Original Research Article

Sonographic evaluation of soft tissue and hollow viscus foreign bodies

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Abstract

Background: Ultrasonography is an useful diagnostic imaging method for localisation of foreign bodies in soft tissues. Approximate anatomical localization in respect with superficial skin marking under guidance is possible with sonography and can facilitate their speedy surgical removal. The complications associated with the foreign body objects like abscess formation, granulomas, pseudo-aneurysm, tenosinovitis can be well documented with sonography. Usefulness of ultrasonography in detecting various types of foreign bodies was studied; its associated complications were correlated with surgical findings. Soft tissue foreign bodies are usual in clinical practice. It is difficult to confirm their presence in soft tissues because X-ray only detects radio-opaque foreign bodies. Sonography can be an useful diagnostic imaging method for visualisation and localisation of non radio-opaque and also radio-opaque foreign bodies in soft tissues.[1,3,4] Few sonographic features like posterior acoustic shadowing and posterior reverberation artefacts help us in localisation of foreign bodies like wooden objects and broken glass, coin objects respectively. **Aim:** The aim of this study was to evaluate diagnostic efficacy of ultrasonography in detection and exact localisation of non-opaque and radio-opaque foreign bodies. **Material and Methods:** A total number of 35 patients were evaluated with suspected / unsuspected persistent foreign body in soft tissues by 10MHz linear array transducer. Radiologist who was doing examinations had more than 10 years experience in soft tissue imaging. Presence of the foreign body in the soft tissues was detected and localised. Approximate anatomical location was also marked over skin as guidance for facilitating the surgery and the sonographic findings were correlated with surgical findings. **Results:** A total number of 41 foreign bodies were seen as hyperechoic foci in 35 patients. Posterior acoustic shadowing was seen in wooden objects; thorns etc. (no. of objects 36) and posterior reverberation artefact was seen in patient having broken glass, coin and metal object foreign bodies (no. of objects 5). 15 patients were having halo sign due to granulation tissue formation; 9 patients were having abscess formation surrounding foreign bodies. Out of 35 patients 32 patients underwent surgery and 38 foreign bodies were removed. 3 patients lost follow up**. Conclusion:** Sonography is a useful diagnostic imaging method in detecting and exactly localising radiolucent or radio-opaque foreign bodies in soft tissue which can facilitate early surgical removal with less tissue damage and avoid misdiagnosis and associated complications**.**

Key Words: soft tissue foreign bodies, ultrasonography, skin marking.

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Received Date: 07/05/2018 Revised Date: 13/06/2018 Accepted Date: 02/07/2018
DOI: https://doi.org/10.26611/1013714

Access this article online

Quick Response Code:

Website: www.medpulse.in

Accessed Date: 10 July 2018

INTRODUCTION

Soft tissue foreign bodies with penetrating injuries are usual in clinical practice[1,2]. It is difficult to confirm their presence by X-ray alone because conventional radiology only detects radio-opaque foreign bodies[3,4]. Undiagnosed retained foreign bodies within soft tissues do complicate many of such injuries.[1,5] Sonography can be an useful diagnostic method for visualisation of radiolucent foreign body and exact localisation of both radiolucent and radio-opaque foreign bodies.[1,3,4] Since a retained foreign body may cause infection or inflammatory reaction; its detection and removal is mandatory.[1,5]. Routinely,

punctured wounds / skin marks and soft tissue lacerations are clinically inspected and explored in OPD to rule out the presence of a foreign body. X ray films are routinely obtained to confirm radio opaque foreign bodies. Radiolucent foreign bodies usually include wooden particles and thorns. Radio-opaque foreign bodies include glass, metal and stone pellet within the soft tissue[1,3,4]. Even though 38% of such foreign bodies are missed at initial examination in casualty[1,6]. The purpose of this study was to determine effectiveness of Sonography for detection and localisation of radiolucent and radio-opaque foreign bodies and to do skin marking for facilitating their speedy surgical removal.

