Ultrasound-Guided Removal of Soft Tissue Foreign Bodies

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ABSTRACT

Background: Foreign bodies in the soft tissues are common, and usually consist of wooden or metal splinters or glass shards. Failure to remove foreign bodies (FBs) may lead to infection, inflammation or possible allergies.

Objectives: To study the advantage of using ultrasound guidance removal of foreign bodies in soft tissues, which at times mostly are difficult to access, costly and technically challenging.

Methods: This is a retrospective study, which was carried out at Ibn-Alnafees hospital in Baghdad from the first of January 2010 to the first of January 2017 on cases with suspected foreign bodies found in the soft tissues. Ultrasound systems were used with high-frequency linear-array probes to specify their locations in order to remove the foreign bodies.

Results: Forty-four patients (42 males and 2 females aged 6 to 68 years, with a mean age 33.4 years and SD ± 13.2 were included. One patient had 2 foreign bodies in his body, another patient had 3 foreign bodies (total 47 foreign bodies). These patients underwent ultrasound-guided removal of the foreign body; two patients were operated upon after few days to remove a foreign body for a second attempt under local anesthesia. Six patients had wound infections postoperatively.

Conclusions: Ultrasound-guided removal of a foreign body found in the soft tissues is a good alternative to surgery as it is relatively straightforward, inexpensive, repeatable and carries a low risk of complications. In addition, failure to remove a foreign body does not preclude traditional surgical removal.

Keywords: Foreign bodes, Ultrasound, Local anesthesia.

Iraqi Medical Journal Vol. 65, No. 1, January 2019; p.1-6.

Foreign body (FB) found in soft tissue is a common cause of consultation in adults and children in clinics of emergency departments[1,2]. It is usually a metal such as bullets or shells, vegetal such as wood and glass fragments. A FB that has not been removed, can lead to both acute and chronic complications such as allergies, inflammation and infection[3-5]. If a FB is close to tendons they may cause tenosynovitis and in case of nerves it causes neuropathies, there may also be migration to joints causing arthropathies and embolic complications due to access to the venous system [1]. Long-term retention of FBs has also led to the onset of tumors[6,7].

FBs can uncommonly be identified and removed based on clinical examination alone and usually only when in a superficial location. Otherwise, imaging techniques are required to identify the FB and establish its exact location prior to surgical removal attempt. To identify and localize FBs other than by traditional radiography, which will usually display radiopaque FBs, echotomography has now proved irreplaceable, with high sensitivity and specificity[8,9].

Methods

A sample of 44 patients were retrospectively studied from the 1st of January 2010 to the 1st of January 2017 in Ibn- Alnafees hospital in Baghdad of Iraq. The age ranged between 6 and 68 years, mean age 33.4 (±13.2), being 42 males and 2 females patients. One patient had two FBs in his body, another patient had three FBs (total 47 foreign bodies). The patients

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were referred to our hospital by surgeons for suspected impalpable FB from penetrating wounds. All patients had a proper clinical examination and plain x-ray to confirm were the diagnosis and localize the FB, some of patient needed CT when the FB were hidden by the bone shadow. Using Toshiba ultrasound systems with high-frequency linear-array probes (7.5 MHz) which was performed by a well-trained specialized surgeon.

The removal procedure started with a diagnostic ultrasound examination to establish the exact location of the FB, its morphology and its relations to nearby structures (vessels, nerves, tendons) at the operating theatre by a radiologist. This initial step was crucial for planning of the treatment and to select the material required and the appropriate ultrasound probe, and logistics (positioning of patient, operator and the ultrasound device). After giving the antibiotic as prophylaxis and disinfecting the patient's skin with Betadine (povidone-iodine) and under sterile conditions (Sterile probe cover, sterile gloves, mask), a 22- to 25-G needle is inserted to reach the FB and a local anesthetic with 2-3 ml of 2% lidocaine administered under ultrasound guidance, leaving the needle in place and opening skin and following needle tract, (Figure 2 A & B).

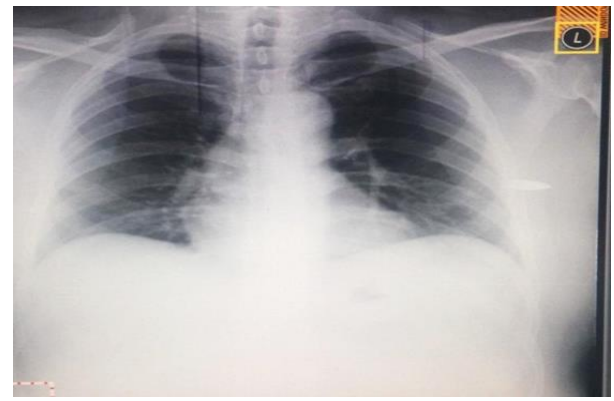

Figure 1: Bullet injury to chest wall.

