Soft- tissue foreign bodies: Diagnosis and removal under ultrasound guidance

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ABSTRACT

Soft tissue foreign bodies due to penetrating injuries are a common reason for emergency department visits.

We present a series of six cases in which ultrasound was used successfully not only as a diagnostic tool but also as a real-time guidance for their removal.

Key words: ultrasound, sonography, foreign body, penetrating wounds.

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OBJECTIVES

This paper aims to fulfill two objectives; firstly to demonstrate the utility of diagnostic ultrasound in the detection and characterization of foreign bodies (FB) retained in soft tissues, and secondly to demonstrate the usefulness of ultrasound in their removal, allowing realtimecontrol maneuver. It also highlights the fact that ultrasound is the imaging method of choice when retained FB are clinically suspected.

INTRODUCTION

FB retained in soft tissue are a common cause of consultation in adults and children (1,2,3,4), usually due to vegetal material (thorns) and lesser to metal and glass fragments.

A FB undetected, can be a source of complications and malpractice lawsuits (5)

Traditionally, and as the first imaging modality for the initial workup,radiography of the area is done, which primarily shows radiopaque objects. For several years ultrasound has been positioned as the first diagnostic method to visualize all types of FB, providing removal guidance.

This article shows a series of patients with soft tissues FB in extremities, in which ultrasound was successful both in detection and removal.

MATERIALS AND METHODS

The sample included 6 patients, studied between March and September 2011.

The age ranges between 5 and 65 years, being 4 male and 2 female.

Patients were referred by surgeons for suspected FB from penetrating wounds, in all cases with an evolution of more than 10 days and less than two months.

In five cases the agent, of organic origin was suspected (plant thorn) while it was unknown on a foot injury case. The symptoms in all cases were persistent pain in the affected area, even after the disappearance of the puncture wound. In a patient with a forearm injury, there was also significant edema and soft tissue infection, and signs suggestive of deficient ulnar nerve involvement.

In three cases the wounds were located in the upper limbs, and the remaining in feet.

In one case there had been previous conventional surgery without FB localization.

Four cases underwent radiograph of the area, being negative. The other two cases were studied only with ultrasound.

Ultrasonographic studies were performed using high frecuency (8-12 MHz) linear transducers in two units (General Electric and Esaotemodel My Lab 50).

RESULTS

Case 1-

66 -year -old patient with a 15 day history of penetrating injury in foot plant, while swimming in a river. The patient does not know the nature of the traumatic agent.

Retained FB is suspected. An X Ray is performed, which shows no abnormality. Given the persistence of pain, ultrasound is performed confirming a 32mm long FB. Consulting plastic surgeon suggested removal under ultrasound guidance. The procedure was performed through the primary traumatic point of entry, obtaining vegetable thorn.

Favorable evolution ,without complications. Figures Case 1

Case 2-

55 -year -old female, with a 15 day history of penetrating injury in her right forearm by palm thorn.Post-traumatic event, radiograph was obtained showing no evidence of FB 24 hours later she begins with soft tissue edema of the affected area, and fever.

Partial response to antibiotics.

Consultation with plastic surgeon was done.