MATERIAL AND METHODS

Study was conducted during app. seven year period (Oct 2010 to May 2017). Total of 35 patients were referred for ultrasound examination for possible retention of soft tissue foreign bodies in the upper or lower extremities. Out of 35 patients 6 patients were having persistent localised pain (in unsuspected cases). 28 patients were male and 7 patients were female. All patients initially underwent plain X-rays as a routine basic investigation and out of which 31 were negative for foreign bodies; in four cases radio-opaque foreign body was visible. Out of six unsuspected case, foreign bodies were unsuspected without any positive history of penetrating injury in two cases; four patients gave retrospective history of penetrating injury almost 2 yrs before. Patients were examined on Aloka alpha 7 and Wipro GE logiq P 9 colour Doppler systems. High frequency linear array probe is needed for good soft tissue resolution and detection of smaller foreign bodies[1] Ultrasonography was done along longitudinal and transverse axis with the help of high frequency probe after clinically evaluating patient's chief complaint and the site of penetrating injury. Whenever a foreign body was localized by ultrasound, its length, breadth was measured and its depth from the skin was also measured using callipers on monitor. Skin marking was done after thorough examination using marker pen for anatomical orientation of foreign body to surgeon; in respect to the nearest possible route for ease of its removal. Ultrasound findings of various soft tissue foreign bodies were recorded; that include their echogenecity, posterior acoustic shadowing, posterior comet tail artefact, posterior reverberation and a halo sign in each and every patient. Also their complications like abscess formation, tenosinovitis, pseudoaneurysm were recorded.

RESULTS

41 foreign bodies were detected and localised in 35 patients by sonography. Foreign bodies that were diagnosed by sonography were surgically removed using skin marking as a guidance; under local anesthesia in 32 patients. 3 patients lost follow up. Surgery revealed that 32 objects were wooden particles and thorns; 6 objects were broken glass particles; broken tile particles; stone pellet; coin and a pencil (32 patients with 38 objects). In 9 patients surrounding abscess was drained.

Table 1:

Wooden splinters	6
Thorns	20
Glass	1
Stone pellet	2
Metal	3
Tile particles	2
Stitch	2
Coin	1
Pencil	1

The smallest foreign body was a thorn object detected in the forearm which measured 3mm in length (1mm thickness) and longest measured 36mm in length. Thorn objects were the most common type.

Table 2: Foreign bodies detected

Forearms	9 patients
fingers / hand	6 patients
foot/toes	5 patients
Leg	2 patients
urinary bladder	1 patient
Stomach	1 patient
Rest of foreign bodies were elsewhere in the body.	

One of the patients had 2 pieces of thorn foreign body in his hand; another patient had 2 pieces of tile foreign body in her hand; one patient had 2 pieces of thorn foreign body in his great toe and one had two stone pellets in elbow. Sonography revealed the foreign body as hyperechoic objects in all 35 patients with posterior acoustic shadowing (Figures 2, 4,6) or or without posterior acoustic shadowing (Figure 3); reverberation artefacts (Figures 9a, b). Sonography revealed the foreign body as a late complication of previous penetrating trauma with sustained pain and tenderness at trauma site in 20 patients; hypoechoic mass was seen surrounding the foreign objects due to abscess (Figures 1, 2) and granulation tissue formation (Figures 3,4).

