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Ultrasound Artifact in an Unusual Site Simulating Bilateral Subdural Haematoma in a Neonate

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Abstract Ultrasound (US) provides a simple way to assess the infant brain. However, all imaging modalities have some sort of artifacts. Some of them will cause diagnostic dilemma or even leading to misdiagnosis. We report a case of an interesting US artifact which simulates a bilateral subdural haematoma in a term neonate. The basic physics of ultrasound and the cause of the artifact are briefly reviewed.

Key words Artifacts; Subdural haematoma; Physics; Ultrasound

Introduction

Ultrasound (US) is frequently performed on preterm and term neonates to screen for intracranial abnormalities. Cranial US is easy and convenient to perform and does not involve use of ionising radiation. However, all imaging modalities have some sort of artifacts. Certain artifacts are specifically pertaining to US. They may cause confusion and diagnostic dilemma to the US operator. Knowledge on ultrasound basis and varieties of artifacts allow the operator to differentiate or suspect the presence of artifact versus a genuine pathology and to prompt further investigation as necessary.

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Case History

A full term baby girl was delivered by emergency Caesarian section due to failed medical induction and unsatisfactory cardiotocographic (CTG) finding after prelabour rupture of membrane. The birth weight was found to be low, at 2.375 kg. Apgar scores were 9 at 1 minute and 10 at 5 minutes. Maternal history included gestational diabetes on dietary control.

On physical examination, bilateral parietal cephalhaematomas were noted. Posterior fontanel was found to be wide, up to 4 cm. No neurological abnormality was found. Skull radiographs showed bilateral parietal soft tissue swelling consistent with cephalhaematoma. No skull fracture was noted. Further investigation revealed hypoglycaemia and abnormal clotting profile. The baby was treated as clinical sepsis with a course of antibiotics.

US of the brain was performed to screen for intracranial complications on day 3 of life. US images were obtained using a Philip iU22 US machine with a linear 12-5 Mhz (L12-5) and a curve 8-5 Mhz (C8-5) transducers. US in coronal plane showed bilateral lentiform shaped hypoechoic lesions superficial to the skull, which were compatible with cephalhaematoma. Underneath the skull, biconvex hypoechoic lesions were seen over bilateral fronto-parietal region (Figure 1). Apparent mass effect was noted onto the underlying brain. They were suspicious of bilateral subdural haematoma (SDH).

