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Usefulness of ultra-sonogram to diagnose non radio opaque foreign bodies and their removal under ultrasound guidance

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Abstract
The foreign bodies like wood, thorn, glass pieces cannot be seen in x rays. If it is small it is difficult to remove. So, blind exploration is more hazardous for patients. Retained FB in the extremities can produce pain and painful restriction of movement. Radiolucent foreign bodies of the musculoskeletal system can be seen by ultrasound so it has become the optimal imaging modality for detecting radiolucent FB. Ultrasound-guided percutaneous removal of FBs is a safe and viable approach to the management of FBs achieving at least 88% success overall. Extraction of ultrasound-guided FB is a good alternative to conventional surgery as it does not require general anesthesia, it is safe, inexpensive, less time consuming and with low complication rates.

Keywords: Radiolucent foreign body, wood, ultra-sonogram, fluoroscopy, MRI, removal of FB.

Introduction
The foreign body (FB) can be divided in two groups according to their composition: FB can be divided into metallic or nonmetallic and nonmetallic into organic and inorganic FB. The metallic FB is easily visible in conventional radiology. Organic material of vegetal origin (thorn) and the inorganic materials (ex. broken glass, plastics, rubber, etc.) are radiolucent and visible in radiograph only in 15% of the cases. Detection and removal of radiolucent soft-tissue foreign bodies is a difficult even when there is clinical suspicion of retained foreign body but radiography is negative. So, blind exploration is more hazardous for patients. Retained FB in the extremities can produce pain and painful restriction of movement. FB can lead to both acute and chronic complications such as inflammation, infection and granuloma formation. The surgical removal of an FB is invasive, costly and sometimes technically challenging. Attempts at blind removal of non-palpable FBs can be very difficult and are often unsuccessful. The procedure carries the risk of complications like bleeding and infection. Ultrasound-guided needle localization reduced the required incision length and depth and helped to minimize the risk of damage to surrounding tissue. The purpose of this study was to determine the accuracy of ultrasonography (USG) in detecting radiolucent soft-tissue foreign bodies and ultra-sonogram guided removal of it.

Materials and methods, results
By using ultra sonogram we have removed fourteen radio opaque FB. They are glass pieces 3; thorn 7, wooden pieces 4.A high frequency linear transducer (7.5 to 10 MHz) is placed where FB is suspected clinically over a glove filled with ultrasound gel which acts as a standoff pad. Foreign bodies will usually appear hyper echoic to the surrounding soft tissue. Material such as wood or plastic tends to produce shadowing. Metal objects tend to produce reverberation or comet tail artifact. FB is in both the sagittal and transverse planes. Once found, the depth down from the skin is measured and also the size of the FB. Surrounding area is surveyed for any vessels. Center the transducer over the foreign body and mark the skin to identify the optimal incision site. Transducer should be covered with sterile (gloves) and proceed skin disinfection.
Under constant ultrasound guidance the skin, sub cutaneous tissue and deep fascia is incised with11 blade knife. The incision must be just large enough for the dissecting forceps to be inserted and also depends on the size of the foreign body. The tip of the scalpel must reach the FB so as to create a complete oblique passage between the skin and the FB. The dissecting forceps or mosquito forceps is inserted through the incision to reach the FB under ultrasonic

guidance. The correct way to hold the FB is to bring the forceps closed until it is in contact with the FB, and gently open it and then move it forward a few millimeters. If the forceps is opened prior to "touch" the FB the procedure is unsuccessful because soft tissues "are clamped" instead of the FB. It should also be secured to one end the FB, allowing the extraction through the longitudinal path created.

Discussion

Anderson *et al.* [1] reported that 38% of retained foreign bodies in the soft tissues were overlooked at initial examination. It is the non-radio-opaque foreign bodies that represent a problem as they remain undetected by both X-rays and fluoroscopy. The traditional radiograms are widely available, simple to perform and inexpensive and will identify radiopaque FBs (glass, metal, stone) in around 80% of cases, but only displays 15% of non-radiopaque FBs (wood, plastic). [2, 3] If the Fb is not removed it can produce complications. When Fb is closer to vital structures like nerves and tendon it can produce neuropathies or tenosynovitis. FBs may also migrate to deeper soft tissues, into the joints, blood vessels [4, 5]. Long-term retention of FBs has also led to the onset of tumours [6]. However, fluroscopy exposes patient and operator alike to relatively high doses of ionizing radiation. Computed tomography (CT) and magnetic resonance (MR) scans are very expensive and have very limited indications for FB detection as they have poor sensitivity and specificity [7].