Figure 1

Figure 2

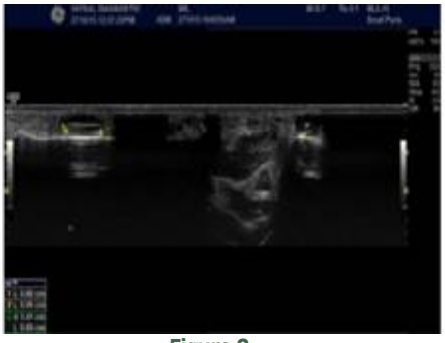

Figure 3

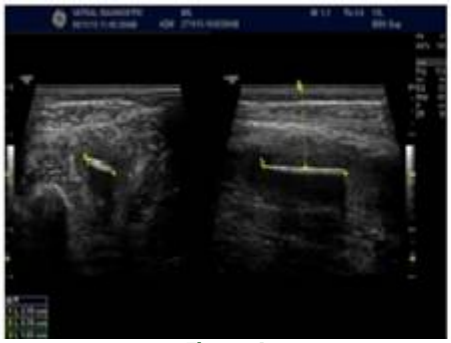

Figure 4

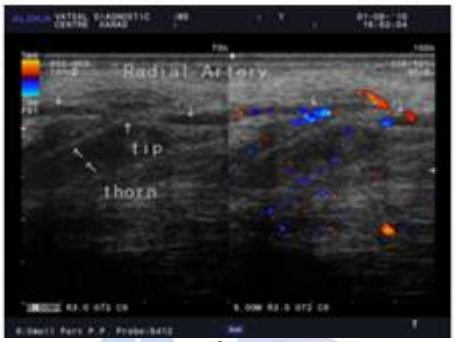

Figure 5

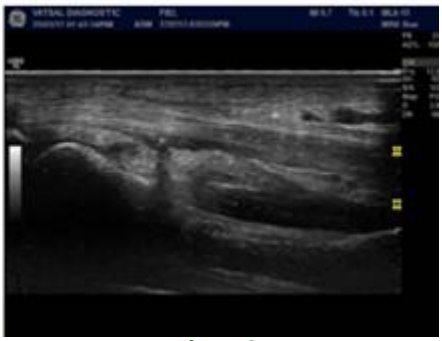

Figure 6

Figure 7

Figure 8

Figure 9

Figure 10

Figure 1: Wood splinter with abscess; **Figure 2:** Thorn with abscess; **Figure 3:** Thorn with granuloma; **Figure 4:** wood splinter with granuloma; **Figure 5:** Thorn touching radial artery; **Figure 6:** Foreign body tenosinovitis; **Figure 7:** Glass touching ulnar artery; **Figure 8 a.b:** bladder foreign body with calculus over it; **Figure a,9b:** Posterior reverberation artefacts in 2 cases; **Figure 10:** Stich granuloma.

In one case thorn tip was abutting radial artery with small pseudo-aneurysm formation of radial artery (Figure 5). In three cases thorn was embedded in tendon with its tenosinovitis (Figure 6) In one case glass surface was abutting ulnar artery serosa (Figure 7). In one patient thorn tip was abutting Lt. posterior tibial artery serosa. In one patient wooden foreign body (pencil) was in urinary bladder with a large calculus formation on one side (Figure 8a, 8b). Posterior acoustic shadowing was seen in wooden objects; thorns and posterior reverberation

artefact was seen in patient with broken glass and coin, metal objects (Figures 9). Stitch granuloma formation was observed in one case in anterior abdominal wall; surrounding sutures of previous surgery one year before (Figure 10). The type of foreign body, its measure, and depth from skin surface are expressed in table 1 (radiolucent foreign body) and 2 (radio-opaque foreign body).

Table 1: Radio-lucent foreign body

Sr. no	Type	Length mm	Breadth mm	Depth mm
1	Wood splinter	36	5.4	19
	"	22	7.8	16
2	"	31	3.1	12
3	"	11	6.2	11
4	"	18.2	8.5	16.2
5	"	20	0.9	5
6	"	12	2.9	17
7	"	10	6.2x3.1	12
8	Glass	20	16	5
9	Thorn	9	0.9	3
10	"	8.5	0.8	3
11	"	14.6	1.7	17
12	"	10	1.2	8
13	"	7	0.8	3
14	"	12.6	0.9	7
15	"	8.7	1.4	3
16	"	30	2	9
17	"	15	2	7
18	"	27	1.6	11
19	"	7	1.7	5.7
20	"	14.5	1.8	8
21	"	19	2	6
22	"	8	0.9	18
23	"	3	1	12
24	"	29	1.8	10
25	"	7	1.6	15
26	"	Two 19; 5.8	1.8; 1	7; 3
27	"	Two 20;5.5	2.4;1	5

Table 2: Radio-opaque foreign body

28	Stone pellet	Two 36; 31	34; 30	2
29	Metal	9.5	3.7	0.8
30	"	13	2	0.7
31	"	3.8	3.7	10
32	Stitch	App. 20	1	10
	"	App. 34	2	12
33	Tile particle	Two 4.8; 5.3	1 ; 1	1.8
34	Stomach coin	14	14	
35	Bladder pencil	65	13	

The sensitivity and specificity of Sonography in comparison with surgery in diagnosis of soft tissue foreign bodies was 100%.