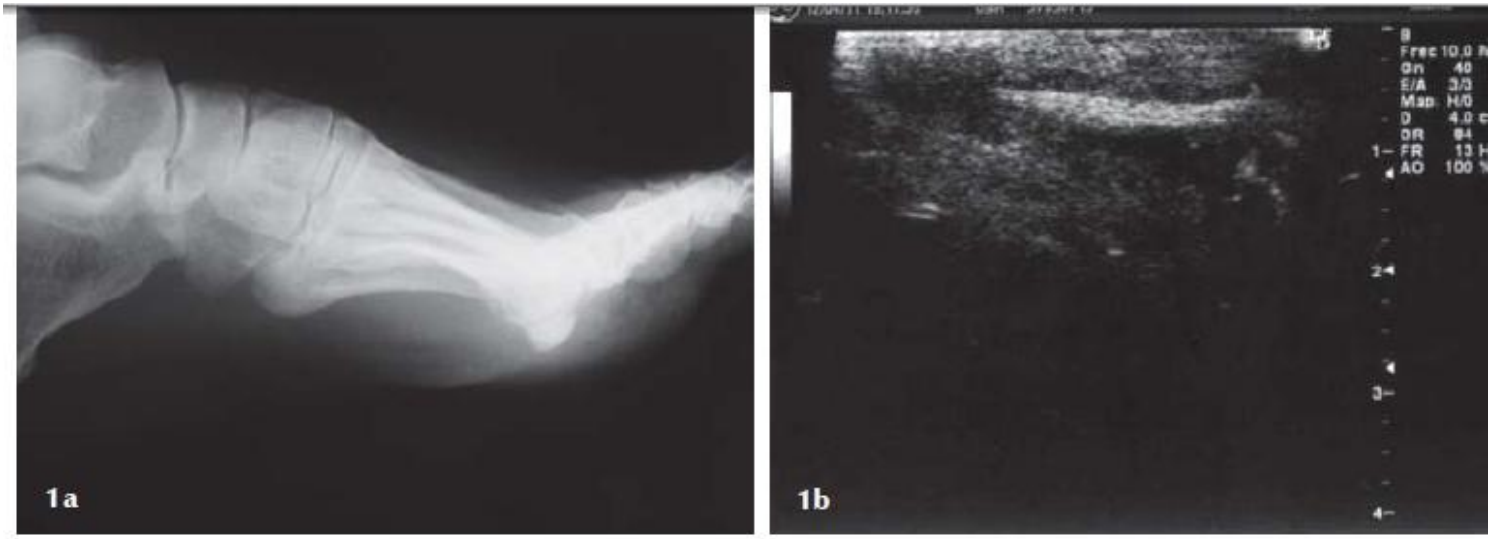
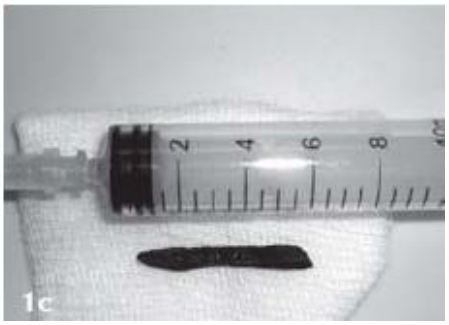


Figura 1
Caso Nº 1. 66 años, 15 días de evolución de herida penetrante en planta de pie.
a) *RX simple de pie no pone en evidencia CE.* ***b)*** *Ante la persistencia de dolor, se realiza ecografía que confirma CE de 32mm de longitud. Se destaca halo hipoecoico, característico de los procesos crónicos, y marcada ecogenicidad del CE debida a encontrarse en posición paralela a la piel.No existen fenómenos de reverberación, por lo que es de suponer que el agente no es de constitución metálica.* ***c)*** *Se realiza extracción guiada mediante ecografía a través del orificio primario traumático, obteniéndose espina vegetal. Evolución favorable sin complicaciones.*



The requesting ultrasound study showed negative results. Afterwards she installs deficit signs of ulnar nerve, whereupon the surgeon requests new ultrasound, confirming the presence of FB. Removal of the FB is performed under ultrasound-guided. Regresion of deficient ulnar afectation as well as the infection were atteined.

Figures Case2

<u>Case 3-</u>

8- year- old girl with a 25 days history of penetrating wound in right or left foot.

FB is suspected with clinical palpation and is operated 10 days after.

Conventional surgery cannot find the FB, and given the persistence of symptoms (pain) an ultrasoundstudy is performed.

Ultrasound confirms FB, 10mm long, without reverberation phenomena, probably vegetable FB. Given the age of the patient, general anesthesia is performed and FB is extracted with ultrasound guidance without complications. Figures Case 3

Case 4-

5-year-old boy, with a 12 day history of penetrating injury in dorsum of foot.

As pain continued, ultrasound was performed confirming the presence of an 8mm FB at the clinical problem area. Due to the inconsistency between the transducer size and localization, which made not possible the removal with ultrasound guidance,she has an intervention under general anesthesia. It is not possible to extract the FB by ultrasound, so skin is marked on the location and removed with conventional surgery.

