

Pictorial Essay

Sonography and Radiography of Soft-Tissue Foreign Bodies

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The identification of soft-tissue foreign bodies is not always a straightforward pursuit. Although routine radiography is the preferred imaging modality for the initial workup, several types of soft-tissue foreign bodies are not radiopaque and therefore remain undetected. Because a retained foreign body may cause infection and inflammation, detection and removal are imperative [1]. Sonography is playing an increasing role in the diagnostic process, not only for the detection of non-opaque foreign bodies but also for the accu-

rate localization of all types of soft-tissue foreign bodies. Accurate localization can be valuable in minimizing surgical exploration, or, alternatively, real-time sonographic visualization can guide percutaneous removal of a soft-tissue foreign body [2]. Sonography can also be used to evaluate associated soft-tissue abscess, neurovascular abnormality, and tendon disorders. This pictorial essay will define the imaging characteristics of various soft-tissue foreign bodies, comparing their appearances on sonography and radiography. Familiarity with the imaging appear-

ances of soft-tissue foreign bodies is critical for an accurate diagnosis.

Materials and Methods

Foreign bodies of various sizes, shapes, and compositions were placed in the heel pad of freshly thawed cadaveric specimens. A 5-mm plantar incision was made with a scalpel and the foreign body was manually inserted through the incision. The foreign body was placed at a random depth and orientation. The feet underwent radiography, and then sonography (Model 5200; Acoustic Imaging, Phoenix, AZ) was performed using a 7-10-MHz linear transducer without a standoff pad.



Fig. 1.—Windshield glass from automobile.

A, Photograph shows 5-mm glass fragment before being placed in cadaveric foot.

B, Lateral foot radiograph shows radiopaque glass fragment (*arrow*).

C, Sonogram of plantar surface of foot reveals hyperechoic glass fragment (*solid arrow*). Note posterior acoustic shadowing (*open arrows*) and reverberation (*arrowhead*). C = calcaneus.

Received September 1, 2000; accepted after revision October 5, 2000.

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AJR 2001;176:1155–1159 0361–803X/01/1765–1155 © American Roentgen Ray Society

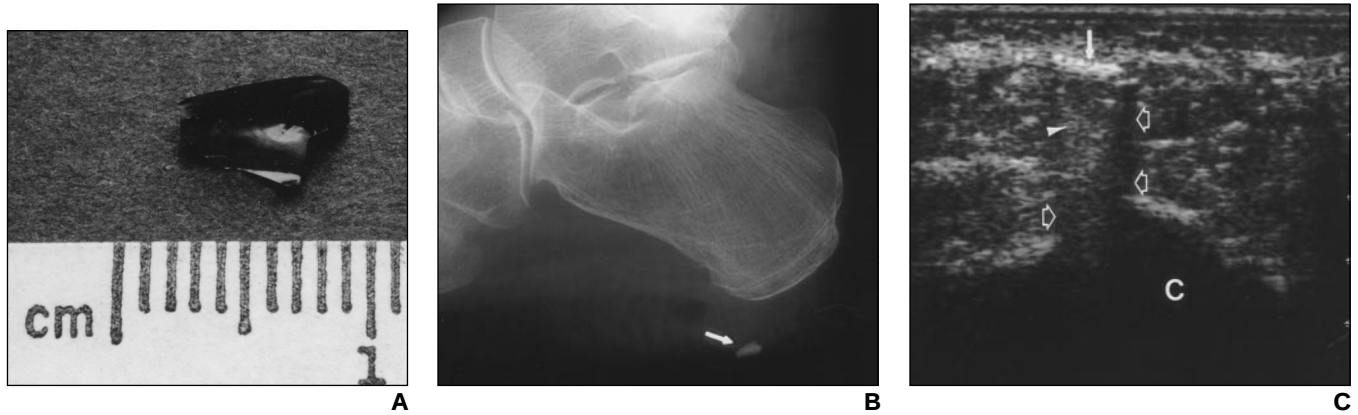


Fig. 2.—Bottle glass.

A, Photograph shows 5-mm amber-colored glass fragment before being placed in cadaveric foot.

B, Lateral foot radiograph shows radiopaque glass fragment (arrow).

C, Sonogram of plantar surface of foot reveals hyperechoic glass fragment (solid arrow). Note posterior reverberation artifact (arrowhead) and shadowing visible at edges (open arrows). C = calcaneus.