DISCUSSION

A neglected retained foreign body in the soft tissues of extremities is not very uncommon in day to day practice. Clinical suspicion is necessary for clinical diagnosis. Exclusion of its presence is important, given the possible allergic, inflammatory, infectious and vascular complications associated due to a retained foreign body.[1,5] X-ray films must be obtained in view of the presence of radio-opaque foreign objects. Plain X-ray films will depict approximately 80% of all foreign bodies, but several types of radiolucent foreign bodies such as wood and thorn remain undetected.[3,4] Plain X-ray films of wooden foreign bodies are negative in 86% of patients with foreign bodies. In such situations, other imaging modalities are needed for diagnosis. In these patients ultrasonography can be the imaging modality of choice for identification of such radiolucent foreign bodies.[1,3,4] Ultrasonography sensitivity for detection of foreign bodies has been reported to be 95%[1,7]. Positive predictive value of plain X-ray film and ultrasonography were 100% and 95% respectively in previous reports for detection of soft tissue foreign bodies. Positive predictive value for Computed Tomography and Magnetic Resonance Imaging (MRI) were 95% and 93.8 respectively. CT had a negative predictive value of 78.3%, while ultrasonography, MRI, and plain X-ray film had 73.7%, 70.1% and 53.7%, respectively. CT had an accuaracy of 84.1%, ultrasonography 81.8%, MRI, and plain X-ray film had 77.3% and 56.8%, respectively.[8] On sonography non-opaque foreign bodies appear as hyperechoic shadow with posterior acoustic shadows[1,2]. This shadow may be either complete or partial which depends on the angle of insonation and the type of the foreign body (1,6). Foreign bodies are usually readily seen due to nearby hypoechoic halo which represents edema in the vicinity, nearby abscess or surrounding granulation reaction[1,9]. The visualisation of wooden foreign bodies may be difficult on MRI, particularly when they are small and without abscess, granulation tissue, or fluid in the vicinity. In those cases, the foreign body may appear as a signal void with surrounding nonspecific edema. Wooden foreign bodies may be seen as signal void in all sequences, but after water absorption it could be seen hypo-intense on TI hyper-intense on T2 images[2]. MRI is more expensive, less readily available as compared to sonography. Also it is quite difficult to detect small wooden foreign bodies on MRI; MRI is also not available in casualty or OPD at many places[2]. Ultrasonography gives relatively valuable information about foreign bodies related to the depth from skin surface, size and their anatomical relationship with nearby structures like vessels, tendons, bone etc.[3,7,2]. CT sensitivity for foreign bodies is 5-15 times more than that of plain radiograph but is not as sensitive as that of

ultrasonography or MRI[2]. In addition, the cost, ionising radiation, and less availability make CT less usable than ultrasound in day to day practice. Skin marking helps surgeon to use shortest possible route to access foreign body. Knowledge of exact location of the foreign body related to adjacent structures like tendons, vessels, muscles prior to surgery also causes less iatrogenic trauma. Foreign body detection by sonography is sometimes quite difficult in particular anatomical locations like inter-phalangeal spaces and with gas contamination after a penetrating injury.[1,7,9,14] Foreign body has to be diffentiated from other hyper-echoic tissues / structures like gas bubble, inter-muscular fascia, ossified cartilages, sesamoid bones, scars etc. Acoustic shadowing has a great help to differentiate foreign body from those structures[1,7], because those don't exibit acoustic shadowing. Peterson JJ *et al*[10] showed that sonography is the modality of choice in patients who have skin puncture or when a penetrating injury by a foreign body is suspected. Fornage BD *et al*[11] showed that wooden foreign bodies are easily identified by sonography as edge of the echogenic wood shows acoustic shadowing. Jacobson JA[3] showed that sonography can locate small wooden foreign bodies as small as 2.5mm in length. Also they noted posterior acoustic shadowing in wooden and thorn objects similar to the previous studies[1]. Dumarey A *et al*[5] showed that CT gives good anatomical perspective, but smaller fragments were difficult to localise. Ultrasonography is very sensitive in patients with penetrating injuries by foreign bodies. Posterior acoustic shadowing was detected in 20 foreign bodies out of 26 wood splinter and thorns which is comparable to previous study.[12] Shadowing depends on angle of orientation and duration of retention of foreign body. Long retained wood with absorb fluid altering its imaging appearance[1]. Posterior reverberation artefact was detected in patient with broken glass and coin objects.[6] The depth of all the evaluated foreign bodies was smaller than 2cm (shortest possible route for removal) in soft tissues of limbs; as most of them were seen distal to knee and elbow. In results this study demonstrated the excellent use of ultrasonography for detection of radiolucent foreign bodies and for localization of both radiolucent and radio-opaque foreign bodies. Therefore it is an important modality that helps a lot to remove foreign bodies by a shorter exploration field with less iatrogenic tissue damage (as facilitated by skin marking).[7]

CONCLUSION

In conclusion, sonography is cost effective, easily available and non-ionising imaging modality. It can be used effectively to locate radiolucent and radio-opaque foreign bodies with high certainty and should be considered as modality of choice for patients suspected of having a foreign body in the setting of negative X-rays, also in missed or under diagnosed cases with retained foreign bodies.

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Source of Support: None Declared
Conflict of Interest: None Declared