Case 5-

48-year-old male who works at a sawmill. 15 days before the consultation suffered a puncture wound in the left palm hand (hypothenar) with a wood splinter. A radiograph was performed. It showed no abnormalities. Given the persistence of pain in emergency consultation, an ultrasound was performed confirming the presence of a FB. An ultrasound-guided procedure was performed. A wood splinter larger than 15mm was removed.

He progressed favorably.

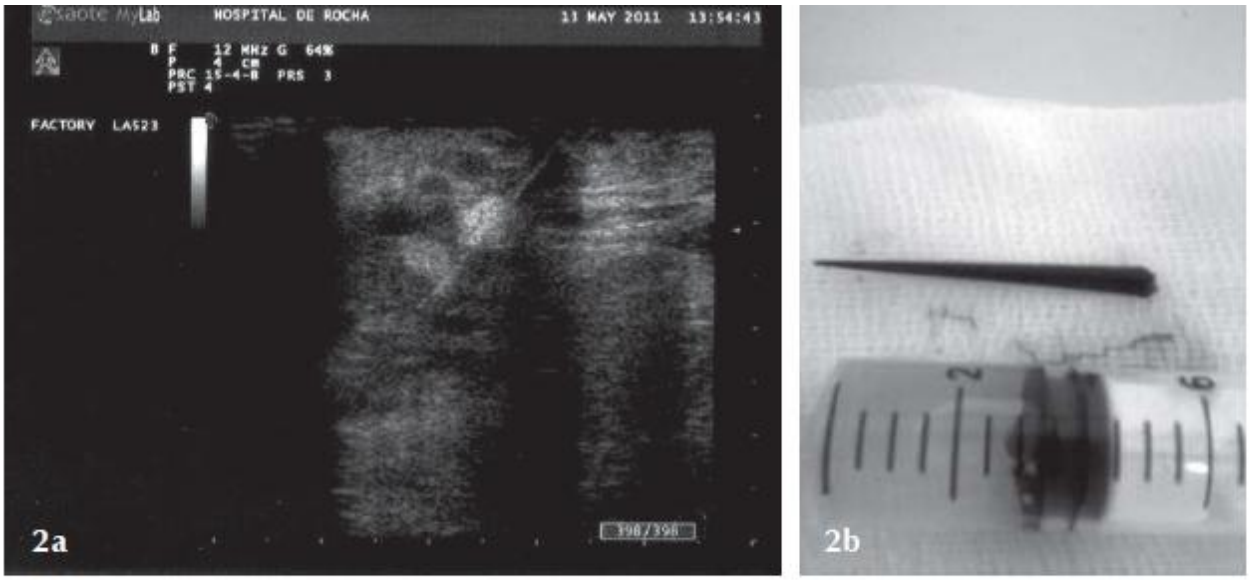


Figura 2
Caso Nº 2, 55 años, herida penetrante en antebrazo derecho por espina de palmera, de 10 días de evolución.
RX no mostró CE. Comienza 24 horas después con edema de partes blandas de la zona afectada y fiebre, se realiza primera ecografía con resultado negativo. Instala posteriormente signos deficitarios del nervio cubital ante lo cual el cirujano solicita nueva ecografía. ***a)*** *Ecografía: Se confirma CE lineal sin fenómenos de reverberación, en posición profunda, con compromiso de planos musculares. El CE es de débil ecogenicidad, debida al ángulo con respecto a la piel.*
b) *Se extrajo CE mediante guía ecográfica, obteniéndose espina vegetal. Rápidamente remitió el dolor, la infección de partes blandas, y el compromiso deficitario del nervio cubital.*

Case 6-

51-year -old male. While pruning a tree suffers a palm penetrating wound in his right hand, on the basis of the fifth finger. Radiographis obtained from the affected area showed no FB images. Ultrasonography was performed confirming FB. Ultrasound-guided procedure is carried on, with the removal of a 12 mm wood splinter. Progressed favorably.

