Detection of foreign bodies using ultrasound: A possible pitfall

Bing Siang Gan MD PhD, Lawrence N Hurst MD FRCSC FACS, H Brian Evans MD FRCSC, Donal Downey MB FRCPC
Departments of Plastic Surgery and Radiology, University Hospital, University of Western Ontario, London, Ontario

BS Gan, LN Hurst, HB Evans, D Downey. Detection of foreign bodies using ultrasound: A possible pitfall. Can J Plast Surg 1994;2(1):35-38. Recently, a number of reports have brought the use of ultrasound scanning in the detection of foreign bodies to the field of hand surgery. A case is presented in which ultrasound was not able to diagnose the presence of a large (3.5 x 0.5 x 0.5 cm) nonradiopaque wooden foreign body lying between the flexor tendons of the forearm. However, embedded in ultrasound gel, the piece could readily be identified. This report serves as a reminder that the anatomical localization of a foreign body amid structures with vastly different echogenicity from its surroundings (such as flexor tendons of the hand and forearm) may reduce the usefulness of diagnostic ultrasound and that in such circumstances clinical suspicion may be a more reliable indication for exploratory surgery.

Key Words: *Foreign bodies, Nonradiopaque, Ultrasound*

Détection de corps étrangers à l'échographie : embûche possible

RÉSUMÉ : Récemment, certains rapports ont parlé de l'application des épreuves échocardiographiques par balayage à la détection de corps étrangers lors de chirurgies de la main. Le cas présenté ici illustre une échographie qui s'est révélée inefficace à diagnostiquer la présence d'une parcelle de bois non radio-opaque qui s'était logée entre les tendons fléchisseurs de l'avant-bras. Toutefois, entourée de gel pour échographie, le morceau a facilement pu être identifié. Ce rapport nous rappelle que la localisation anatomique d'un corps étranger au milieu des structures très différentes de son environnement sur le plan de l'échogénicité (comme les tendons fléchisseurs de la main et de l'avant-bras) peuvent rendre douteuse l'utilité de l'échographie diagnostique et que dans de tels cas, les indices cliniques orienteraient davantage l'intervention vers une chirurgie exploratoire.

Recent reports suggest that ultrasound is the diagnostic modality of choice to detect nonradiopaque foreign bodies such as wood slivers. A case is presented in which ultrasound failed to diagnose a large nonradiopaque wooden foreign body lying between the flexor tendons of the forearm. The pertinent literature is discussed.

CASE REPORT

A nine-year-old boy sustained a puncture wound to his right volar forearm 3 cm proximal to the wrist crease after falling in the bushes. A sliver was removed from the laceration and local wound care was administered by the family. Several days later increased redness associated with a purulent discharge from the wound was noted. The discharge contained several large slivers. Six days after the injury, medical attention was sought and examination in the emergency department showed a warm erythematous area measuring 4 x 2.5 cm and a small purulent puncture wound. There was no limitation of movement in the forearm or hand, nor was there any neurovascular compromise. A foreign body was suspected but could not be palpated.

Correspondence and reprints: Dr Lawrence N Hurst, Department of Plastic Surgery, University Hospital, 339 Windermere Road, London, Ontario N6A 5A5. Telephone (519) 663-2921, Fax (519) 663- 2907.

X-rays did not show any abnormality, but ultrasound investigation revealed a subcutaneous tract in the proximal direction with a total length of 2.5 cm. At the end of this tract a foreign body measuring 0.2 x 0.2 cm was noted (Figure 1). The antebrachial fascia did not appear to be violated and in real-time mode flexor tendons could be seen moving freely without evidence of a foreign body. The puncture wound was thoroughly irrigated, but in view of the small size of the foreign body, surgical exploration was not considered to be indicated. The patient was discharged home on oral antibiotics and local wound care.

