particles. Retained foreign body may remain asymptomatic for prolonged periods or result in various complications like granuloma formation, abscess formation, necrotizing fasciitis, neural injury, tendon injury or even vascular injury [3-5].

Imaging plays a major role in not only confirming the presence of foreign body, but also in exact localization. The first choice of imaging modality for most physicians is radiographs to rule out radio-opaque foreign bodies. However, most of the wooden particles are radiolucent and will be missed in radiographs [6,7]. Revolution in the field of engineering of ultrasound probes has made the field of USG a great asset in the imaging world. Due to its easy availability,

cost effectiveness and non ionizing nature, HRUSG has become an important tool in detecting foreign body reactions.

The present study was intended to know the utility of high resolution USG in the diagnosis and localization of foreign body and enumerate its imaging features.

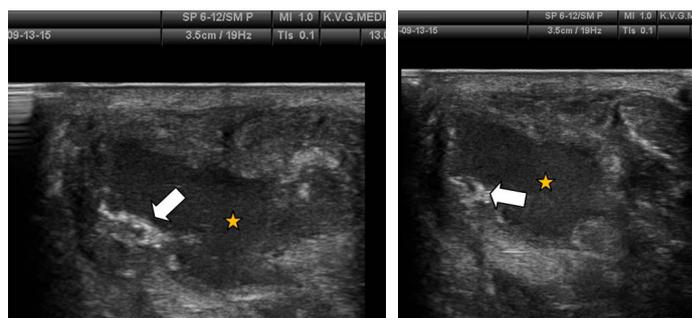
MATERIALS AND METHODS

This was a prospective study conducted in forty six patients with history of foreign body injury and/or foreign body reaction referred to the Department of Radiodiagnosis and Imaging for high resolution USG in KVG Medical College and Hospital Sullia, Karnataka, India. Ethical committee clearance was obtained from the institute. The study period was for two years, from October 2014 to October 2016. All 46 patients after obtaining the written informed consent underwent initial plain radiographs with two projections perpendicular to each other. High resolution USG was performed by a single radiologist with experience of more than seven years in ultrasound. Study was performed with 7.5 to 13 MHz linear transducer on GE Voluson expert 730 pro.

Patient was made to sit or lie down in his or her position of comfort

Part involved	Number (%)
Lower limb	26 (56.5%)
Upper limb	19 (41.3%)
Cheek	1 (2.2%)

[Table/Fig-1]: Distribution of the foreign bodies based on part involved in the body.



[Table/Fig-2a,b]: High resolution ultrasonography of the thenar region of right hand depicting thick walled echogenic collection {yellow star} (abscess) with multiple dependent hyperechoic foci {white arrow} (foreign bodies) showing minimal acoustic shadowing.

with part to be examined being exposed. Initial spanning high resolution USG was performed to know the region of involvement. Once foreign body was identified its size, shape, nature, number, depth from the skin surface and post acoustic shadowing was looked for. Note of complications of foreign body was made in the form of abscess/granulation tissue. Plane of the foreign body reaction was mentioned. Finally, surface marking was done to guide the surgeon for its removal or treatment. All 46 patients underwent surgical exploration, of which two were explored under ultrasound guidance. Sonographic findings were then correlated with surgical findings.

STATISTICAL ANALYSIS

The data was analysed by calculating statistical values of sensitivity, specificity, positive predictive value and negative predictive values.

RESULTS

In this prospective study 46 patients were enrolled, 29 male and 17 female patients. Age of the patients ranged from five years to 61 years with mean age of 34.89 years. Majority of the foreign body reaction was noted in the lower limb accounting for 26, followed by upper limb in 19 patients. One patient had foreign body in the cheek [Table/Fig-1].

On USG, foreign body was diagnosed as linear or focal hyperechoic lesion with or without post acoustic shadowing surrounded by a ring of hypoechogenicity, which may represent abscess/ granulation tissue. In case of formed abscess, movement of echogenic particles are noted within the collection with floating or fixed foreign body with. Average distance of foreign body from the skin surface was 3.2 cm with minimum of 1.0 cm and maximum of 4.2 cm [Table/Fig-2].

Out of 46 patients, 41 were diagnosed to have foreign body with foreign body reaction on HRUSG. Five patients showed focal hypoechogenicity on HRUSG without any evidence of foreign body which may represent granulation tissue/abscess [Table/Fig-3].