In 4 patients XRays were performed, they failed to show evidence of FB, even in a case of a bulky one.

Figures Case 1

Ultrasonography was diagnostic in all cases.

Clinical examination was unable to make the diagnosis in all cases.

In 5 patients the FB was successfully removed under ultrasound guidance by the sonographer itself, as discussed in case 4, given the inconsistency between the transducer and the affected area the removal was not possible, so the FB localization is marked on the skin and removed with conventional surgery.

In all cases the vegetable thorn was obtained and visualized as linear or cuneiform echogenic structures surrounded by a hypoechoic rim with faint shadow cones. The sizes varied between 8mm and 30mm.

All patients recovered favorably with pain remission, even in the case of the patient with ulnar compromise (Case 2), in which the referred motor deficit remitted with the FB removal.

DISCUSSION

FB held in soft tissues from penetrating injuries are common causes of consultation in emergency services. They are also considered as the second leading cause of emergency medical lawsuits.

A FB that has not been removed, can lead to both acute and chronic complications such as allergies, inflammation and infection.(1,2,3,6,7). If FB is close to tendons they may cause tenosynovitis, and in case of nerves neuropathies, as it occurred in one patient in this study. There may also be migration to joints causing arthropathies and embolic complications due to access to the venous system. (1)

According to the evolutionof the injury, the condition may be classified in stages:

1) Acute: less than 3 days.

2) Intermediate: 3 to 10 days.

3) Chronic: more than 10 days. (5)

The sonographic appearance of FB is related to the evolution time.

In our series, all patients were in chronic stage.