Follow-up one week later showed marked improvement. However, after finishing the complete course of antibiotics, renewed purulent drainage containing some black foreign body was noted. Oral antibiotics and local wound care were reinstituted with limited benefit. Nineteen days after injury the boy was taken to the operating room for surgical exploration and removal of a suspected foreign body. The ultrasound-diagnosed subcutaneous tract was easily found and debrided of granulation tissue. At the proximal end of the tract some tiny pieces of bark located superficially to a small laceration of the antebrachial fascia were found. The fascia was incised and immediately a large foreign body measuring

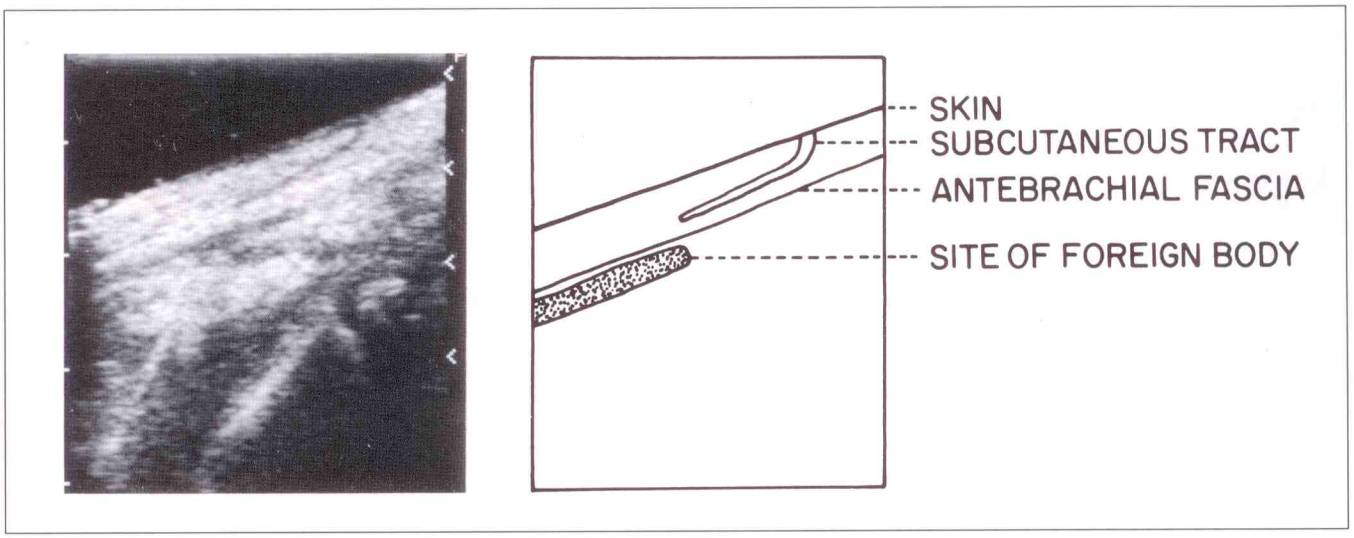

Figure 1) *Ultrasound image showing the presence of a subcutaneous tract and the presence of a small (0.2 x 0.2 cm) foreign body at its apex. Note the absence of an acoustic shadow behind the foreign body*

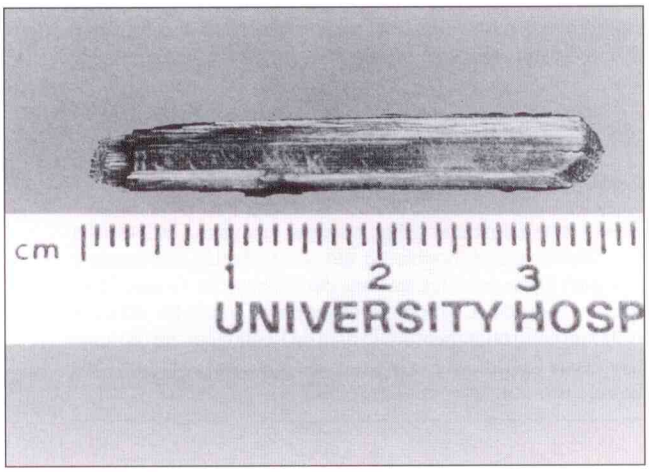

Figure 2) *Photograph of the foreign body found at exploration*

3.5 x 0.5 x 0.5 cm lying parallel to the flexor tendons became evident (Figure 2). Uneventful healing occurred within 10 days. Postoperatively, the piece of wood was taken to the ultrasound department and embedded in standard ultrasound gel. The sliver could be readily detected under these circumstances, indicating that the material itself was echogeneic (Figures 3, 4).