Parameters	Present - Surgery	Absent-Surgery
Positive - HRUSG	41	2
Negative - HRUSG	0	5

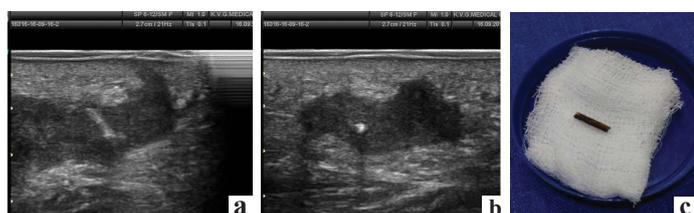
[Table/Fig-3]: Correlation between HRUSG and surgical diagnosis.

Type	Number
Wooden	36
Metal	1
Plastic	1
Gravel particle	1

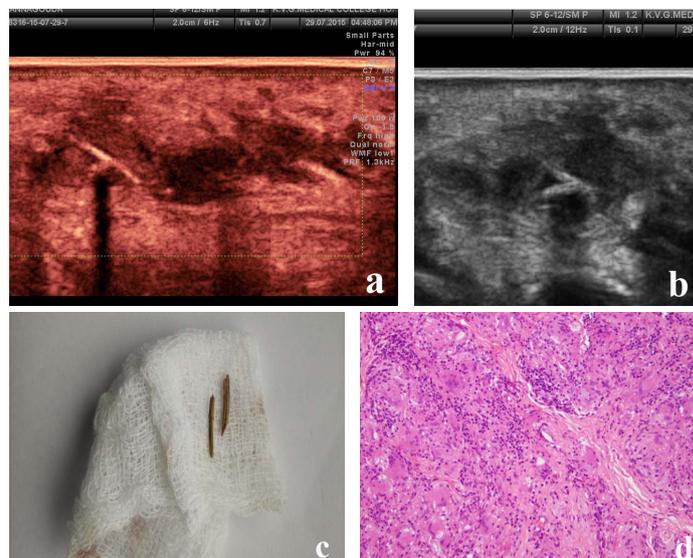
[Table/Fig-4]: Various types of foreign bodies.

Sensitivity	100%
Specificity	95.1%
Positive predictive value	71.4%
Negative predictive value	100%

[Table/Fig-5]: Table showing sensitivity, specificity, PPV and NPV.



[Table/Fig-6]: a,b) High resolution ultrasonography of sole of left foot depicting echogenic collection (abscess) with linear hyperechoic focus (foreign body) showing posterior acoustic shadowing; c) Third image shows wooden foreign body on surgical exploration.



[Table/Fig-7]: a, b) High resolution ultrasonography of sole of right foot depicting irregular echogenic collection (abscess) with linear hyperechoic foci (foreign bodies) within showing posterior acoustic shadowing; c) Shows two wooden foreign bodies on surgical exploration; d) Histopathological slide 10X showing foreign body reaction in the form of abscess or granulation tissue.

All 46 patients underwent surgical exploration, two among them with ultrasound guidance. Out of 41 patients who were diagnosed sonologically to have foreign body with foreign body reaction, 39 revealed foreign body on surgical exploration whereas two patients had only abscess with no foreign body. Five patients who were diagnosed to have only abscess/granulation tissue with no evidence of foreign body on HRUSG were confirmed on surgical exploration. Out of 39 foreign bodies which were explored surgically 36 were wooden splinters, one metal piece, one plastic and one gravel particles [Table/Fig-4]. Thirty six patients had single foreign body, one patient had two foreign bodies and two patients had multiple foreign bodies. All the cases diagnosed on HRUSG were concordant with the histopathological diagnosis. Majority of our cases were wooden foreign bodies (39) and all these foreign bodies were not detected on radiographs. Also, one plastic foreign body was not detected radiographically whereas the metal and gravel foreign bodies were seen as opacities in radiographs.

On statistical analysis sensitivity and negative predictive value of the study was 100%. Specificity and positive predictive value were 95.1% and 71.4% respectively [Table/Fig-5].

