US-guided Localization and Removal of Soft-Tissue Foreign Bodies

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RadioGraphics 2020; 40:0000–0000

https://doi.org/10.1148/rg.2020200001

Content Codes: IR US

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SA-CME LEARNING OBJECTIVES

After completing this journal-based SA-CME activity, participants will be able to:

- Discuss US as the technique of choice for identifying foreign bodies and guiding percutaneous removal.
- Identify the US imaging features of various foreign body types.
- Describe the US-guided technique for removal of foreign bodies.

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US-guided foreign body removal is a nonsurgical highly effective technique used to manage symptomatic foreign bodies and should be considered as a first-line treatment procedure. The authors describe a technique used for US detection and US-guided removal of various types of foreign bodies and discuss the efficacy of the procedure. Soft-tissue foreign bodies can result from accidents or medical procedures, and they are a relatively frequent reason that patients obtain medical consultation. Foreign body objects include vegetal, metallic, and glass objects, and they may be medical devices such as contraceptive implants. Frequently, physical examination is not sensitive enough to detect the presence of a foreign body, and imaging is necessary. US has demonstrated high specificity and moderate sensitivity for detection of foreign bodies, and it has the advantage of depicting all types of materials. Thus, US has become the imaging technique of choice for evaluating suspected foreign bodies. Although the US features are dependent on the foreign body type and shape, all foreign bodies are echogenic and frequently demonstrate posterior shadowing or reverberation artifact. US has an added value in that it can be used to plan the removal of a foreign body and also guide the entire percutaneous removal procedure. Through a small incision in the skin, just wide enough for the foreign body to pass through, surgical forceps can be inserted and directed under US guidance to reach the foreign body and remove it. The effectiveness of US-guided percutaneous removal can be near 100%.

Online supplemental material is available for this article.

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Introduction

Foreign bodies in the soft tissues are a relatively frequent reason for medical consultation in the clinical setting. In most cases, foreign bodies result from accidents and can include wooden or metal splinters and glass shards (1–4). Foreign bodies can also result after medical procedures as retained material (eg, drains, contraceptive implants, or surgical devices) (5). Foreign bodies may cause acute pain and/or functional impairment, as well as acute or late complications such as inflammation, infection, or allergic reactions (4,6–8). Thus, foreign body removal is warranted in most cases.

When superficially located, foreign bodies can be identified at clinical examination and removed. Otherwise, imaging is required to identify the foreign body and establish its exact location before the removal attempt. Intraoperative US and fluoroscopy have been used to help in surgical removal (3,9–13). However, the surgical removal of a foreign body is invasive and technically challenging, and it requires a relatively large cutaneous and sometimes fascial incision,

TEACHING POINTS

- At US, foreign bodies always appear echogenic. The degree of echogenicity varies on the basis of the object's material and thickness and the angle of insonation.
- At US-guided foreign body removal, a small incision is made in the skin with a scalpel. The incision must be wide enough for the surgical forceps to be inserted and for the foreign body to pass through when it is removed.
- Surgical forceps are inserted through the incision and directed under constant US guidance to reach the foreign body. Hartmann alligator and Halsted mosquito forceps are the most suitable types of forceps to use for this task.
- US-guided removal can be successfully used to detect and remove contraceptive implants.
- Our US-guided foreign body removal technique is highly effective and safe. In our case series, all but one of the foreign bodies were successfully removed.

with isolation of neurovascular structures. The procedure may fail in some cases, and it carries the risk of complications and always has some degree of aesthetic impact (4).

Percutaneous US-guided removal of a foreign body was described in 1990 (2). It is a minimally invasive inexpensive technique with low risk of complications. Real-time US guidance helps to accurately localize and remove the foreign body, minimizing the amount of bleeding and avoiding injury to adjacent structures. A small incision is created, which minimizes the risk of infection and the aesthetic impact. Furthermore, failure does not preclude surgical removal (4,14–18).

In this article, we describe how various types of foreign bodies can be removed using US guidance. We also discuss the US findings of a variety of foreign bodies, which can aid in identification and help guide the removal procedure.

Imaging Foreign Bodies

Foreign bodies are frequently difficult to palpate or detect at direct examination. Therefore, imaging localization is required. Traditionally, patients with a suspected foreign body may undergo radiography, but this is only useful for imaging radiopaque material (eg, metal, glass, and some plastics) of a certain size (15). Similar to radiography, CT is only useful for imaging radiopaque material (1). In a recent meta-analysis, US demonstrated a high specificity (92%) and a moderate sensitivity in the identification of retained foreign bodies and has the advantage of depicting all types of materials (19). Therefore, US is the technique of choice not only for detecting but also for guiding removal of foreign bodies (2–5,12–18). Although it is sensitive for imaging superficial foreign bodies, US is less effective for imaging those foreign bodies with a deeper location (1).