A

B

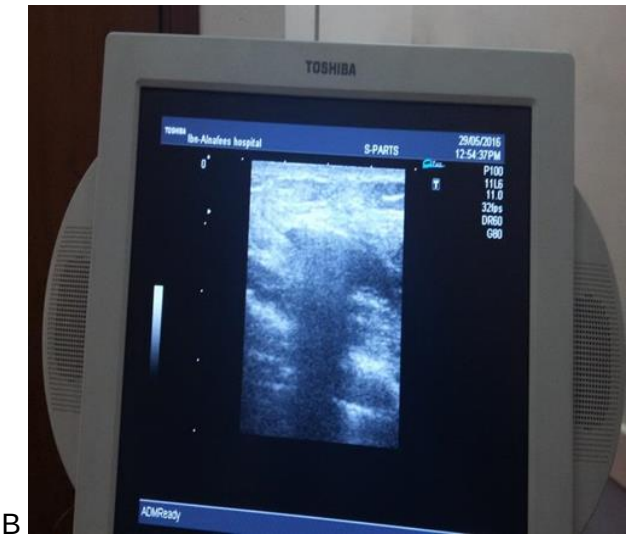

Figure 2: A, needle localization of foreign body. B, US image of foreign body.

Another method is by injecting the anesthetic close to the FB would detach it from the surrounding tissues thereby facilitating subsequent removal. The anesthetic drug continued to be injected while retracting the needle to anaesthetize the needle path to be used during removal. Under constant ultrasound guidance, the skin was then incised, with just large enough incision for the surgical forceps to be inserted, or wide enough for the FB to

pass through. The tip of the scalpel might reach the FB so as to create a complete linear passage between the skin and the FB. The operator then inserted the surgical forceps through the incision to reach the FB, following its passage in real time on ultrasound longitudinal scans. The arms of the forceps are then opened slightly, displacing the tissues surrounding the FB, to grip the object (axial scanning planes are useful at this stage to facilitate penetration) and then remove it.

Results

We included forty-four patients with 47 FBs (one patient had two FBs in his body another patient had three FBs) in this study. They were operated on by US guided methods in Ibn-Alnafees Hospital, Imaging confirmed the diagnosis and identified 47 FBs of various materials, which measured from 0.5 cm to 4 cm and located in different body parts, (Table 1). Standard X-ray displayed FBs made of metals, glass and stones in 42 out of 47 cases, (Figure 1) but failed to detect vegetable and plastic FBs. Ultrasound identified FBs in all cases. There distribution showed two females (4.5%) and 42 males (95.5%). Table 2 shows the distribution of FBs in the body regions. Patients had primarily been diagnosed by x-ray except one with a wooden FB which did not appeared radiologically. In two patients (4.5%) the FB removed at second attempt after decreasing pain and swelling (Figure 3), one of them after first failed surgical removal trial at another hospital one week before, (Table 3).

The average time taken for the operations ranges from 5 to 30 minutes with a median time of 15 minutes. All FBs were removed and no one needed GA or fluoroscopy (Figure 4, A and B). The operations completed safely and no surgical complications had been documented (Figure 5, A and B).

Table 1: Patients' sex and type of foreign bodies distribution.

	Bullet	Shrapnel	Needle	Glass	Wooden	Total
Male	32	9	1	1	2	45
Female	2					2
Total						47

Table 2: Distribution of foreign bodies in the body.

	Upper limb	Lower limb	Anterior chest wall	Posterior chest wall	Neck
Number of FB	8	12	11	13	3
Total					47

Figure 3: Attempts, after failed attempt in another hospital.

Table 3: Distribution of the rates of removal.

1st attempt removal	45(95.74%)
2nd attempt removal	2(4.26%)
Referred for GA removal	0(0%)

Table 4: Distribution of the types of complications.