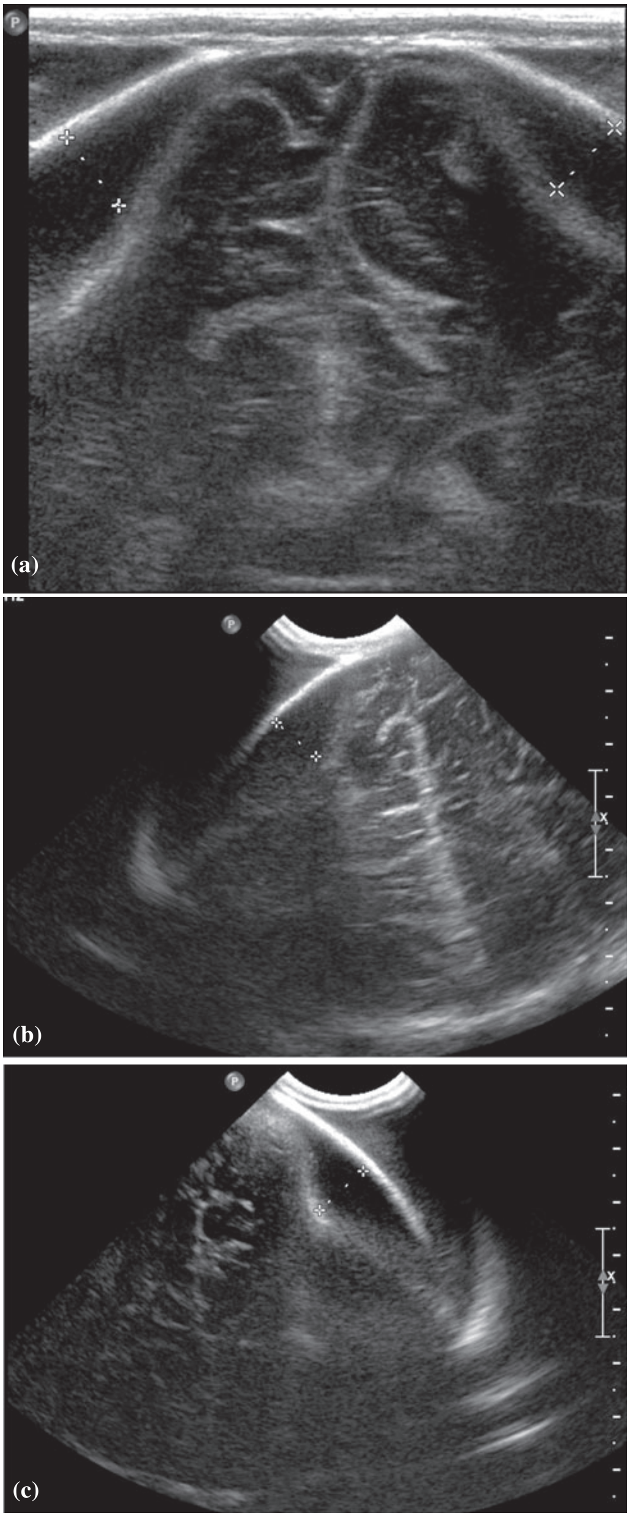

Figure 1 US scan of the brain via anterior fontanelle in coronal plane using L12-5 US transducer. Hypoechoic lentiform shaped structures are seen over both sides beneath the skull vault (a). Appearance is suggestive of bilateral subdural haematoma. Panning to right (b) and left (c) sides using C8-5 US transducer, apparent mass effect on the underlying brain parenchyma can be seen.

A magnetic resonance (MR) study of the brain was performed immediately following the ultrasound study to investigate for the subdural haematomas (Figure 2). However, the MR scan demonstrated only the presence of cephalhaematoma with absence of evidence of subdural haematoma or collection.

The cephalhaematoma was managed conservatively. The baby girl was discharged on day 13 of life.

Discussion

Although MR is the gold standard for imaging the infant brain,[1] US is frequently performed due to its convenience and limited availability of MR. Performing US study is fast and can be done at bedside. Reports have shown MR is superior to US in preterm neonate. However data is lacking in full-term neonate and some argue US can be as good as MR.[1] Anterior fontanel is usually used as an acoustic window for scanning.[2]