DISCUSSION

Nonradiopaque foreign bodies have always been a problem to diagnose. Over the past decade, several reports have suggested that these can best be detected by ultrasound.

Ophthalmologists now universally accept diagnostic ultrasound as the safest, most accurate and inexpensive tool for the detection of foreign bodies in the orbit. Numerous reports (1,2) have established a very high accuracy with specificity and sensitivity approaching 100%. Probably because of these impressive numbers, ultrasound was introduced as a means to detect foreign bodies elsewhere and individual case reports appeared in the literature (3-6).

Several groups documented the usefulness of ultrasound beyond casuistry. In a canine laboratory model, ultrasound has been shown to detect 100% of foreign bodies embedded in muscle. Wooden foreign bodies were easier to visualize than glass, plastic or metal foreign bodies (7). Also, in a suspension of minced meat, ultrasound was able to detect all inserted foreign bodies in various shapes and sizes, whether lead, plastic, metal, rock, glass, wood or surgical sponge (8). When cubes of beef instead of a suspension of meat were used, 59 out of 60 embedded foreign bodies were detected, missing only one glass foreign body (9). One hundred percent of foreign bodies inserted in chicken breast could also be retrieved (10). It should be kept in mind, however, that these studies were performed under optimal circumstances for the use of ultrasound, since the foreign bodies were all embedded in a uniform medium that would not cause interference from other structures. It is, therefore, not unexpected that in the clinical situation ultrasound proved not to be as sensitive.

In a human cadaveric study, ultrasound detected 58 of 65 hidden foreign bodies for a sensitivity of 89% (11). Similar detection rates were found clinically. In one study reviewing its use for detection of foreign bodies in the extremities of 50 patients, ultrasound detected 21 of 22 foreign bodies found at operation. There were three false-positive and only one false-negative examination for a sensitivity of 95% and specificity of 89% (12). Almost identically, in a prospective study ultrasound was inaccurate in three of 45 patients (two false-positive and one false-negative; the data could not be interpreted for sensitivity and specificity calculation) (13).

The use of ultrasound for detection of foreign bodies specifically in the hand was also examined. In 39 patients, ultrasound missed one foreign bodies and falsely predicted two, again yielding 95% sensitivity and 89% specificity (14). On the basis of such studies, ultrasound is thought to have a sensitivity around 95% and specificity around 90% in the diagnosis of foreign bodies in the extremities. In none of the studies, however, was much attention paid to the false-negative results. Only in one study (12), the negative predictive value was calculated to be 96%.