Use of ultrasound in detecting FB began in 1978, since then it became an excellent alternative in detecting FB, besides providing three-dimensional information, and FB relationship with relevant soft tissue structures, such as muscles, tendons, vessels, nerves, etc. The exact location of a radiopaque foreign body, its relationship to surrounding structures, and the degree of associated soft-tissue injuries can be defined with USG. ltra sound is the first choice investigation in the diagnosis of an FB retained in the soft tissues, as it has a sensitivity and specificity of 90% and 96%, respectively [8, 9]. The development of high-frequency transducers, up to 12 MHz, may identify FB less than 1mm in diameter. Thanks to its high spatial resolution, ultrasound will identify FBs smaller than a millimeter [10]. wood, glass, metal or plastic. The limitations of ultrasound are well known: it is an operator-dependent technique and will only display FBs retained in superficial tissues [11].

Ultra sonogram finding

The artifact occurring deep to a foreign body depends primarily on its surface attributes rather than its composition. Smooth and flat surfaces produce dirty shadowing or reverberation artifact, whereas irregular surfaces and those with a small radius of curvature produce clean shadowing. Metal and glass often demonstrate reverberation due to their flat surfaces [12]. The sonographic appearance of organic FB also varies taking into account the evolution time.

In the acute phase (up to 3 days after injury) the FB has a bright echogenicity with posterior acoustic shadowing well marked. This is mainly due to the air that is trapped within the material. When the FB is parallel to the skin it can be the visualized easily.

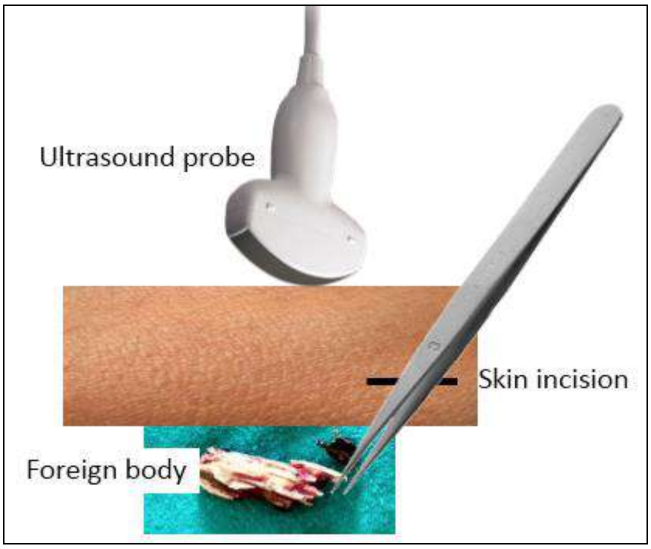
If a foreign body is present in the soft tissues longer than about 24 hours, Due to inflammatory reaction with edema, pus or granulation tissue formation there is hypo echoic rim around the echogenic foreign body. This hypo echoic rim improves the sensitivity and specificity of the US examination [13]. In the intermediate stage (3 to 10 days) the halo becomes more marked, and the echogenicity of the material decreases, while the shadow cone becomes less defined.

In the chronic stage (after 10 days) a dense granulation tissue encapsulates the FB. In almost all cases of this study, hypo echoic halo was present, which showed the chronicity of the process, and facilitated the identification of the FB, especially the smaller ones. While a small object of 5mm can be easily identified when superficial, bigger FB may not be detected in deeper areas. Ultra sonographic evaluation provides important information on the depth, size and shape of the foreign body as well as its anatomical relationship with the surrounding structures [14]. Surgical dissection is facilitated by accurate knowledge of the location of the foreign object relative to the skin surface, adjacent muscles and tendons. Doppler sonography may aid in localization if the foreign body lies in proximity to a blood vessel [15].