At US, foreign bodies always appear echogenic. The degree of echogenicity varies on the basis of the object's material and thickness and the angle of insonation (1,3,8,16,20–25). After the foreign body has been present within the soft tissues for 24 hours, a hypoechoic halo is frequently observed around the echogenic foreign body owing to perilesional inflammation (Fig 1). Power Doppler US images can also show hyperemia (Fig 2). The hypoechoic halo can be helpful for detecting the foreign body location (1,15,26).

Another US feature that can be helpful for detecting a foreign body is the presence of acoustic shadowing. This artifact appears behind the foreign body and is mainly caused by the surface attributes of the foreign body rather than its composition; smooth surfaces generate dirty acoustic shadows, while irregular surfaces and those with a small radius of curvature produce clean shadows. Flat surfaces can also create reverberation artifacts, which are frequently depicted with metal or glass foreign bodies, dependent on the angle of insonation (1,27) (Figs 1c, 3).

US-guided Foreign Body Removal Technique

We provide the step-by-step procedure for foreign body removal used at our institution in the Table. US is first performed to identify and locate the foreign body. It is also performed to plan the removal procedure and determine the relationship to nearby structures to avoid complications. If other exploratory studies are available, they must be reviewed. The foreign body must be imaged in both the longitudinal and transverse axes using a high-frequency linear-array US transducer. Then, the path to the foreign body is planned, and the access point is marked on the skin.

After disinfecting the skin and under sterile conditions, local anesthesia is administered both at the skin access point and along the planned path. A local anesthetic must also be administered around the foreign body to separate it from the surrounding tissues, which facilitates the subsequent removal (Movie 2).

A small incision is made into the skin with a scalpel. The incision must be wide enough for the surgical forceps to be inserted and for the foreign body to pass through when it is removed. When possible, the tip of the scalpel should reach the foreign body to create a complete path to it, although this is not mandatory.

Surgical forceps are then inserted through the incision (Fig 4) and directed under constant US guidance to the foreign body. Hartmann alligator and Halsted mosquito forceps are the most suitable types of forceps to use for this task (Fig 5). Once the forceps reach the foreign body, the arms

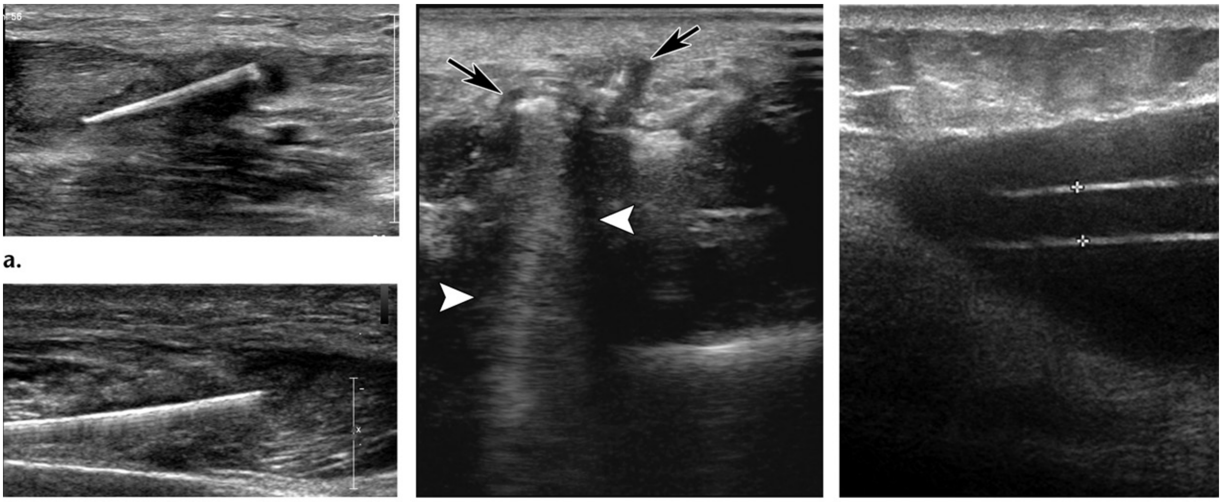


Figure 1. Various types of subcutaneous foreign bodies at US. **(a)** US image shows a thorn stuck into the palm of the hand. **(b)** US image shows a metal needle located in the leg, with reverberation artifact depicted behind the needle. **(c)** US image shows glass shards (arrows) in the sole of the foot. Note the reverberation artifacts (arrowheads) depicted behind the fragments. **(d)** US image shows a surgical Penrose drain in the gluteal region that was retained after surgery. The two parallel lines that correspond to both walls of the tube are depicted within a fluid collection.