General Comments

All soft-tissue foreign bodies are initially hyperechoic on sonography [1]. However, wooden foreign bodies may become less echogenic over time [1]. The conspicuity of soft-tissue foreign bodies on sonography is increased by a surrounding hypoechoic halo of granulation tissue, edema, or hemorrhage [1, 3]. This in vivo response was not present in the cadaveric specimens used in this study.

Glass does not have to contain lead to be radiopaque—all glass material is radiopaque to some degree on radiographs [4]. The higher density and the effective atomic number of glass compared with the surrounding soft tissue are the factors responsible for its radiographic appearance [4]. Common glass products such as a drinking glass, a light bulb, and the two types of glass used in our study (the windshield and bottle glasses) contain no lead and yet are radiopaque [4].

Sonographic artifacts from soft-tissue foreign bodies aid in their identification. Such artifacts are seen deep in relation to the foreign bodies on sonography and are not related to the composition of the material; the surface characteristics of the object influence the type of artifacts produced, particularly “clean” versus “dirty” shadowing [5]. Objects with a small radius of curvature or a rough surface (i.e., a wooden toothpick and pencil) resulted in clean shadowing [5]. Objects with a large radius of curvature or smooth surface (i.e., glass and metal) result in dirty shadowing and reverberation artifacts [5, 6].

Windshield Glass

A 5-mm fragment of glass from a domestic automobile was examined (Fig. 1A). On

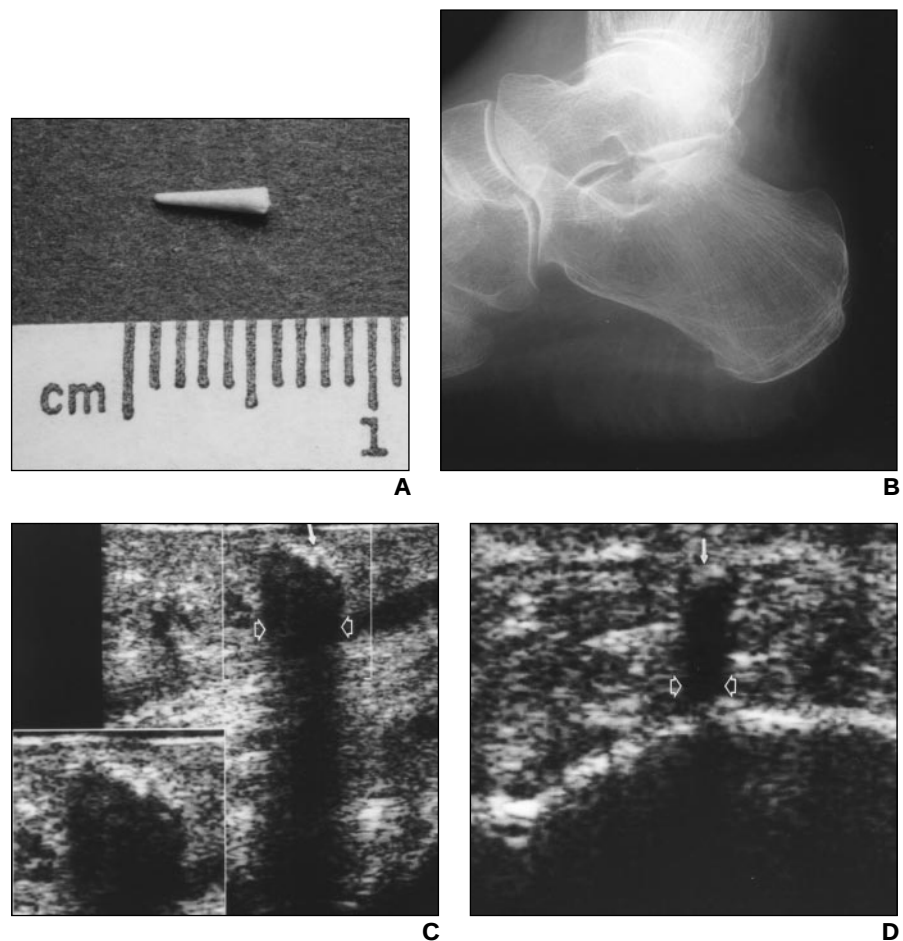


Fig. 3.—Wooden toothpick.

