Foreign bodies in superficial tissues: Ultrasonography makes your clinical practice easy

Poster No.: C-0573
Congress: ECR 2016
Type: Educational Exhibit
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Keywords: Trauma, Inflammation, Foreign bodies, Surgery, Removal, Diagnostic procedure, Ultrasound, CT, Conventional radiography, Soft tissues / Skin, Musculoskeletal soft tissue
DOI: 10.1594/ecr2016/C-0573

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Learning objectives

To highlight the effectiveness of ultrasound examination in detecting solid foreign bodies (FBs) in the subcutaneous tissues and superficial muscle groups, a statistically common problem and a "common trouble" for traumatology with not so much interest in bibliography. Furthermore this paper is an attempt to present a variety of characteristic cases of FBs as demonstrated on US.
Background

Imaging techniques have made a significant progress but the exact topographic localization of a foreign body still remains a hard and challenging task and demands proper imaging modalities for the better localization. Furthermore the detection of FBs in the soft tissues is often a challenge, even if it is clinically suspected. Occasionally, patients may present after some time (even months or years) from the initial injury and consequently clinical evaluation may fail to elicit a history of antecedent skin puncture. FBs after trauma or postoperatively may be disclosed by X-rays, Computed Tomography (CT) or Magnetic Resonance Imaging (MRI), depending on the material, position and size of the FB. Specifically, X-Rays may fail to detect the embedded radiolucent foreign bodies leading to a retard or total miss of the diagnosis. In such cases diagnostic ultrasound detection can be seen as a valuable screening tool. Moreover, just the detection of a foreign body may not give sufficient evidence. Crucial information can be given from the relation (contact, distance, etc.) of the foreign body with the adjoining structures and especially by the vascular formations, even better when they are "important" vessels. In such cases CT or MRI can be used. However, these methods are not always available, additionally are expensive, and while the first faces the problem of radiation the latter is time-consuming and not satisfactory or even dangerous for the detection of metal bodies that are affected by the magnetic fields. Therefore, ultrasound examination can be used as a participatory, reliable, cheap, easily available, and harmless, without the use of radiation diagnostic modality.
Findings and procedure details

X-ray, CT, MRI, Ultrasound Sonography (US) can be used for the detection of the presence of a foreign body in the human organism. Depending on the material (Table 1), the size of the foreign body and its position, there are certain limitations of the various imaging modalities. Especially for the foreign bodies in the superficial structures, X-rays cannot always reveal the embedded foreign bodies, whereas the combination of sonography with X-rays permits the diagnosis and detection virtually of all the foreign bodies that are found in such depth in relation to the skin that is possible to be approached by the ultrasonic beam. Ultrasound has been thoroughly studied for the evaluation of foreign bodies and it has been proven to be quite sensitive and specific enough in such a rate that ultrasound constitutes the preferred modality in patients who have traumatic break in the continuity of their skin or/and strong suspicion of an embedded foreign body. For the detection of possible foreign body the ultrasound examination is performed with linear transducer, at frequencies from 7.5MHz to 17MHz. Ultrasound can be used effectively for the detection of especially small radiolucent foreign bodies, even if they are small in length and thickness (<=2 mm). The ultrasound detection provides important information according to depth, size and the anatomical relation of the foreign body with the surrounding structures. Furthermore, is the modality that can confirm the complete removal of the body after the operation. FBs regardless of their constitution, in ultrasound examination give an intense back-acoustic shadow (they do not permit the spread of the ultrasound beyond that point). Even in the cases (small chance) when the back-acoustic shadow is not intensively produced in the whole area of the foreign body, the input end of the body creates a remarkable back-acoustic shadow, is helpful in diagnostic approach. In cases with air presence, posterior comet tail sign may be present beyond this area.

The majority of the metal and the glass foreign bodies can be detected with a simple X-ray, whereas the organic materials like the wood and the plant ones are radiolucent and it is more often to provoke reactive inflammation and infection. Due to their porous structure and to the fact that they are excellent carriers of microorganisms, infection of the soft issues, abscess, or fistula formation can be caused. Additionally, it can be provoked folliculitis if a joint is affected and/or osteomyelitis to the adjacent bone structures. The imaging when combined with clinical information can be accurate enough and can offer a valuable diagnosis. US is an effective tool for the detection of FBs and especially for the radiolucent ones which are embedded in the subcutaneous tissues. In addition, it is an imaging method that facilitates the removal of the object with the least surgical detection and therefore, it causes less iatrogenic damage to the tissues.