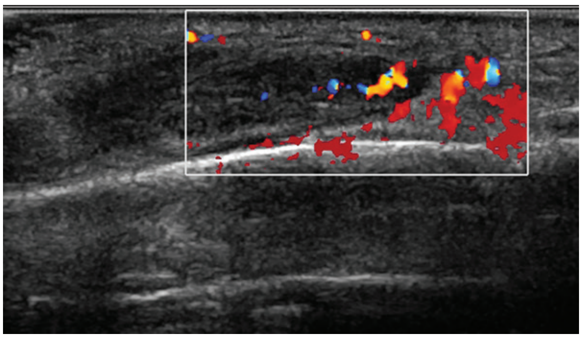


Figure 2. Doppler US image shows vessels within a hypoechogenic halo that surrounds a foreign body (not shown).

Figure 3. US image shows a tree branch fragment (arrowhead) embedded in the forehead. A marked acoustic shadow can be observed behind the fragment.

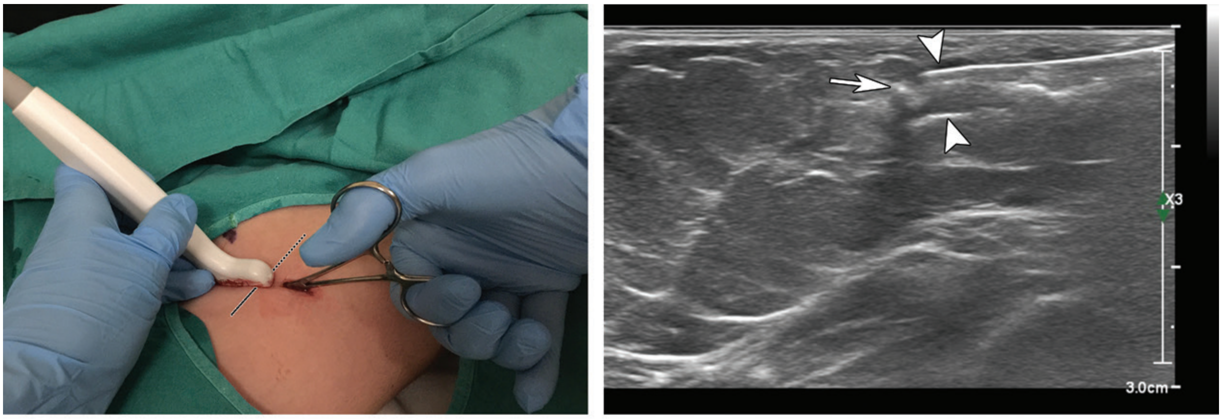
Step-by-Step Procedure for US-guided Foreign Body Removal

1. Localize the foreign body by using US; obtain images in longitudinal and transverse planes (Movie 1).
2. Perform Doppler US evaluation (Fig 2).
3. Identify critical structures at risk for injury (eg, vessels, nerves).
4. Under US guidance, administer a local anesthetic to separate the foreign body from adjacent soft tissues (Movie 2).
5. Plan the path to access the foreign body.
6. Make an incision in the skin.
7. Insert the forceps (Hartmann alligator or Halsted mosquito forceps) and guide them to the foreign body (Fig 4, Movie 3)
8. Grasp the foreign body with the forceps using US guidance (Movie 4)
9. Remove the foreign body through the incision.
10. Evaluate the soft tissue with US for additional foreign bodies or debris.
11. Close the incision with adhesive strips.

of the forceps should be opened slightly, displacing the tissues surrounding the foreign body, and then moved forward to grasp the object and remove it (Movie 2). Often, several attempts are required. As most foreign bodies are elongated, a transverse approach facilitates grasping and removal.

The procedure ends with disinfection of the skin and closure of the wound with adhesive strips. The use of surgical sutures is rarely necessary. Antibiotic prophylaxis is used after removal to prevent septic complications.

To explore and specifically to remove foreign bodies by using US guidance, the use of high-resolution linear US transducers is mandatory. The use of a "hockey stick" transducer, although not required, is helpful for removal because of its



a. b.

c.

