Emergency and Critical Care Medicine

OPEN

Brain abscess diagnosis with transcranial ultrasound: a case report

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Brain abscess is a focal encapsulated space occupying lesion in the central nervous system, associated with a high mortality rate.[1] Signs and symptoms are not specific, and neuro-imaging plays a key role in the diagnosis of brain abscess. Computed tomography (CT) scan remains the standard of diagnosis, although magnetic resonance imaging (MRI) allows greater resolution.[2] Point-of-care ultrasound (POCUS) is used in emergency departments (EDs) for a wide range of indications, and transcranial ultrasound scanning (TCUS) through temporal bone windows is increasingly used for imaging of the brain.[3,4] Despite the challenges of image acquisition, point-of-care TCUS may become another option in the ED as a rapid, cheap, and noninvasive procedure to aid diagnosis of brain abscess.[4–6] This report describes the TCUS appearance of a brain abscess identified in the ED.

A 33-year-old male patient presented to the ED with a 6-day history of persistent, progressive frontal headache, despite the use of over-the-counter paracetamol and ibuprofen. He had no fever, neck stiffness or vomiting. He was given paracetamol and sumatriptan with remission of the headache and discharged from the ED.

Two days later, he represented to the ED with increased headache, pain score 10/10 despite analgesia. He had also started vomiting, and according to his partner had become more restless than on his initial presentation and was now confused. The patient had recently traveled to Africa for work purposes. He was otherwise fit and well, human immunodeficiency virus negative, and not on regular medication.

CT scan was performed in the ED, which showed a peripherally enhancing mass lesion in the left temporal lobe with marked surrounding edema. The mass appeared relatively thin-walled, anteriorly and laterally, and the appearance was highly suspicious of an abscess rather than a neoplasm. Bedside TCUS was performed while the patient was waiting for MRI. Ultrasound demonstrated a hypoechoic lesion in the brain approximately 4 cm × 4 cm, with hyperechoic walls consistent with the diagnosis of abscess (Fig. 1). MRI confirmed the diagnosis of brain abscess in the left temporal lobe, with mass effect and midline shift (Fig. 2).

Dexamethasone, ceftriaxone, metronidazole, and levetiracetam were initiated in the ED, before admission under neurosurgery for left temporal craniotomy and evacuation of abscess later that day. Microscopy and culture of pus identified *Streptococcus constellatus* and antibiotics were continued. The patient was discharged without neurological sequelae on long term levetiracetam.

Brain abscess has been reported to have an annual average incidence in developed countries of about 0.9 per 100, 000 with 1-year mortality of 20%, and significant long term sequelae among survivors.[7] The annual incidence in low- and middle-income countries (LMICs) is 8%.[1] As in this case report, brain abscess is most commonly present in men aged 30–50 years. The most common presentation is insidious headache, followed by fever, and signs and symptoms of raised intracranial pressure and cerebral irritation.[1,8]

Neuroimaging is essential to the diagnosis. Contrast-enhanced MRI is superior to contrast-enhanced CT.[1] Magnetic resonance spectroscopy is an option to avoid the use of contrast agents.[8]

However, these neuroimaging modalities are expensive and in many healthcare contexts are difficult to access rapidly, especially in LMIC.

POCUS is cheap, noninvasive and readily accessible in many EDs in both high- and low- resource settings. It can be used to triage and expedite more advanced imaging, and the use of bedside TCUS has recently been proposed as a screening tool for the diagnosis of intracerebral hemorrhage.[9]

The use of trans-fontanelle POCUS in critically ill neonates is well-established, to assess brain parenchyma with B-mode, and cerebral blood flow with color Doppler.[10] Trans-fontanelle POCUS has been shown to reliably detect hydrocephalus and cerebral abscess in infantile meningitis in Nigeria.[11] TCUS is also established in critically ill postcraniectomy adult patients, using the craniectomy site as the acoustic window[12]; intraoperative ultrasound can also be used to facilitate brain abscess drainage.[1] All these uses rely on the absence of cranial bone to obtain acoustic windows.