Ultrasound has become the optimal imaging modality for detecting radiolucent foreign bodies of the musculoskeletal system in emergency settings because of its high sensitivity and specificity in detecting radiolucent objects. It is also widely available and accessible, with portable scanners, and, of course, it does not involve ionized radiation [16]. A high-frequency (7.5-MHz or higher) linear array transducer is optimal for sonographic evaluation of suspected foreign bodies of the musculoskeletal system. The echogenicity of a foreign body is related to the nature of the object itself, although foreign bodies of the musculoskeletal system usually show hyperechogenicity [17]. Ultrasound is currently the imaging method of choice. In a study by Michael Orlinsky *et al.*'s study [18] the accuracy, sensitivity, and PPV of USG determined by a radiologist in detecting radiolucent foreign body were 83%, 83%, and 83%. In contrast, artifacts occurring deep in relation to the foreign body depend on characteristics of the object's surface. A foreign body with irregular or curved surfaces will produce “clean” posterior shadowing; if the surface is flat and smooth, “dirty” shadowing will be produced, which is known as the posterior reverberation, or comet tail artifact. This latter finding has been described for metal bullet fragments, glass, and plastic [19].

Other methods for identifying FB

Many techniques for removing foreign bodies of the musculoskeletal systems with or without imaging guidance have been described, such as fluoroscopy-or ultrasound-guided removal and the use of magnetic attraction with an eye magnet [20]. For recently entered foreign bodies, the surrounding inflammation appears as hypo-intensity on T1-weighted imaging and hyper-intensity on T2-weighted and other fluid-sensitive sequences in MRI scan. In contrast, in long-standing foreign bodies of the musculoskeletal system, wherein the granulation tissue is likely to have undergone structural alterations, the MRI appearance may be mistaken for a well-encapsulated multi-loculated cystic mass suggests seroma, liquefied hematoma, cold abscess, or cystic degeneration within soft-tissue sarcoma [21]. US have been proved effective only for superficial foreign bodies. Foreign bodies and their accompanying shadowing or reverberation may not be well visualized if they are located adjacent to bone or deep to subcutaneous gas [22]. Ultrasound-guided percutaneous removal of FBs is a safe and viable approach to the management of FBs achieving at least 88% success overall and with attention to the pitfalls, the learning curve should improve the success rate [23]. The procedure was accomplished most easily and quickly when one physician performed sonography and hemostat removal of the foreign body simultaneously [24]. The technique is cost effective, readily available, and can be very helpful in locating difficult-to-find radiolucent foreign bodies at the time of surgery [25]. Usually no complications arose either during or after the procedure. Ultrasound-guided removal of an FB retained in the soft tissues is a good alternative to surgery as it is relatively straightforward, inexpensive and repeatable and carries a low risk of complications. In addition, failure to remove an FB does not preclude traditional surgical removal. The advantages of this real-time procedure and the use of small instruments minimize bleeding time and avoid injury to surrounding structures. Patient compliance is enhanced by the fact that the procedure has little or no aesthetic impact. These encouraging results suggest ultrasound-guided removal as a first-choice procedure for the extraction of foreign bodies [26]. Ultrasound can be done at the bedside in emergency departments. Sonography can locate radiolucent FB. It provides information on the depth, size and shape of the foreign body. Its anatomical relationship with the surrounding structures Extraction with ultrasound guidance reduces the amount of bleeding and prevents damage to nearby relevant structures to the FB. Using small instruments, an excellent cosmetic result is achieved. It also facilitates removal of the object by enabling a shorter exploration with less iatrogenic tissue damage. Using sonographic techniques, percutaneous FB removal by radiologists is a minimally invasive and obviates the open surgical procedures. It reduces unnecessary admission and tissue trauma by unguided surgical exploration. Extraction of ultrasound-guided FB is a good alternative to conventional surgery as it does not require general anesthesia, it is safe, inexpensive, less time consuming and with low complication rates. Even if it fails conventional surgery can be done. Limiting factors are experience of the ultra sonologist and the cost-effectiveness.



Conclusion

Ultrasound is the imaging method of choice for radiolucent FB when clinically suspected and when radiography is negative. Sonography has a definite advantage over conventional radiography and fluoroscopy in the detection and localization of foreign bodies embedded in the soft tissues, since it locates even those that are radiolucent. USG identifies the radiolucent foreign bodies, its location and assessment of surrounding structures like tendons and vascular structures It also facilitates removal of the object by enabling a shorter exploration with less iatrogenic tissue damage. Sonography depends on the personal experience of the ultra sonologist and the cost-effectiveness.

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