Figure 4. **(a)** Photograph shows the procedure for US-guided removal of a contraceptive implant in the shoulder using a hockey stick transducer and Halsted mosquito forceps. A dashed line is drawn to show the theoretical location of the implant, perpendicular to the forceps. **(b)** US image shows the jaws of the forceps (arrowheads) transversely approaching the contraceptive implant (arrow). **(c)** Photograph shows the forceps grasping the removed contraceptive implant.

small size. This is especially useful when removing foreign bodies from the hands and feet. Using higher frequencies and a shallow focus during the US examination is advised.

Foreign Body Cases at Our Institution

In the past 5 years, we have removed foreign bodies in 41 patients by using the previously described technique. These cases included 22 male and 19 female patients, ages 3–84 years old. In three cases, two foreign bodies were removed from the same location. The locations of the foreign bodies were variable: the shoulder (22 cases), hand (six cases), foot (three cases), leg (one case), thorax (four cases), face (two cases), abdomen (two cases), and perineum (one case). Of those foreign bodies located in the shoulder, 21 were contraceptive implants specifically placed at this location. The nature of the foreign bodies was diverse.

Vegetal

Vegetal types of foreign bodies were found to be located mainly on the hands (six cases), with one case located on the face. At US, these appeared as elongated echogenic findings, usually surrounded by a hypoechoic halo. In all cases, acoustic shadowing was visualized (13,28) (Figs 3, 6, 7; Movies 1, 4).

Metallic

Metallic foreign bodies were also seen at our institution. At US, metallic needles and wires appeared as hyperechogenic linear structures, sometimes with reverberation artifacts, often surrounded by a hypoechogenic halo (Fig 8). A piercing fragment embedded in the shoulder appeared as a hyperechogenic finding, with strong acoustic shadowing (Fig 9).

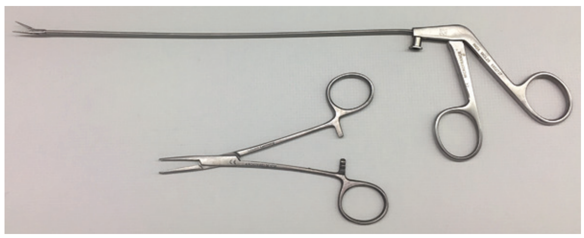


Figure 5. Photograph shows the Hartmann alligator (top) and Halsted mosquito (bottom) forceps, which are the most suitable surgical forceps for removing foreign bodies.

Glass

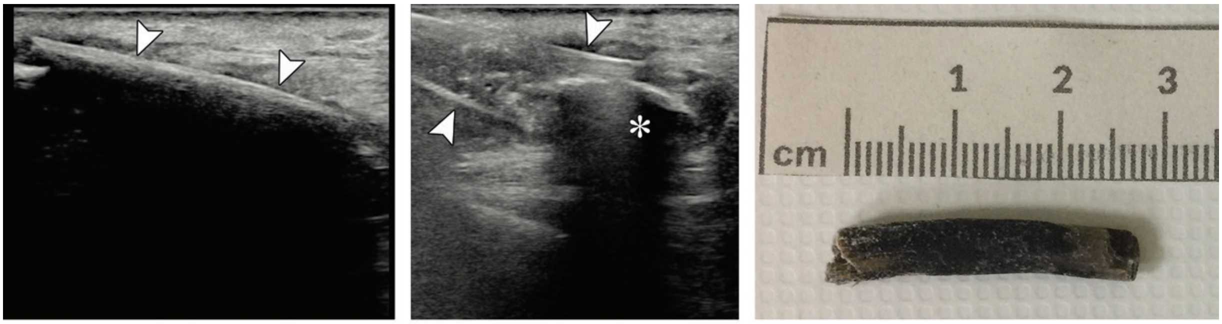
Glass is the most difficult material to visualize at US. It appears as a slightly echogenic structure with dirty acoustic shadowing (Figs 1c, 10).

Catheter Fragments

Catheter fragments appear as to two parallel hyperechogenic linear findings. We found that most were located in the thoracic wall between the ribs, as they were distal fragments from pleural catheters (Fig 11, Movie 5).

