

## The Role of Ultrasonography in Detection and Localization of Radiolucent Foreign Body in Soft Tissues of Extremities

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### ABSTRACT

**Introduction:** Retained non-radiopaque foreign body inside soft tissue can be a cause of prolonged morbidity. Detection and localization is difficult task with conventional radiography. Ultrasonography, CT and MRI are other modes of evaluation but both of CT and MRI are expensive and not easily available.

**Methods:** Twenty three patients were evaluated with ultrasonography (8 MHz linear probe) and X-ray for clinically suspicious non-radiopaque foreign body in soft tissue of extremities. Clinical presentation, duration of symptoms, anatomical location and foreign bodies retrieved after surgical explorations were recorded.

**Results:** X-ray could not detect any foreign body in all 23 patients. Ultrasound findings were suggestive of foreign body in 19 patients (male: female=2:1, mean age 31.68±11.8 years, range 12 - 54 years) which was confirmed after surgical exploration except in one where only foreign body granuloma was found. 4 (21%) weren't aware of prick injury. Fifteen patients had attempted removal of foreign body themselves or at medical shop or local health post. Interval between injury / symptoms appearance to hospital ranged from 4-56 days. Foot and ankle was involved in 10 (52.6%), calf in 3 (15%), dorsum of hand in 2 (10.5%), palm in 2 (10.5%), shoulder in 1 (5.2%) and knee in 1 (5.2%) case. Foreign bodies retrieved were wood in 12 (63%), thorn in 4 (21%) and bamboo twig in 2 (10.5%) patients.

**Conclusion:** Plain X-ray isn't sensitive for detection of non-radiopaque foreign body in soft tissue. Ultrasonography is sensitive and specific for detection and localization of foreign body which should be included in evaluation for clinically suspicious retained non-radiopaque foreign body in soft tissue of extremities.

**Key words:** non-radiopaque foreign body; sensitivity; specificity; ultrasonography

### INTRODUCTION

Prick injuries with metallic or non-metallic foreign body are commonly encountered cases in orthopaedics clinics. Detection of retained of non-radiopaque foreign bodies

like wooden pieces, thorns lodged inside or in between soft tissue is difficult by conventional radiography. Specially, when patients present with pain, recurrent swelling or discharge but forget or are not aware of prick injury, diagnosis is often missed or delayed leading

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to multiple unsuccessful explorations which prolongs morbidity and increases treatment cost. Even with a high degree of suspicion, localization and estimation of number of non-radiopaque foreign body remains difficult with X-ray evaluation. When foreign body break inside or pieces are left, causing false impression of complete removal, may lead to inflammatory, allergic or infectious complications like painful lump, chronic pain, abscess, sinus and osteomyelitis.

Computed tomography (CT) and Magnetic Resonance Imaging (MRI) though useful mode of evaluation are costly and not readily available.<sup>1</sup> We present the prospective study of detection of non-radiopaque foreign body in soft tissue of extremities by ultrasonography.

## METHODS

A retrospective study on 23 patients presented to orthopaedics outpatient department (OPD) in Dhulikhel Hospital, Katmandu University Teaching Hospital, in two years duration (January 1, 2006 – December 31, 2007) were evaluated for clinically suspicious non radiopaque foreign body in extremities by ultrasonography and conventional radiography. Sonograms were obtained with 8MHz linear transducer of B-K Medical system. In ultrasound, linear lesion with distal acoustic shadow and surrounding hypoechoic area was suggestive of foreign body. Localization of foreign body was done in relation to skin depth and surrounding muscle, bone or tendon. Details of history of prick injury, symptoms, duration of presentation, clinical, sonographic findings and surgical findings were recorded and data was analyzed using Microsoft Excel.

## RESULTS

Out of 23 patients, 19 patients had sonographic features suggestive of foreign body. Age and sex distribution with male to female ratio of 2:1, mean age  $31.68 \pm 11.8$  years (range 12 to 54 years) is shown in table 1. Fifteen cases (78.9%) had history of prick injury and four (21%) were not aware or did not remember of any prick injury among which two cases were located on lateral boarder of foot and one each on leg and ankle. Case no seven presented with pain and tender swelling on planter aspect of foot without any history of prick injury for four weeks. Needle aspiration revealed no pus and no organism was isolated on Gram staining and culture sensitivity. X-ray was normal. Detail evaluation revealed history of cutting wooden logs with barefoot before symptoms started. With suspicion of non-radiopaque foreign body, sonographic evaluation was asked for which revealed linear echogenic structure with hypoechoic surrounding beneath skin suggestive of foreign body. About 3 cm wooden splinter was recovered on surgical exploration (Figure 1).