A, Photograph shows 5-mm wooden toothpick fragment before being placed in cadaveric foot.

B, Lateral foot radiograph does not show wooden foreign body.

C, Sonogram of plantar surface of foot reveals hyperechoic wooden toothpick (in long axis) (solid arrow). Note complete posterior acoustic shadowing (open arrows). Inset image is magnification view of foreign body.

D, Sonogram of plantar surface of foot after insertion of 2.5-mm wooden toothpick fragment reveals hyperechoic foreign body (solid arrow). Note complete posterior acoustic shadowing (open arrows).

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radiography, the glass appeared radiopaque (Fig. 1B). On sonography, the glass appeared hyperechoic with posterior shadowing intermixed with a small amount of reverberation artifact (Fig. 1C).

Bottle Glass

A 5-mm piece of glass was obtained from an amber-colored bottle (Anchor Steam, San Francisco, CA) (Fig. 2A). On radiography, the glass was opaque (Fig. 2B). On sonography, the glass was hyperechoic and showed a posterior reverberation artifact and shadowing from the edges (Fig. 2C).

Wooden Toothpick

A 5-mm toothpick was selected as an example of a wooden foreign body (Fig. 3A). On radiography, the toothpick was not visualized (Fig. 3B), and on sonography it appeared hyperechoic with complete posterior shadowing (Fig. 3C). The oblique orientation of the toothpick did not affect the degree of posterior shadowing. Sonography of a 2.5-mm wooden foreign body shows similar characteristics (Fig. 3D). Sonography can reveal wooden foreign bodies as small as 2.5 mm in length with 87% sensitivity and 97% specificity [1].

Pencil Fragment

A fragment from a standard #2 pencil containing wood and graphite was examined (Fig. 4A). On radiography, the 4-cm fragment appeared centrally radiopaque, which represented the graphite, surrounded by the more radiolucent wood (Fig. 4B). On sonography,

the pencil was hyperechoic and showed complete posterior shadowing (Fig. 4C).

Sewing Needle

A 15-mm metal sewing needle was examined (Fig. 5A). On radiography, the needle appeared opaque (Fig. 5B). On sonography, the small diameter of the needle made it difficult to identify; however, a bright echo could be seen on close scrutiny

(Fig. 5C). Posterior acoustic shadowing further aided in localization of the echogenic needle.

Galvanized Steel

A 3 × 7 mm piece of 28-gauge galvanized steel was obtained from a pipe of a forced-air heating system (Fig. 6A). On radiography, it appeared radiopaque (Fig. 6B). On sonography, a bright linear echo was revealed with

Fig. 4.—Wood and graphite pencil.
A, Photograph shows 4-cm pencil fragment before being placed in cadaveric foot.
B, Lateral foot radiograph shows pencil as centrally radiopaque, which represents graphite (*arrowhead*). Surrounding lucency represents wood (*arrow*).
C, Sonogram of plantar surface of foot reveals hyperechoic pencil (in long axis) (*solid arrows*). Note complete posterior shadowing (*open arrows*).

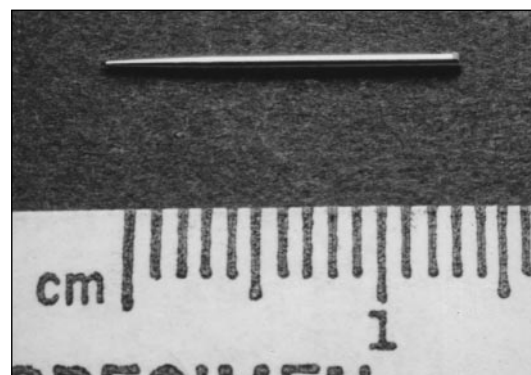
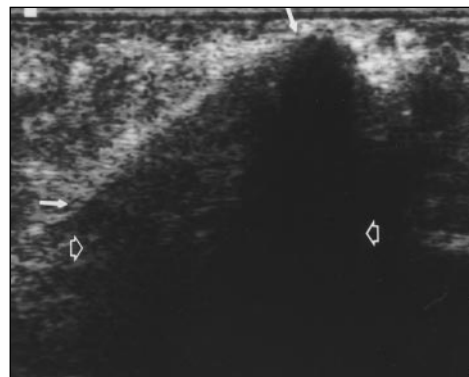
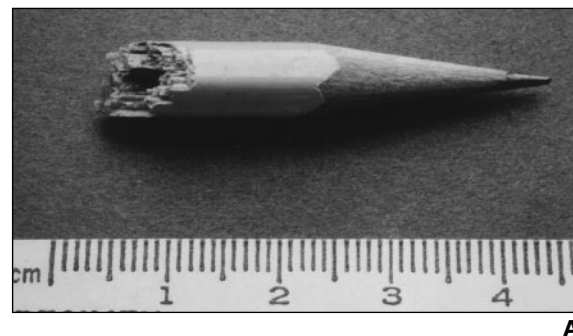