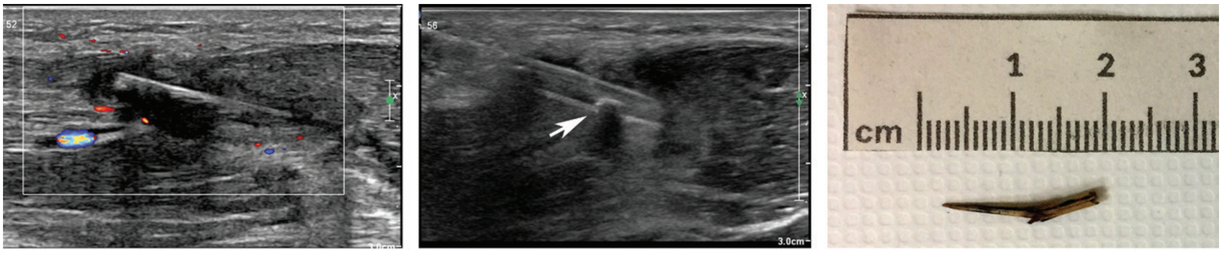
Contraceptive Implants

Contraceptive implants are silicone rubber capsules measuring 34 mm long and 2.4 mm in



a. b. c.

Figure 6. Vegetal foreign body removal (same case as in Fig 3). **(a)** Longitudinal US image shows a large foreign body (arrowheads) embedded in the forehead. **(b)** US image shows the foreign body (*) being grasped by the jaws of Halsted mosquito forceps (arrowheads). **(c)** Photograph shows the removed foreign body, a tree branch fragment. Movie 4 demonstrates the entire procedure.



a. b. c.

Figure 7. Removal of a thorn stuck in the palm of the hand (same case as in Fig 1a). **(a)** Doppler US image shows the thorn with a surrounding hypoechoic halo. Performing Doppler US is mandatory for identifying nearby vessels to avoid injuring them during removal. **(b)** US image shows the thorn (arrow) being grasped with Halsted mosquito forceps. **(c)** Photograph shows the removed thorn.

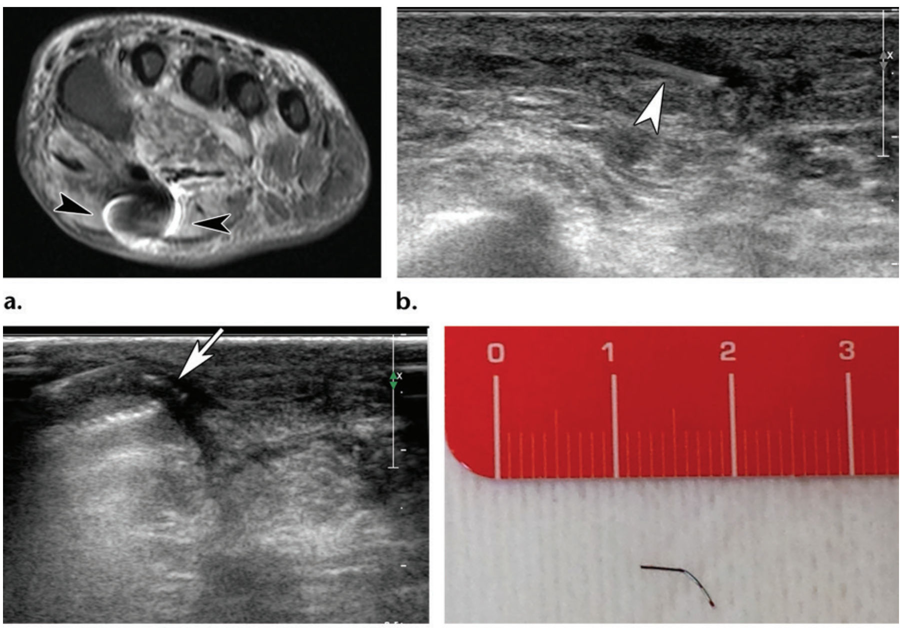
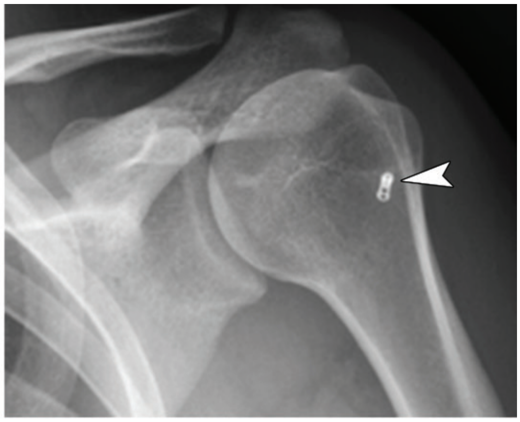


Figure 8. Foreign body in a 25-year-old man who reported pain in the left foot, which had worsened in recent weeks, and no previous trauma or injury. Physical examination results were normal. **(a)** Axial MR image shows a magnetic susceptibility artifact (arrowheads) on the sole of the foot. **(b)** US image obtained at the point of the observed artifact at MRI shows a small linear hyperechogenic finding (arrowhead) surrounded by a hypoechoic halo. A foreign body was diagnosed. **(c)** US image obtained during the removal procedure shows the jaws of the Halsted mosquito forceps grasping the foreign body (arrow). **(d)** Photograph shows the removed foreign body, which was a thin metal splinter.