Infection	6(12.76%)
Hematoma	1(2.12%)
Nerve injury	0(0%)
Vascular injury	0(0%)

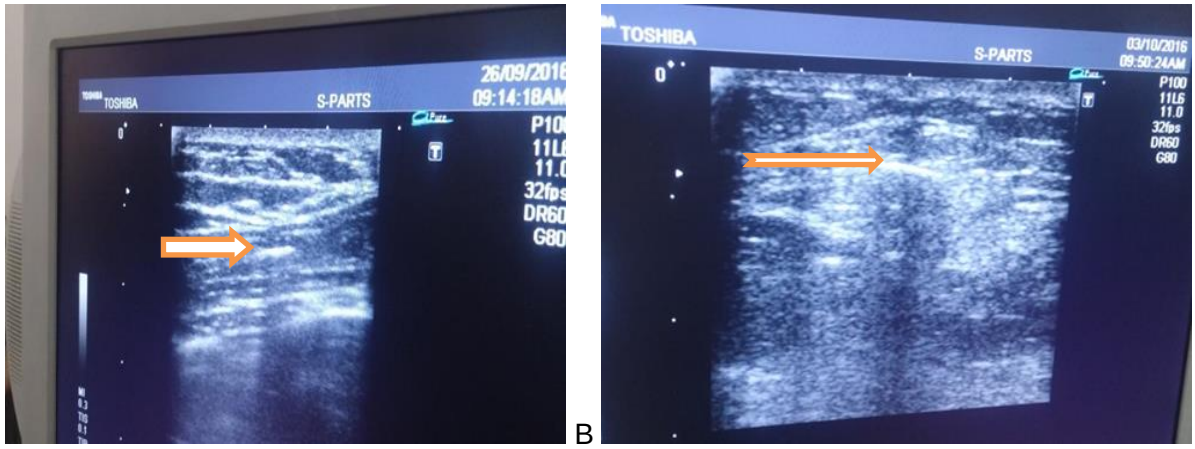

Figure 4: A, bullet at chest wall. B, shell at chest wall.

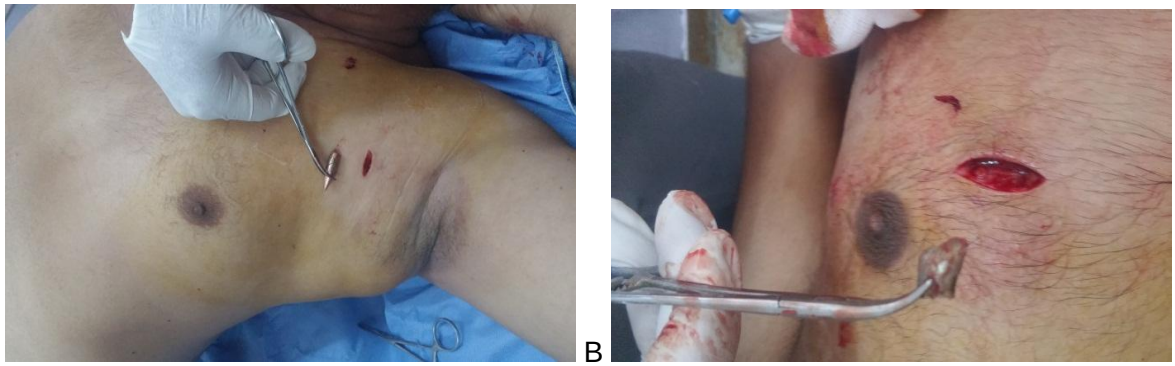

Figure 5: A, bullet in the chest. B, shell in the chest.

Discussion

The traditional radiography is widely available, simple to perform, inexpensive. X-ray is the reference examination[4] and will identify radiopaque FBs such as glass, metal, stone in around 80% of cases, but only displayed 15% of non-radiopaque FBs such as wood, plastic[10,11]. Radiography offers a more accurate topographic assessment and allows reference points to be marked on the skin to aid subsequent FB removal. However, radiography exposes the patients and operators alike to relatively high doses of ionizing radiation. Computed tomography (CT) (Figure 6), and magnetic resonance (MRI) scans are very expensive and have very limited indications for the FBs detection as they have poor sensitivity and specificity[11,12].