DISCUSSION

With a gamut of various imaging modalities, diagnosis of foreign body with foreign body reaction is not a difficult entity to encounter. Foreign bodies can be radio-opaque or radiolucent depending on their nature. Metal and glass foreign bodies are radio-opaque [8] whereas only 15% or less of wooden foreign bodies are radio-opaque [9]. Computed tomography is more sensitive than radiographs but has cons of radiation exposure, lesser availability, expensive and unable to detect wooden foreign bodies [10]. Magnetic Resonance Imaging (MRI) is an expensive modality, not easily available and most foreign bodies depicted as flow voids. Metallic foreign bodies are contraindicated in the MRI [11]. With the formation of abscess and granulation tissue identification of wooden foreign bodies is even more difficult on MRI [11].

Apart from the limitation of operator dependence, high resolution USG is safe, inexpensive, non ionizing, portable and easily available imaging modality for diagnoses of foreign body with foreign body inflammatory reaction.

In the present study none of the wooden foreign bodies which were in majority were detected on radiography.

In the present study, all foreign bodies were linear or focal hyperechoic structures with rind of hypoechogenicity on high

resolution USG [Table/Fig-6a,b] with presence of one wooden foreign body on surgical exploration in one of the case [Table/Fig-6c]. Histopathological examination in the current study revealed granulation tissue or abscess as prime cause of this peri foreign body hypoechogenicity. Similar findings were also noted in the studies conducted by Peterson JJ et al., [12]. Rind of hypoechogenicity around the foreign body could represent oedema, abscess, granulation tissue or haematoma [12].

All the visualized foreign bodies were hyperechoic with posterior acoustic shadowing in this study [Table/Fig-7a,b]. Two wooden foreign bodies are seen on surgical exploration [Table/Fig-7c]. All 46 patients had foreign body reaction in the form of abscess or granulation tissue [Table/Fig-7d]. Sheils WE et al., in his study revealed that soft tissue foreign bodies are hyperechoic on ultrasound with partial or complete acoustic shadowing and are with or without surrounding hypoechoic halo [13]. In the literature, two ultrasound artifacts are described in concern with soft tissue foreign bodies, posterior acoustic shadowing and reverberations [8]. Foreign bodies with smooth and flat surfaces like metal and glass will produce reverberations whereas foreign bodies with irregular surfaces and those with smaller radius of curvature show clear posterior acoustic shadowing [8].

Sensitivity and negative predictive value of the present study is 100%. Similar results were also noted by Mohammadi A et al., Rockett MS et al., and Sah PL et al., [11,14,15]. Turkcuer I et al., conducted experiential model study for the detection of wooden foreign bodies with USG and showed sensitivity and specificity of 85% and 80% respectively [16].

Two of forty one patients who were diagnosed to have foreign body with foreign body reaction on USG did not show any evidence of foreign body on surgical exploration. Possible justification for these two cases could be presence of air bubbles or smaller foreign body particles, as both were open wounds.

Probability of false positive results are likely as it is important for the radiologist to differentiate foreign bodies from other hyperechoic structures on high resolution USG like gas bubbles, sesamoid bone, deep fascia and scar tissue [11]. As discussed earlier acoustic shadowing acts as pointer in favour of foreign body and helps to differentiate it from other hyperechoic mimickers.

Retained foreign bodies are associated with various complications like granuloma formation, abscess formation, nerve injury, vessel injury or tendon injury, among which abscess/granuloma formation stands out to be most common [8]. All forty six referred cases of foreign body injury were found to be complicated by abscess, granuloma formation, which was depicted as hypoechoic rind surrounding the foreign body or as localized collection. The findings of HRUSG were confirmed on surgical exploration and histopathological examination.

Two among 46 patients were surgically explored under ultrasound guidance with no complications. Morteza T et al., used ultrasound guidance for foreign body removal in more than 30 cases with no short term complications [17]. In his study, he emphasized on the role of USG for providing guidance and exact anatomical location for

foreign body removal which avoids the extensive surgical exploration performed otherwise.

LIMITATION

The presence of gas shadowing, severe tender swellings where the patient was uncooperative were the limitations of the study.

CONCLUSION

In conclusion, HRUSG shows high efficiency in not only diagnosing and localizing the foreign body with its complications but also helps to guide for surgical explorations. From the study it can be conveyed that HRUSG of soft tissues must be used as an initial standard imaging modality in case of retained foreign body and foreign body reactions.

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