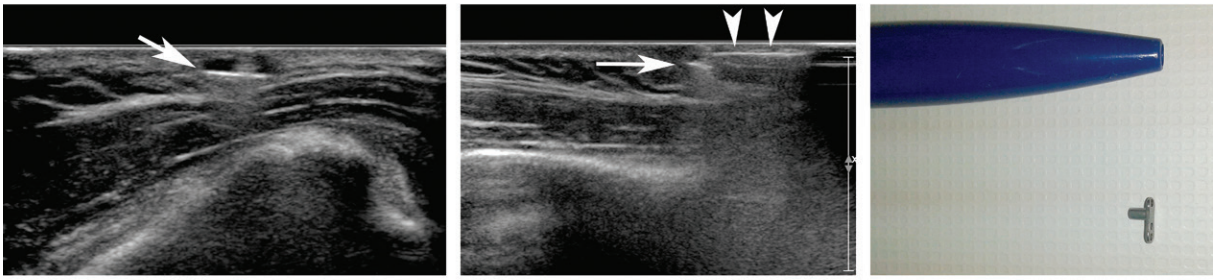
diameter. The capsules release progestogen into the bloodstream to prevent pregnancy. They can last for 3 years.

Contraceptive implants are designed to be placed using a sterile disposable applicator in a subcutaneous plane. The appropriate location is in the medial aspect of the upper part of the nondominant arm, about 6–8 cm above the medial epicondyle, in the groove between the biceps brachii and the triceps brachii muscles (5).

Removal procedures are usually quite straightforward, especially when the capsules are inserted

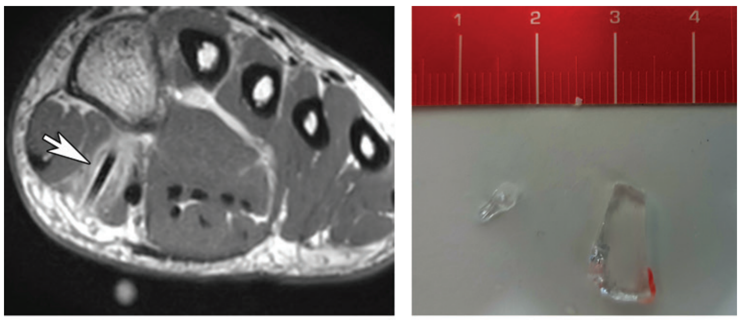


a.



b. c. d.

Figure 9. Portion of a piercing lost below the skin in a 19-year-old woman. **(a)** Radiograph shows a small piece of metal (arrowhead) in the left shoulder. An attempted removal by palpation was unsuccessful. **(b)** US image shows a hyperechogenic finding with reverberation artifact, corresponding to the metal fragment (arrow). **(c)** US image obtained during the US-guided removal procedure shows Halsted mosquito forceps (arrowheads) aimed toward the foreign body (arrow). **(d)** Photograph shows the removed metal fragment, with a pen lid included for size comparison.



a. b.

Figure 10. Foreign body in a 20-year-old man who presented with limping and worsening pain in the left foot (same patient as in Fig 1c). The patient reported a previous wound in the sole of the left foot sustained after walking barefoot on the beach. The results of a physical examination noted only the scar from the previous wound. **(a)** Axial MR image shows a foreign body (arrow) depicted as an area of signal void in the flexor hallucis brevis muscle, surrounded by edema. US image of the area (shown in Fig 1c) helped confirm the presence of a foreign body, with findings suggestive of a glass fragment. **(b)** Photograph shows two glass shards, which were removed during a US-guided procedure.

properly. Most contraceptive implants can be located by palpation. However, some implants are nonpalpable owing to suboptimal placement, the development of a fibrous sheath around the implant, an increase in subcutaneous fat in the area in the years after placement, and implant migration (5).

Blind surgical removal of the implant is aggressive and can lead to complications. US-guided removal can be successfully used to detect and remove contraceptive implants (5). Similar to the appearance of catheters at US, contraceptive implants appear as hyperechogenic parallel lines, which are about 2 mm wide and 4 cm long, with slight posterior acoustic shadowing (Figs 5, 12; Movie 6).