A wide spectrum of FBs can be demonstrated by US including pebble, needle, stent, wooden pin, piece of glass, firearm projectile, plastic, wire, and catheter fragments. Tips and tricks in the examination procedure are presented. Only 35.14% of the FBs seen by US were also depicted on X-rays, according to our records. FBs not seen on X-rays include plastic, aluminium, glass, fish - meat bones etc. In the limited number of cases where CT was also performed a full agreement with US was observed.
<table>
<thead>
<tr>
<th>AW</th>
<th>Foreign body</th>
<th>X-rays</th>
<th>CT</th>
<th>MRI</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>organic materials, low atomic weight (&lt;20)</td>
<td>thorn of plants-flower, woods, herbs, seeds, splinter of canes, plastic, polyurethane, tires, fibers, etc.</td>
<td>—</td>
<td>—</td>
<td>+/—</td>
<td>+</td>
</tr>
<tr>
<td>metals of low atomic weight (AW: 20:40)</td>
<td>aluminium, common glass, silicons, rocks of calcareous stones, soil, fish-meat bones, etc.</td>
<td>they cannot be easily depicted</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>metals of high atomic weight (AW &gt; 40)</td>
<td>iron, nickel, copper, lead, silver, gold, etc (it can be found to sheet metal cars, to glasses from the windscreen of a car-color from heavy metals).</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

AW: Atomic Weight, CT: Computed Tomography, MRI: Magnetic Resonance Imaging, US: Ultrasound

**Fig. 1:** Table 1.
Fig. 2: (a) Chest X-ray (b) #-ray (tangential or "skyview") focused on the point of the getaway entrance of the foreign body. From the co-evaluation of the images, it is identified a foreign body with a shape compatible with the reported bullet-tip coming from an air gun, and it is out of the pectoral hull in the right subclavian area. There is no observable damage neither in the lung parenchyma, nor in the bones. In second X-ray (b) an edematous supraclavicular area (thick arrow) is noted and within this area a radiolucent, linear area that probably corresponds to the course that the foreign body has followed; this becomes more clear if the direction of the wedged bullet-tip was checked.
Fig. 3: Ultrasound of the right subclavian area. Ultrasound revealed the bullet in the back surface of the subclavian muscle and in the fascia area. Posterior acoustic shadow (arrow) also was revealed (caused by the interruption of the ultrasound transmission in the area that is back of the bullet).

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**Fig. 4:** Plain and profile X-ray of the hand. No bone abnormality is observed. Presence of edema in the dorsal hand, in the metacarpal is identified (arrow in profile X-ray). No foreign body is identified.

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**Fig. 5:** Ultrasonography in the area of the edema of the soft tissues. The presence of foreign body of wedge-shaped morphology that is surrounded by an uneven area that corresponds to a surrounding edema is noted. Rear the foreign body it is identified a mild posterior acoustic shadow. Centrally in the foreign body it is noted linear hypointense depiction (porous structure). IV: 4° Metacarpal bone.

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Fig. 6: Surgical removal of the foreign body.

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Fig. 7: Plain X-ray at the site of pelvis: two linear radiopaque "metal" foreign bodies (red arrows) are visualized. One of them was across the minor pelvis and the other is illustrated left ride obliquely to the pubic bone.

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Fig. 8: Ultrasonography exploration followed, which confirmed the position, identified depth, size and relationship with adjacent structures.

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Fig. 9: Ultrasound: Soft tissue swelling at the site of the needle - tip is noted.

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Fig. 10: Ultrasound: Soft tissue swelling at the site of the needle - tip is noted.

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**Fig. 11:** Surgical excision of foreign bodies metal sewing-needles, corresponding to US findings (3.5cm and 4.5cm) are removed. [potential self-harm]

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**Fig. 12:** Ultrasonography (longitudinal) at the site of the left femoral inguinal region revealed a stent (note: lumen recognition) [white arrow]. Coexistence of edema and fluid collections with internal echoes also were noted.

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Fig. 13: Same patient and findings in transverse plain (US). An image corresponding to abscess also is noted (white arrow).

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**Fig. 14:** Computed Tomography (axial view) confirmed the US findings.

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Fig. 15: CT, (sagittal view) which confirmed the US findings (presence of foreign body, swelling and dirt in the vicinity and abscess).

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Fig. 16: X-rays (en-face and profile) of the hand. No bone pathology is observed. In the profile, presence of edema in the plantar hand, in the area of the thenar muscle is noted (arrow). No presence of any foreign body is identified.

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Fig. 17: Ultrasonography. The presence of a foreign body of linear morphology is noted. The foreign body is surrounded by an area of edema. A slightly recognised posterior acoustic shadow is noted at the tip of the foreign body.

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Fig. 18: Point of entrance of the foreign body (palmar surface - site of thenar muscle).
Conclusion

US is an efficient means for revealing superficially embedded FBs and could be utilized as the initial examination in patients suspected for FBs presence in the subcutaneous tissues or superficial muscles. The accuracy of the ultrasound is operator dependent, but has the ability to contribute significantly to the reduction of the morbidity and to the expenses that relate to the traumatic implantation of foreign bodies to the superficial soft tissues.
References