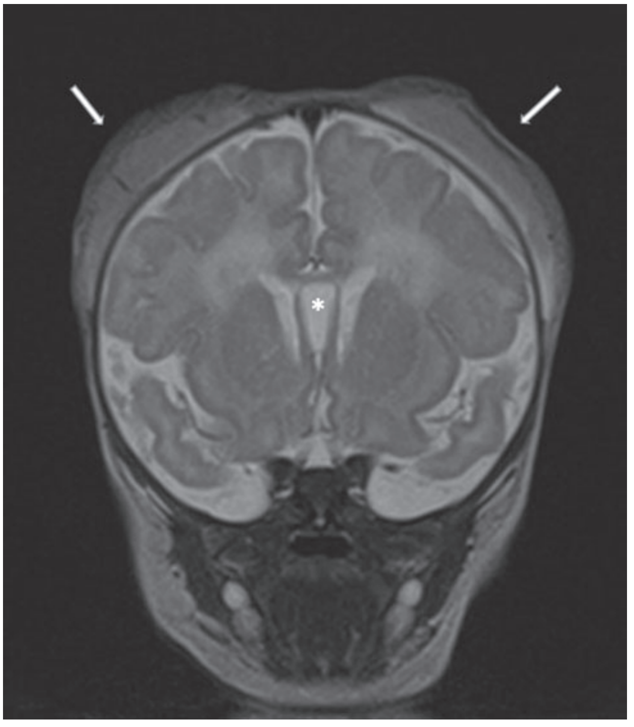

Figure 2 Coronal T2-weighted MR scan through frontal and temporal lobes. Bilateral immediate signal intensity lesions are seen over bilateral skull vaults in keeping with cephalhaematoma (arrows). No evidence of subdural haematoma is demonstrated on MR. A cavum septum pellucidum is incidentally seen, a normal variant (asterisk).

Despite the advantages of US, artifacts are common. When the US image formed contains structures that do not accurately depict the anatomy, artifact is said to be present.[3] Myriad of US artifacts have been described and their causes elucidated.[3-5]

In our patient, the initial US showed biconvex hypoechoic structures simulating the presence of subdural haematoma. This is due to the presence of "mirror-image artifact".[3-5] To understand the formation of such artifact, the physics behind US imaging has to be discussed.

US images are generated first by pulse formation at the transducer. The US beam propagates in the tissue where it interacts with reflective surface. Echoes are then generated and returned to the transducer. The transducer, which also acts as a receiver, detects these echoes. The echoes are processed by the computer. Based on the echo intensities and time of arrival at the transducer, the echoes are assigned to brightness and locations on the images, respectively.[3] This results in the usual B-mode or brightness-mode images. Image processing and display rely on a number of physical assumptions:[3]

1. Echoes are assumed to return to the transducer after one single reflection and in a straight path.
2. The depth of the object is directly related to the amount of time for the ultrasound beam to propagate and return to the transducer.
3. The speed of the ultrasound energy is also assumed to be constant in the human body at 1540 m/sec.

In the case of mirror-image artifact, a highly reflective surface is involved. The primary US beam encountered this highly reflective surface. It is reflected to the back side of a structure and then back towards this reflective surface. Finally it is reflected back again to the transducer. As a result, assumption 1 is violated. And since there is one additional reflection, the object is displayed at a greater depth than their true anatomic depth based on assumption 2. "Mirror-image" artifact is so-named as it creates a duplicated image equidistant but deep to a strongly reflective interface.[3] A classic example of such artifact is commonly seen at the diaphragm/lung base due to the high reflectivity of lung. In our case, this would be related to the high reflectivity of skull bone. The mirrored image is more hypoechoic and more blurred or distorted than the image of the original structure.[5]

Knowing the physics behind the formation of this artifact, there is little we can do to eliminate it since it is due to the intrinsic nature of US and underlying tissue characteristics. The artifact would likely persist despite a change in scanning orientation. In such case, the US operator should bear in mind that the suspected lesion, as the name of the artifact suggests, is a mirror image of another structure displayed on screen. Such appearance should prompt the operator to consider the possibility of an artifact, especially when the patient has a known extracranial lesion like a cephalhaematoma. The operator may attempt scanning through the transtemporal approach or mastoid fontanel. This may also help clarify the confusion.

While some artifacts, like acoustic enhancement or shadowing, help us characterise the physical nature of the structure, some hinder our ability to diagnose. Possibility of over diagnosing US artifacts as genuine pathology may lead to serious consequence. For instance, over diagnosing subdural haematoma in an older infant may prompt unnecessary investigation for the possibility of non-accidental injury.[6] or an unnecessary operation to drain the non-existent subdural haematoma. Although some artifacts may be clarified by changing the scanning angle or plane, many artifacts will persist despite our best attempt to eliminate them. When there is suspicion about the US diagnosis, further confirmatory investigations such as MR or CT has to be performed. For the US operator, recognising the varieties of US artifact and their appearance is critical to make correct diagnoses and prevent over diagnosis and, as a result, over treating patients.

Declaration of Interest

The authors declared that they have no conflicts of interests.

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