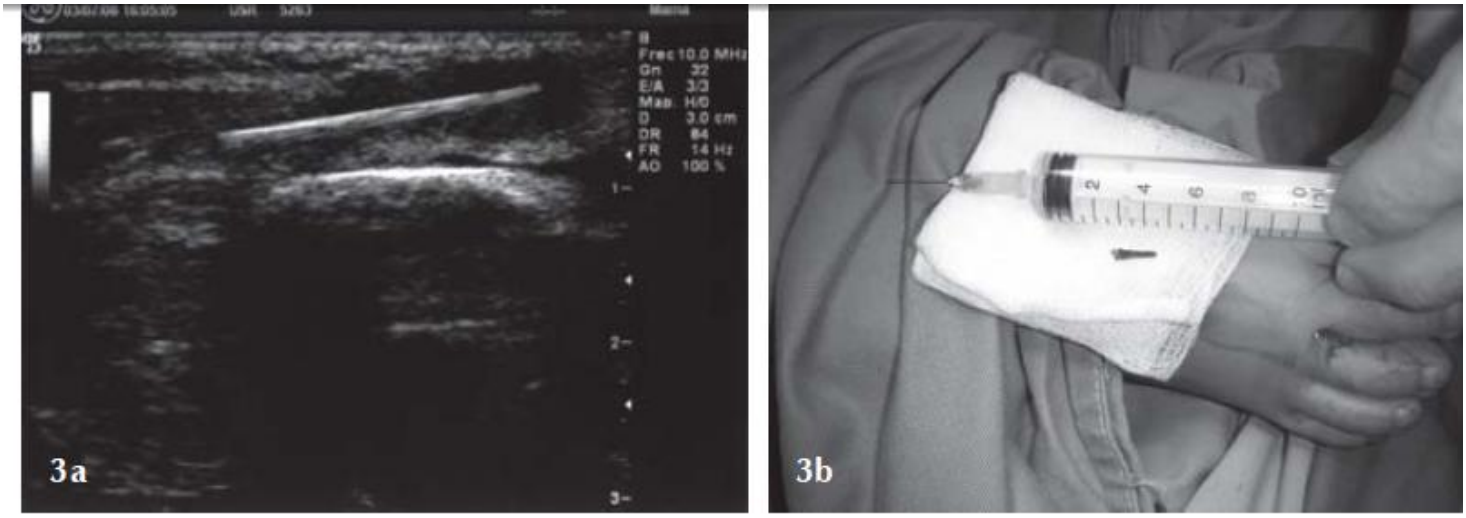


Figura 3
Caso Nº 3, 8 años, herida penetrante en pie de 25 días de evolución.
Se plantea CE diagnosticado con palpación clínica y es intervenida 10 días después.
La cirugía convencional no permite encontrar al CE, por lo que ante la persistencias de síntomas (dolor) se remite para estudio ecográfico. ***a)*** *ecografía confirma CE, de 10mm de longitud, sin fenómenos de reverberación, compatible con CE vegetal. Se observa halo hipoecoico rodeando el CE.* ***b)*** *Bajo anestesia general dado la edad de la paciente, se extrajo CE con guía ecográfica sin complicaciones.*

The economic cost of FB extraction with sonography is significantly lower than that of small conventional surgery, even in the case of children requiring general anesthesia. There are very significant benefits in shortening the surgery act Moreover, an ultrasound guided failed removal does not exclude conventional surgery.

At our institution, there is agreement with the surgeons that the sonographer tries at first instance and by himself the FB removal.

A critique of this study may be the low number of patients in this series, although it should be noted that it is a rare condition, taken in a short period of time, with a sample taken from a single geographic region, and carried on by a single operator. Another limitation is that all the FB diagnosed were vegetable origin, so experience with other materials is lacking in this study.

CONCLUSIONS

For suspected FB, the first imaging method to be performed must be sonography which allows diagnosis, interventional procedure removal, with great advantages for the patient.

APPENDIX

Soft-tissue foreign bodies: diagnosis and removal technique under ultrasound guidance.

The FB can be divided in two groups according to their composition:

a) Metallic

b) Organic

c) Inorganic

The metallic consist of any material with high atomic number, therefore they have the ability to stop the photons, and can be easily visible in conventional radiology (1,2,5,6,7)

The organic are referred to the organic material of vegetal origin, such as wood splinters, vegetable thorns, etc.

The inorganic materials come from not living beings, such as broken glass, plastics, rubber, etc.

A) Diagnosis

When a retained FB is suspected , the first method is clinical examination which is positive only when the FB is in superficial tissues and can be palpable. This occurs in a very small number of patients, so in the vast majority of cases, imaging tests are needed to confirm the presence and localization overlooking the removal.

As previously mentioned, clinical examination was unsuccessful in all cases of this study.

Simple radiograph is the initial study when a FB is suspected is simple radiograph of the region since it is widely available and has low cost (2,4,5,6,7)

Metal objects with high atomic weight, that stop photons (radio-opaque) are most easily detected by this method. These materials such as glass, metal and stones, are detected up to 80% of the cases.

The radiopaque FB as plastic or glass, are visible in radiograph only in 15% of the cases. (1,3,4,5,6)

In our experience in 4 cases radiograph wasnegative, including a 32 mm long thorn located in plantar foot.

1) Radioscopy

As simple radiograph, radioscopy shows radiopaque objects. When it is possible to identify the FB, fluoroscopy provides an adequate topographical idea, allowing skin marking on the reference points for removal. (1, 2) However it exposes the operator and patient to high doses of radiation. (1,2,7)

2) Ultrasound

The 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.(1,2,3,4,5,6,7)

The development of high-frequency transducers, up to 12 MHz, has improved spatial resolution, achieving anatomic detail of small structures with high accuracy and may identify FB under 1mm in diameter. Ultrasound is currently the imaging method of choice, with a sensitivity of 90% and a specificity of 96%.(1.2)

For proper technique, requires a slow and meticulous examination, especially in cases of small FB less than 1cm in length, where they can be unnoticed, also in anatomical areas like hands and feet, where echogenic structures exists such as sesamoid bones that can result in false positives.

Another aspect to consider is that echogenicity of a FB also varies according to the orientation of the long axis FB with respect to the skin. When the FB is parallel to the skin the visualization is maximum. Moreover it should be noted that small punctate structures may correspond to bulky FB if the cutting plane was carried by the short axis, as for example in the case of thorns.

It has been described that the size of the FB contributes most to the detection than the composition. 2

The sonographic appearance of organic FB also varies taking into account the evolution time. 1.2.5.6

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.