When reviewing the literature, it becomes clear that in the

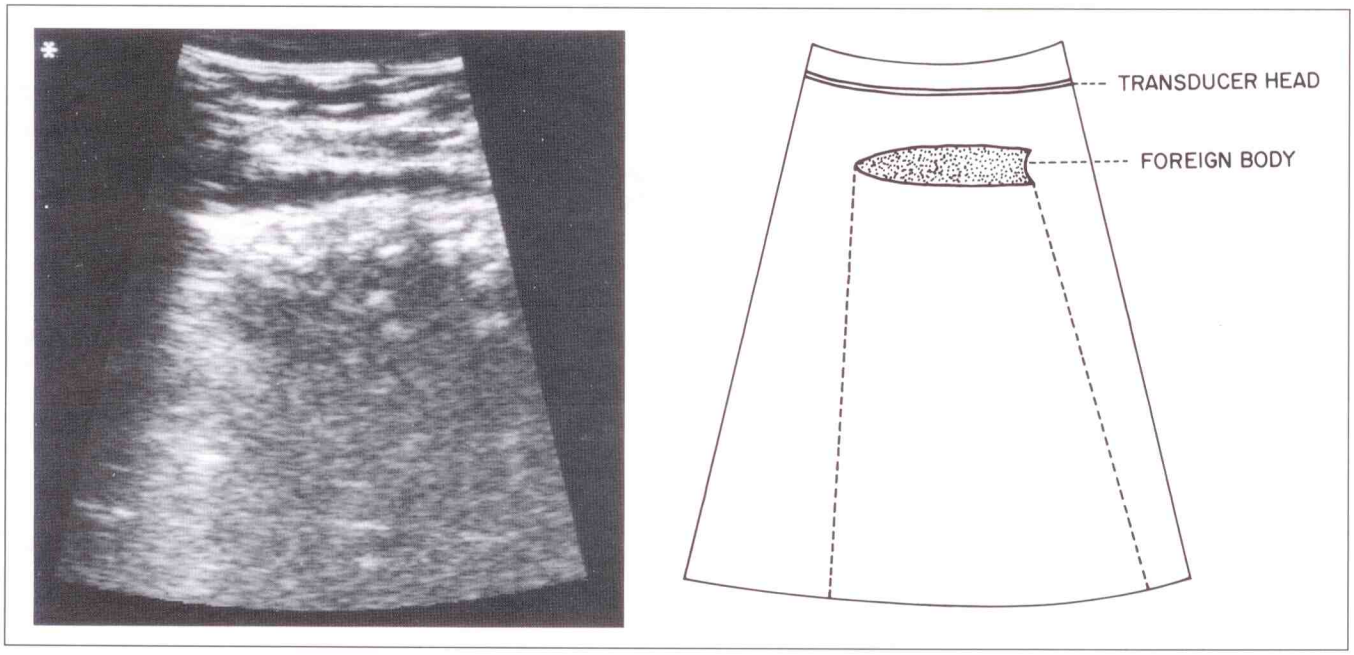

Figure 3) *Ultrasound image of the longitudinal plane of the foreign body embedded in standard ultrasound gel. Note the acoustic shadow*

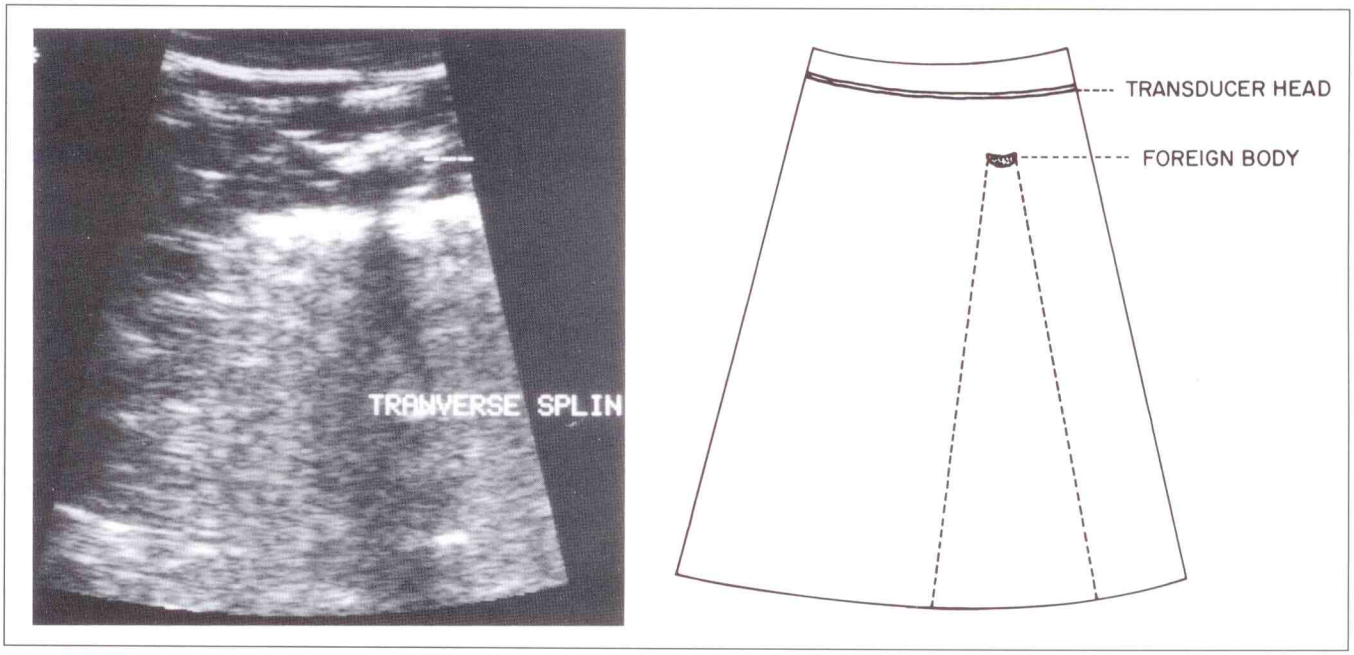

Figure 4) *Transverse ultrasound image of the foreign body. Again the clear presence of the acoustic shadow is noted*