Fishbones

Ingested fishbones can sometimes migrate out of the digestive tract and can rarely reach superficial planes of the abdomen. On US images, fishbones appear as linear echogenic findings, included in fluid purulent collections (Fig 13, Movie 7).

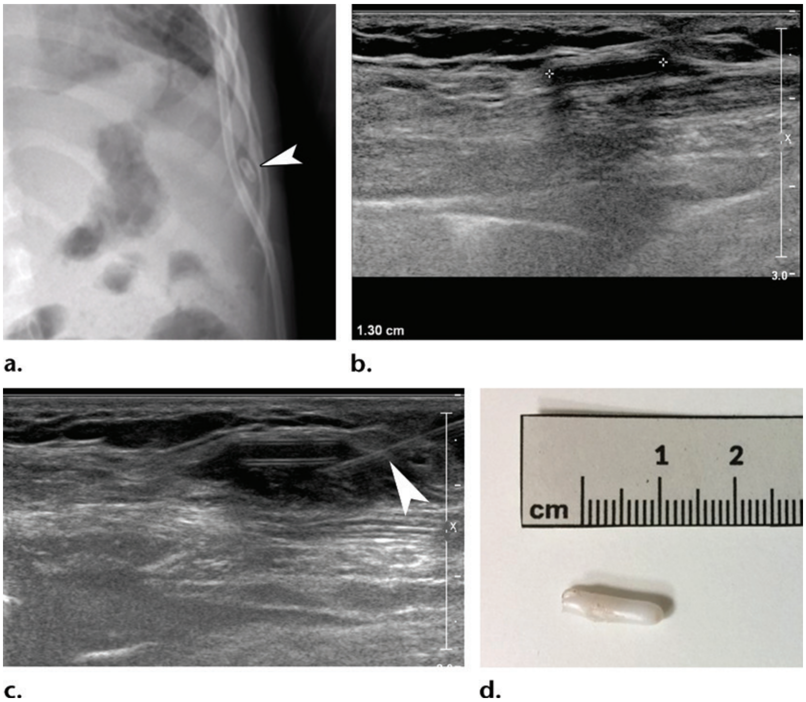


Figure 11. Foreign body in an 8-year-old boy with left pleural effusion who underwent a second pleural drainage after a failed first attempt. **(a)** Posteroanterior chest radiograph obtained after pleural drainage shows a fragment of a pleural catheter (arrowhead) in the ninth left intercostal space. The tip of the pleural catheter was accidentally cut during the first attempt. **(b)** US image of the left chest wall shows the catheter fragment depicted as two parallel 1.3-cm lines in the subcutaneous tissue. **(c)** US image shows the removal procedure, which began with placing a needle (arrowhead) next to the catheter to administer a local anesthetic around the foreign body. Movie 5 demonstrates the removal procedure. **(d)** Photograph shows the removed foreign body.

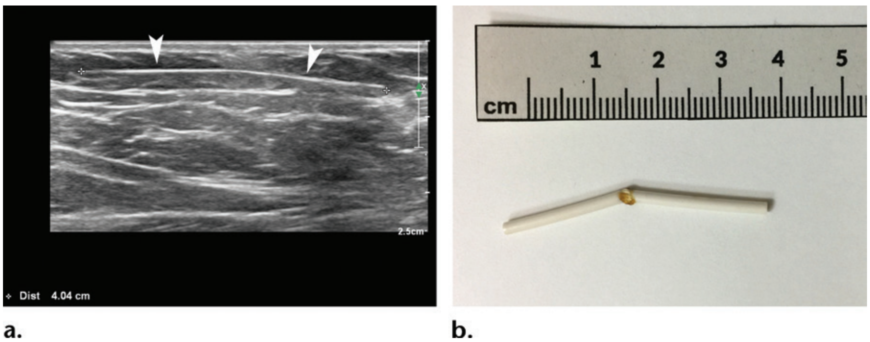


Figure 12. Contraceptive implant in the shoulder of a 25-year-old woman. The device had been in place for 3 years, and palpation for removal was not possible. **(a)** US image shows a straight linear echogenic line that is 4 cm long, which is the typical imaging appearance of these devices. **(b)** Photograph shows the removed contraceptive implant. Movie 6 demonstrates the US-guided implant removal.