Twelve patients had attempted removal of foreign body with home available unsterile instruments. In three

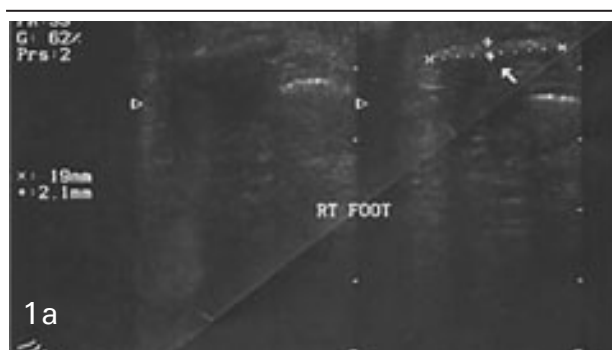
cases, unsuccessful attempt of surgical exploration was done at local medical shop or health center and none of them received tetanus toxoid vaccine Case no two had injury over his ankle while working in maize field. He developed pain, swelling and wound with seropurulent discharge with wooden piece. Plain radiograph was normal but sonography revealed evidence of foreign body. Wound was explored and wooden pieces were removed but discharge was persistent for two weeks. Further sonographic evaluation revealed a retained piece of foreign body which was removed by re-exploration (Figure 2).

The duration of presentation to hospital ranged from four days to eight weeks. Wooden pieces were common variety of foreign body retrieved in 12 cases (63%) followed by plant thorn in 4 (15.7%) and bamboo twig in 2 (10.5%). A boy (case no 1) had prick injury with bamboo twig over his right foot while playing football barefooted and he himself removed a piece of twig but he had persistent pain while walking for two months. Clinical evaluation revealed a small black tender induration and ultrasound revealed linear structure with distal acoustic shadow suggestive of foreign body. Surgical exploration revealed 7 cm long bamboo twig (Figure 3). Foreign bodies retrieved were wood in 13 (86%) patients had sustained prick injury while working in field and 2 (14%) had history of playing with bare foot when they sustained injury. Anatomically foot and ankle was involved 10 (52.6%), calf in 3 (15%), dorsum of hand in 2 (10.5%), palm in 2 (10.5%), shoulder in 1 (5.2%) and knee in 1 (5.2%) case. All 19 patients subjected to surgical exploration. In one case, ultrasonography was suggestive of foreign body of 3mm over ankle but surgical exploration revealed only foreign body granuloma. Summary of patients history and verities of non-metallic foreign bodies retrieved during surgery (Table 1). No significant complications were found in subsequent follow up except in one who had prick injury to dorsum of hand with rupture of extensor digitorum of middle finger, had persistent extensor lag despite repair of tendon.

## DISCUSSION

Retained foreign body in the soft tissue can lead to significant morbidity along with loss of time and money of the patient. It is not uncommon to forget about the incident of penetrating injury and remain undetected for long time till pain, swelling or discharging wound appear. In such cases, detection of non radiopaque foreign body in the soft tissue becomes extremely difficult.

Several imaging modalities are available for detection and localization of non-radiopaque foreign body in soft tissue. Conventional plain radiography or xeroradiography is less effective. Ex vivo tissue study conducted by Oikarnen et al and Manthey DE et al



**Figure 1:** 1a. Ultrasonography with linear shadow with distal acoustic shadow Figure 1b, 1c. Wooden splinter (arrow head) removed from sole



**Figure 2:** 2a. Ultrasonography with linear shadow with distal acoustic shadow (AS) 2b, 2c. Wooden piece (arrow) removed from ankle

found conventional radiography is not able to detect radiolucent foreign body at all.<sup>1,2</sup> No radiolucent foreign body was detected in plain radiographs in the present study also. Turkcuer I et al reported sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) for wooden and rubber foreign body embedded in chicken soft tissue is 5%, 90%, 33% and 48% respectively.<sup>3</sup> Xeroradiography though provides better edge enhancement, is not commonly available in all radiographic department, requires special equipment, have 20 time radiation exposure than plain X-ray and reported to show negative result in 80% patient.<sup>4</sup>

CT scan, MRI and ultrasonography are other investigation modalities advocated for evaluation of non metallic foreign body. CT and MRI are useful to identify objects, approximate size, and determine relationships to nearby structures. CT typically shows the retained wood as

a linear area of increased attenuation, which is best seen on wide window settings. The identification of wooden foreign bodies may be exceedingly difficult on MR imaging, especially when foreign bodies are small and there is no associated abscess or fluid collection. Both of CT scan and MRI are not only expensive but are also not readily available and impractical for routine use.