cases where ultrasound failed to detect the foreign bodies, local factors may have played a role in diminishing the difference in acoustical impedance between the object and the surrounding tissues. In two cases difficult access for the transducer head to the webspace leading to artefact was thought to account for the ultrasound failure. In one case it was thought to be interstitial gas.

In our case, it was shown that the foreign body could readily be detected under optimal circumstances when it was embedded in a uniform medium (Figures 3, 4). As there was no problem in obtaining high quality images from the forearm, we believe that detection of the foreign body was complicated by the echo patterns of the surrounding structures. In retrospect, the foreign body may well have been interpreted as a tendon. It has previously been emphasized that the angle of scanning may influence the appearance of tendons on the ultrasound screen (15). This makes the interpretation of these echopatterns more operator-dependent and this will likely affect the accuracy of this test when it is more widely used by nondedicated radiologists.

The surgeon should be aware of the possibility that the acoustically dense tendons may decrease the ability of ultrasound to detect foreign bodies. Under such circumstances, clinical suspicion may be a better indication for surgical

exploration than a negative ultrasound scan, despite the previously reported high negative predictive value of this diagnostic procedure.

REFERENCES

1. Nouby-Mahmoud G, Silverman RH, Coleman DJ. Using high-frequency ultrasound to characterize intraocular foreign bodies. Ophthalmic Surg 1993;24:94-9.
2. Bryden FM, Pyott AA, Bailey M, McGhee CN. Real time ultrasound in the assessment of intraocular foreign bodies. Eye 1990;4:727-31.
3. Nyska M, Sperbert AD, Howard CB, Nyska A, Dekel S. Ankle extensor tendon synovitis due to a date palm thorn. Foot Ankle 1989;10:180-3.
4. Bray H, Stringer DA, Posbitt K, Newman DE, MacKenzie WG. Maple tree knee: a unique foreign body - value of ultrasound and CT examination. Ped Radiol 1991;21:457-8.
5. Hansson G, Beebe AC, Carroll NC, et al. A piece of wood in the hand diagnosed by ultrasonography. Acta Orthop Scand 1988;59:459-60.
6. Coombs CJ, Mutimer KL, Slattery PG, Wise AG. Hide and seek: pre-operative ultrasonic localization of non-radiopaque foreign bodies. Aust N Z J Surg 1990;60:989-91.
7. Little CM, Parker MG, Callowich MC, Sartori JC. The ultrasonic detection of soft tissue foreign bodies. Invest Radiol 1986;21:275-7.
8. Suramo I, Pamilo M. Ultrasound examination of foreign bodies. Acta Radiol Diagn 1986;27:463-6.
9. Schlager D, Sanders AB, Wiggins D, Boren W. Ultrasound for the detection of foreign bodies. Ann Emerg Med 1991;20:189-91.
10. Gooding GA, Hardiman T, Sumers M, Stess R, Graf P, Grunfeld C. Sonography of the hand and foot in foreign body detection. J Ultrasound Med 1987;6:441-7.
11. Blyme PJ, Lind T, Schantz K, Lavard P. Ultrasonographic detection of foreign bodies in soft tissue. A human cadaver study. Arch Orthop Trauma Surg 1990;110:24-5.
12. Gilbert FJ, Campbell RSD, Bayliss AP. The role of ultrasound in the detection of non-radiopaque foreign bodies. Clin Radiol 1990;41:109-12.
13. Banerjee, B, Das RK. Sonographic detection of foreign bodies of the extremities. Br J Radiol 1991;64:107-12.
14. Crawford R, Matheson AB. Clinical value of ultrasonography in the detection and removal of radiolucent foreign bodies. Injury 1989;20:341-3.
15. Fornage BD, Rifkin MD. Ultrasound examination of tendons. Radiol Clin N Am 1988;26:87-107.