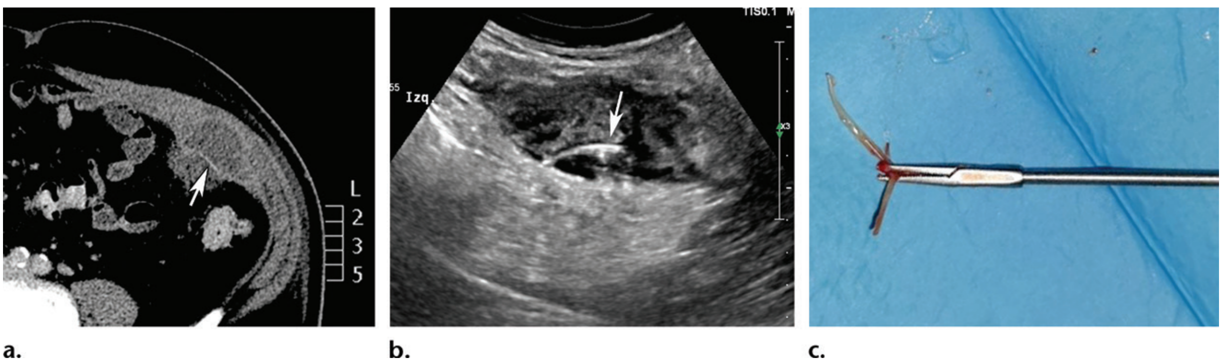
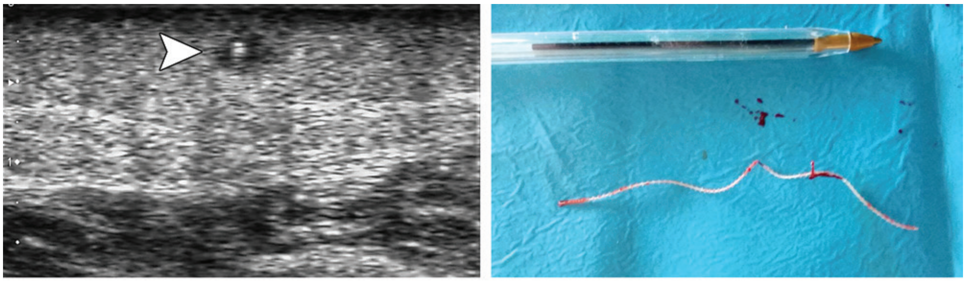


Figure 13. **(a)** Axial CT image of the abdomen in a 67-year-old man with acute abdominal pain and fever shows an abscess in the abdominal wall with an attenuating linear finding (arrow). **(b)** US image shows a linear structure (arrow) within the fluid collection. **(c)** Photograph shows a fishbone, which probably migrated from the intestine. The foreign body was removed percutaneously by using Hartmann alligator forceps. Movie 7 demonstrates the percutaneous removal.

Facial Tensor Threads

The use of facial tensor threads is a popular nonsurgical lifting technique that purportedly stimulates facial tissue and the formation of collagen, which produces skin regeneration and skin tissue tension. The threads are resorbable long sutures composed of biocompatible materials. These threads and/or wires are placed in the face, sometimes in a V shape. The potential complications from this procedure include



a. b.

Figure 14. Barbed facial tensor thread removed after rejection. **(a)** Transverse US image shows the thread (arrowhead) as a V-shaped hyperechogenic line crossing the face, surrounded by a hypoechoic rim. **(b)** Photograph shows the removed thread next to a pen for size comparison. A small incision was made near the tragus, through which forceps were inserted and used to grasp the thread at the most posterior part.

infection and rejection, and both complications require removal of the threads. The threads appear as thin long linear echogenic findings on US images (Fig 14).

Procedure Outcomes

Our US-guided foreign body removal technique is highly effective and safe. In our case series, all but one of the foreign bodies were successfully removed. In one case, a second procedure was performed, as another foreign body was observed after removal of the first one. In another case, a second successful attempt at removal was made after the foreign body could not be initially removed owing to its small size and difficult location (perineal region).

There were two cases that required surgery. In one case, a fishbone was removed from a patient's abdomen (Fig 13), but the patient was later referred for surgery after an attempt to remove a second fishbone that remained in a deeper location failed. In another case, and despite a successful US-guided removal, a local infection persisted with continuous suppuration and eventually required surgery. No other complications were observed.

Conclusion

US is a key imaging modality for the detection and treatment of foreign bodies. US-guided removal is a highly effective nonsurgical technique for managing symptomatic foreign bodies and should be considered as a first-line treatment approach when dealing with such conditions.

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