Several studies have tested the effectiveness in detecting and localizing of non-radiopaque foreign body in soft tissue with ultrasonography with variable success. Gilbert FJ et al reported detected non-radiopaque foreign bodies by ultrasonography (10 MHz transducer) in 21 true positive and 3 false positive; 25 true negative and one false negative in 50 patients with sensitivity and specificity of ultrasound 95.4% and 89.2%, respectively. Surgical exploration confirmed true positive cases with wooden piece in 17, thorns



**Figure 3.** 3a. Ultrasonography showing linear hyperechoic structure with surrounding halo (H) and distal acoustic shadow (AS) 3b. Induration with black discoloration (arrow head) at prick injury site 3c, 3d. Bamboo twig removed from planter aspect of foot

in 2 and glass in 2.<sup>5</sup> Ultrasound is found to be 95% sensitive and 89.5% specific for suspected retained foreign body in the hand by Crawford R et al when plain radiographs were normal and was also accurate in predicting the foreign body's exact location, size, depth, orientation, and relationship to other structures.<sup>6</sup> Turkcu I et al reported sensitivity, specificity, PPV, NPV, positive likelihood ratio and negative likelihood ratio of ultrasound for detection of wooden and rubber foreign body embedded in chicken soft tissue 90%, 80%, 81%, and 89%, 4.5% and 0.5% respectively.<sup>3</sup>

Other ex vivo tissue studies with chicken bone or beef cube or fresh human cadaver have shown variable results. Orlinsky M et al conducted study with 150 chicken thighs embedded with toothpick of 1.5 cm in half of the cases involving two experienced ultrasound technologist, one radiologist and two newly trained emergency physicians and found sensitivity 79% specificity 86%, PPV 85%, and NPV 80%. The accuracy of the radiologist, ultrasound technologists and emergency physicians was 83%, 85% and 80% respectively ( $p=0.42$ ) with overall accuracy 82%.<sup>7</sup> Sensitivity for detection of wooden and plastic foreign body embedded into 53 fresh amputated human legs by 7.5 MHz linear array transducer is reported to be 93% and 73% respectively by Hill R et al and the more experienced and the less experienced investigator did

not differ significantly in overall accuracy (77% versus 70%,  $p=0.47$ ).<sup>8</sup>

The lower rate of sensitivity and specificity reported in some studies do not represent actual clinical conditions. Inflammatory response though not necessary for detection of foreign body by ultrasound seen in living tissues cannot be mimicked and created in chicken bone of beef muscle cube or human cadaver. These studies did not take account of clinical history and examination findings also. Higher frequency transducer is reported to have better accuracy than 7.5 MHz transducer which is reported to have low sensitivity and specificity. The experience of operator is not limiting factor because studies have shown that no significant difference between experienced ultrasonologist and newly qualified emergency physician who have no prior experience.<sup>8</sup>

Soudack M et al considered ultrasound as a first line of investigation while evaluating any soft tissue superficial mass to rule out any non radiopaque foreign body even in the absence of history of penetration injury and no further work up was recommended once foreign body was detected.<sup>9</sup> In the present study also, four patients (21%) did not give history of previous prick injury who presented with pain swelling or discharging wound but sonography revealed features suggestive of soft tissue foreign body which was confirmed by surgical findings.

**Table 1.** Age and sex distribution, history, anatomical sites and types of foreign body among 19 patients

Case No.	Age (Years)	Sex	History of prick injury	Pain	Swelling	Discharging wound	Duration of symptom	Anatomical location	Type of foreign body
1	14	Male	Yes	Yes	No	No	8 wks	Foot	Bamboo twig
2	31	Female	Yes	Yes	Yes	Yes	4 wks	Ankle	Wooden pieces
3	12	Male	No	Yes	Yes	No	2 wks	Foot	Wood
4	17	Male	Yes	Yes	Yes	Yes	8 wks	Foot	Wood
5	40	Male	Yes	Yes	No	No	4 days	Palm	Wood
6	42	Male	Yes	Yes	Yes	Yes	4 wks	Dorsum of hand	Wood
7	50	Male	No	Yes	Yes	Yes	6 wks	Foot	Wood
8	36	Male	Yes	Yes	No	No	5 days	Leg	Wood
9	37	Female	No	Yes	No	No	4 wks	Ankle	Thorn
10	42	Male	No	Yes	Yes	No	3 wks	Ankle	Thorn pieces
11	20	Male	Yes	Yes	No	No	7 days	Ankle	Wood
12	25	Female	Yes	Yes	Yes	No	2 wks	Leg	Granuloma
13	36	Female	Yes	Yes	No	No	4 days	Palm	Wood
14	18	Female	Yes	Yes	Yes	No	6 days	Ankle	Bamboo twig
15	34	Male	Yes	Yes	No	No	7 days	Shoulder	Wood
16	38	Male	Yes	Yes	Yes	No	12 days	Leg	Thorn
17	54	Female	Yes	Yes	Yes	No	16 days	Dorsum of hand	Thorn
18	27	Male	Yes	Yes	Yes	No	3 wks	Knee	Wood
19	29	Male	Yes	Yes	Yes	No	3 wks	Foot	Wood

## CONCLUSION

Ultrasonography is superior to conventional radiography for detection of non radiopaque foreign body. It is less expensive and easily available unlike CT scan and MR imaging and is not associated with radiation hazard. Early detection of non radio opaque soft tissue foreign

body by ultrasound can reduce prolonged morbidity to the patient and related complications. Localization provided by sonography also helps to make smaller incisions and remove foreign bodies with a minimum amount of dissection and operating time. It should be part of routine investigation for evaluation of non-radiopaque foreign body in soft tissue.

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