At the end of this stage, there may be a hypoechoic rim surrounding the FB. It has been thought to be due to edema, pus or granulation phenomena. 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. 5 In almost all cases of this study, hypoechoic halo was present, which showed the chronicity of the process, and facilitated the identification of the FB, especially the smaller ones.

Ultrasound has the disadvantage of being an operator-dependent method, and hence with variable results according to the experience of the operator.

Another limiting factor of the method is the depth at which the FB is located .2.5

While a small object of 5mm can be easily identified when superficial,

bigger FB may not be detected in deeper areas.

The air trapped within a penetrating wound, may also create false positives, when producing images that mimic echogenic FB, or also hide them.2.5

3)Computed Tomography (CT)

It can also be used in the detection of foreign bodies. Against is its high cost, limited availability, and high irradiation. In case of children may also require general anesthesia. 1.5.7

4) MRI

It can also be used, although given it's high cost makes it prohibitive as a routine method. Both CT and MRI have low sensitivity and specificity. 1.5.7

B) Description of the procedure.

Extraction of ultrasound-guided FB is a good alternative to conventional surgery, because it is safe, inexpensive, and with low complication rates. On the other hand, if it fails, it does not exclude conventional surgery.1.4.5

Once located the FB and been decided its removal under ultrasound guidance the elements prepared to use are:

1) ultrasound equipment 2) aseptic matherial, syringes, scalpel, sterile drapes, gauze etc. 3) small forceps or mosquito clamp. 1.5.8.9

High frequency transducers are needed, usually between 8 and 12MHz to achieve higher image quality in superficial structures. Linear transducers are generally used, although in some situations and narrow anatomic places which leads to difficult anatomical approach,it may be useful small convex transducers to suit any surface. Transducer should be covered with sterile (gloves), and proceed skin disinfection.

The techniques used are "free hand" in which the same operator maneuver with one hand the transducer (not skillful hand) and with the other hand (skilled) manipulates the instruments and long axis technique .1.8

Once located the FB is displayed in its entire length.

Using the long axis of the transducer, and close to it, the skin is infiltrated with 1% lidocaine and the way to the FB, trying to reaching it, and creating a "collection" around it. Besides the anesthetic effect, it facilitates the visualization and subsequent maneuvers for the removal. In case of children, such as in small conventional surgery, general anesthesia is always required, which allows to work accurately without inconveniences.

The needle is removed and it is necessary to wait for the local anesthetic to take effect. In the puncture site, an incision is made in the skin, with a small scalpel blade (number 11) creating a path to the FB, always in real-time visualization. 1 It must ensure that the scalpel tip reaches the FB, and this incision is also wide enough to enter and allowing the manipulation forceps therewith.

The operator proceeds then to introduce the forceps, and through real-time control, the extraction of FB. (1.5.8.10)

The correct way to hold the FB, is to bring the forceps closed until its contact with the FB, and gently open it and then move it forward a few millimeters. (10)

If the forceps is opened prior to "touch" the FB,it is likely that 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. (10)

Once the procedure is finished, a cure is done with sterile equipment. Usually stitches to close the wound are not required.

On the other hand, if wound on the skin corresponding to the inlet port of the traumatic event exists, it should be used as the preferred way to withdraw the FB, and proceed in a similar way as related previously.1.5.

In this series no prophylactic antibiotics were used, although some authors routinely indicate them.

This procedure requires some manual dexterity, but the learning curve can be shortened with practice in biological models such as chicken or turkey. 1.8.

As for conventional surgical management of FB, it can be said that there are two groups, one with large open wounds such as scalping or attritioning tissue, and one with small inlets. In the first group, it requires a thorough examination to rule out neurovascular injuries, tendons, etc., and this exploration also allows the simultaneous search of FB.

Even if no neurovascular or tendinous structures injury exists, it requires extensive dissection to allow correct FB search.

In case of small FB with minimal entry into skin, conventional surgery is usually avoided because of the risk of injury, and the difficulty in finding the FB in the operative field, both because of bleeding and the variable appearances of FB. (1)

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. (1)

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