Fig. 5.—Metal sewing needle.
A, Photograph shows 15-mm metal sewing needle before being placed in cadaveric foot.
B, Lateral foot radiograph shows radiopaque needle (*arrow*).
C, Sonogram of plantar surface of foot reveals hyperechoic needle (in short axis) (*solid arrow*). Note posterior acoustic shadowing (*open arrows*). C = calcaneus.



Fig. 6.—Galvanized steel fragment.

A, Photograph shows 3 × 7 mm galvanized steel fragment before being placed in cadaveric foot.

B, Lateral foot radiograph shows radiopaque steel foreign body (*arrow*).

C, Sonogram of plantar surface of foot reveals hyperechoic galvanized steel (*arrow*). Note posterior reverberation artifacts (*arrowheads*).

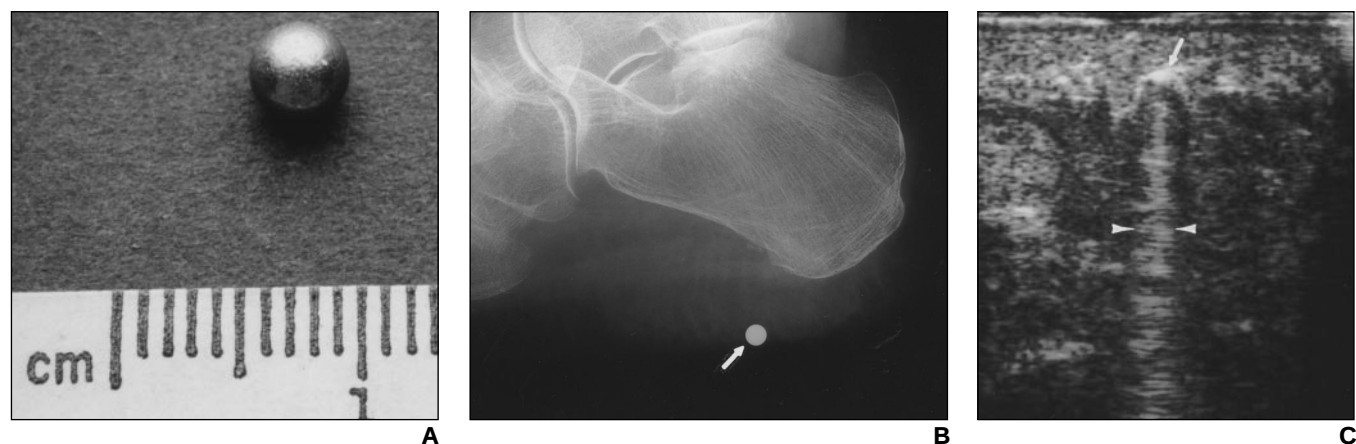


Fig. 7.—Zinc-plated steel BB shot pellet.

A, Photograph shows 4-mm zinc-plated steel BB shot pellet before being placed in cadaveric foot.

B, Lateral foot radiograph shows radiopaque metal foreign body (*arrow*).

C, Sonogram of plantar surface of foot reveals hyperechoic BB shot pellet (*arrow*). Note posterior reverberation artifact (*arrowheads*).