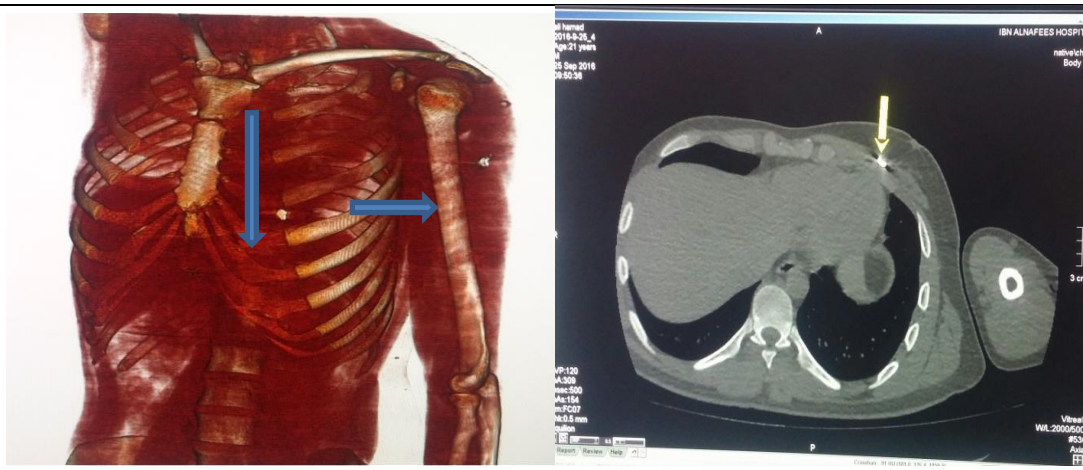

Figure 6: CT of chest shows multiple shells to chest and left upper arm.

Ultrasound is found to be the first choice investigation in the diagnosis of a FB found in the soft tissues, as it has a sensitivity and specificity of 90% and 96%, respectively[13,14].

Clinical examination alone fails to identify a FB in a high percentage of cases (up to 38%)[14], due to the pain, swelling and hematoma following the injuries. For this reason imaging techniques were appropriate to identify FBs and their exact location. Ultrasound could identify FBs smaller than a millimeter[15]. The limitations of ultrasound are well known as it is an operator dependent technique would only display FBs retained in superficial tissues[16] and results may be difficult to interpret in areas of previous surgical exploration. Air in a laceration can prevent penetration of ultrasound waves or by itself masquerade as a foreign body. Fresh hematoma may be isoechoic to the foreign body, thus obscuring its presence. New-generation of ultrasound devices fitted with high frequency probes will identify FBs with a thorough morphological and volumetric assessment and exact information on their three-dimensional spatial location[10]. High frequency transducers may be both highly sensitive and specific. At higher frequency, the wavelength is shorter that would enable a better resolution and facilitate precise localization of foreign bodies in soft tissue. However, high frequency waves cannot penetrate deeply into the tissue. Fortunately, most foreign bodies are superficial. We should select the highest frequency that would allow sufficient penetration. Gilbert et al used a 10 MHz probe to examine suspected radiolucent foreign bodies in extremities and described a sensitivity of 95% and specificity of 89%[17].

In some cases, the location of the foreign body may be so superficial that we cannot focus the image clearly. FBs are usually displayed as hyperechoic areas with varying degrees of posterior acoustic shadowing or comet tail artifact. Wood yields the strongest acoustic shadow and is the one most easily visualized. Long after the traumatic event, the FB may be surrounded by a hypoechogenic halo caused by granulomatous inflammatory reaction[16]. In this case it is important to establish an accurate differential diagnosis between FBs and any small air pockets, calcifications, skin scars, keratin deposits, hematomas or sesamoid bones[10].

The clinical relevance of this technique can be used to remove foreign bodies while minimizing patient discomfort and potential tissue damage [18]. Ultrasound examination will also establish the integrity of the surrounding ligaments, tendons, joint capsules and neurovascular structures (with the aid of color Doppler) and accurately depict the relations between the FB and adjacent structures such as tendons, nerves and vessels to ensure the

safe removal of the FB, avoiding iatrogenic lesions or complications[10,16]. A possible small residual scar has little or no aesthetic impact.

In conclusion: Ultrasound-guided removal of a FB retained in the soft tissues is a good alternative to surgery under GA in most cases due to its relatively straightforward, inexpensive, repeatable and carries a low risk of complications. In addition, failure to remove a FB does not preclude traditional surgical removal. Whereas surgical removal entails a significant loss of substance, ultrasound-guided removal of a FB is a minimally invasive procedure as its point entry is a simple skin incision of usually less than a centimeter.

The real-time features of the ultrasound-guided procedure minimize the amount of bleeding and avoid injury to structures surrounding the FB, while the sterile approach and antibiotic prophylaxis after the procedure reduces the risk of septic complications, and the use of small instruments minimizes any aesthetic impact, thereby enhancing patient compliance. Though the competency and the experience of the surgeons should not ignored, in both cases ultrasound should be used anywhere in casualty, in the ward considering that ultrasound could be used as a safe first choice to remove a FB and reserve deep and difficult FB to surgery.

Acknowledgment: We are grateful to Professor Basim Al-Shahabi, London University for reviewing the paper and his constructive comments.

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