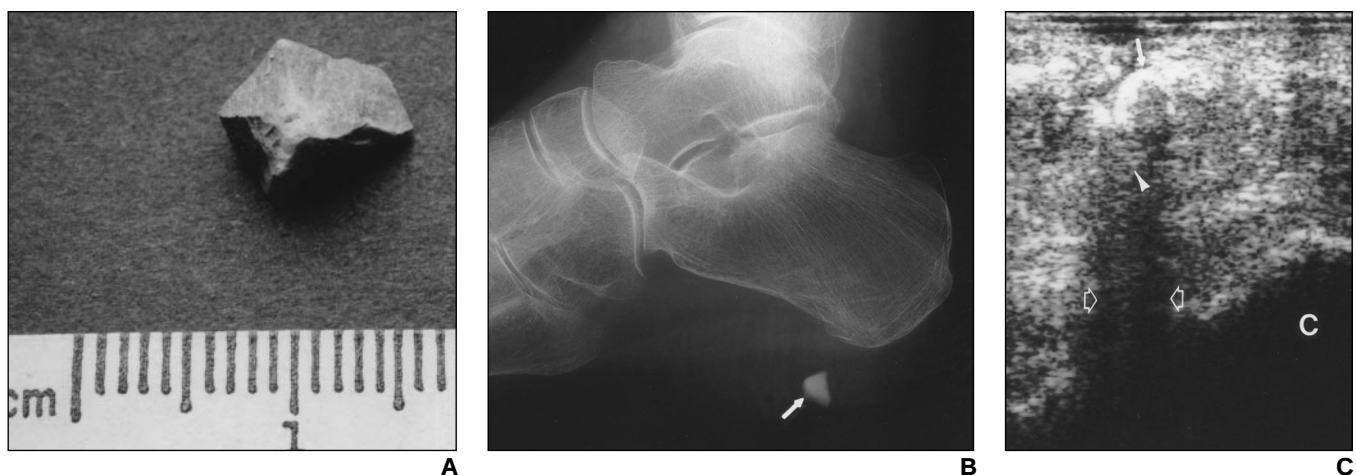


Fig. 8.—Stone.

A, Photograph shows 9-mm common roadside stone before being placed in cadaveric foot.

B, Lateral foot radiograph shows radiopaque stone (*arrow*).

C, Sonogram of plantar surface of foot shows stone as hyperechoic (*solid arrow*). Note posterior acoustic shadowing (*open arrows*) and minimal reverberation artifact (*arrowhead*). C = calcaneus.

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posterior reverberation artifact caused by its smooth surface (Fig. 6C).

BB Shot Pellet

A 4-mm zinc-plated steel BB shot pellet (Fig. 7A) appeared radiopaque on radiography (Fig. 7B). On sonography, a bright echo was seen with posterior reverberation artifact (Fig. 7C).

Stone

A 9-mm common roadside stone was radiopaque on radiography (Figs. 8A and 8B) and showed a bright irregular echo with posterior acoustic shadowing and minimal reverberation artifact on sonography (Fig. 8C).

Plastic

A 15 × 6 mm fragment of plastic from an automobile radio was examined (Fig. 9A). The plastic was not identifiable on radiography (Fig. 9B). On sonography, the plastic was less echogenic than the other foreign bodies studied, which may have been a result of its orientation not being perpendicular to the transducer beam (Fig. 9C). The plastic foreign body also showed marked posterior acoustic shadowing, which assisted in localization of the plastic fragment.

Conclusion

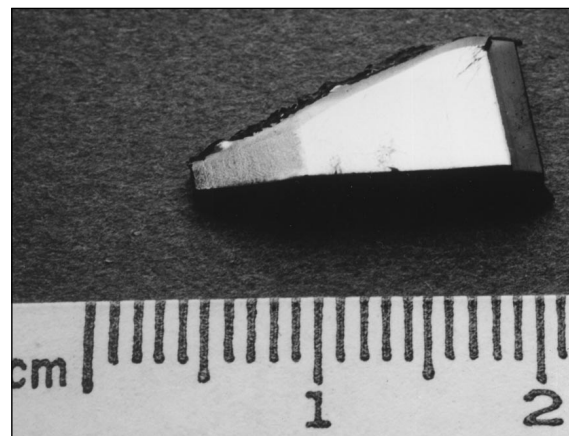
Several soft-tissue foreign bodies, such as wood and plastic, are not radiopaque and may remain undetected on radiography; however, all foreign bodies are hyperechoic on sonography. Sonographic artifacts deep in relation to soft-tissue foreign bodies are related to the surface attributes rather than the composition of the foreign body and aid in their identification [1].

Fig. 9.—Plastic.

A, Photograph shows 15 × 6 mm plastic fragment before being placed in cadaveric foot.

B, Lateral foot radiograph does not show plastic foreign body.

C, Sonogram of plantar surface of foot reveals hyperechoic plastic foreign body (solid arrows). Note marked posterior shadowing (open arrows).



A



B



C

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