An earlier study, however, had demonstrated the utility of TCUS in the evaluation of headache in older children, using acoustic windows obtained through bone to identify brain cysts, hematomata, and hydrocephalus, although brain abscess was not mentioned. It was noted that the use of TCUS in this context had been neglected in high-income settings because of the ready availability of CT and MRI.[13]

It is unsurprising therefore that there are few reports of the use of TCUS in adults, in whom bone windows are even harder to obtain due to temporal bone thickness and texture.[14] A recent study presented B-mode ultrasound images of brain topography obtained through temporal bone windows, including hemorrhage, edema, and hydrocephalus but did not include cerebral abscess.[15]

Cheong has presented 2 cases of intracranial abscess identified with TCUS: a parietal lobe brain abscess[12] and a temporal epidural abscess.[16] Both were in critical care patients' intensive care after craniectomy, and images were obtained through the craniectomy.

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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Emergency and Critical Care Medicine (2025) 5:3

Received: 28 November 2024; Accepted: 16 January 2025
Published online: 4 February, 2025

http://dx.doi.org/10.1097/EC9.0000000000000142

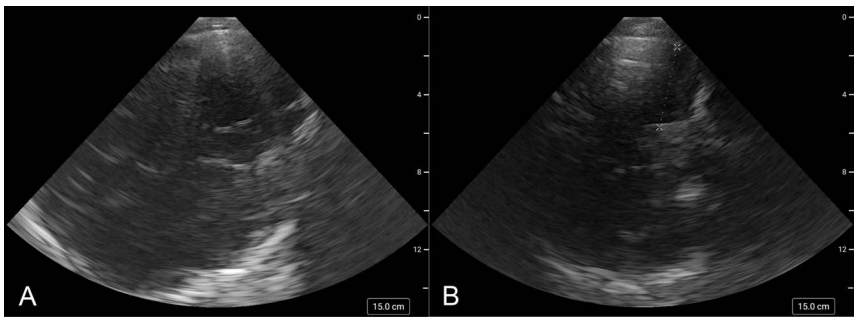

Figure 1. TCUS images of hypoechoic brain lesion. (A) Without calipers. (B) With calipers. TCUS, transcranial ultrasound.

The limitations of POCUS were acknowledged: difficulty obtaining images without craniectomy, poor resolution of images with low specificity, and interoperator variability. However, the point was made that POCUS could be a first-line diagnostic tool to facilitate further imaging with CT and MRI and expedite surgery.[16]

In this case report, we report the use of POCUS using a bone window for image acquisition of brain abscess in an adult. As expected, the image quality is not high, and the images are not specific for brain abscess. There is no indication of the mass effect identified on CT. Even in neonates, it is recognized that POCUS is not accurate enough for a firm diagnosis.[10] Sensitivity is low because bone windows can only be achieved in a minority of patients.[7] Specificity is low because the appearance of a hypoechoic lesion could indicate other causes such as hematoma or cyst.[15] However, the images presented here clearly indicate the presence of a hypoechoic lesion which requires further definitive imaging.

Brain CT and subsequent MRI are the standard modes of imaging for the diagnosis of brain abscess, as in this particular case in a high-income setting in the UK, where the TCUS findings did not change management. In LMIC, however, where CT and MRI might be unavailable, TCUS might be a valuable triage tool to identify patients who need to be transferred to a facility with more advanced diagnostic services and neurosurgical capabilities.[17] Even in high-resource settings, it is not standard practice to obtain CT or MRI for headache patients presenting to an ED without "red-flag" features as part of their initial work-up. TCUS might still be of benefit to expedite care, as the identification of a suspicious mass on ultrasound would function as a red flag for further imaging.

Brain abscess has a high morbidity and mortality, but most signs and symptoms are nonspecific, and in many contexts definitive diagnosis with CT or MRI is not readily available. POCUS might provide a means of further triage, especially in LMIC. Although the quality of POCUS images through bone windows is low and insufficient for diagnosis, it might nonetheless rapidly identify those who need advanced imaging, to expedite diagnosis and surgical management.

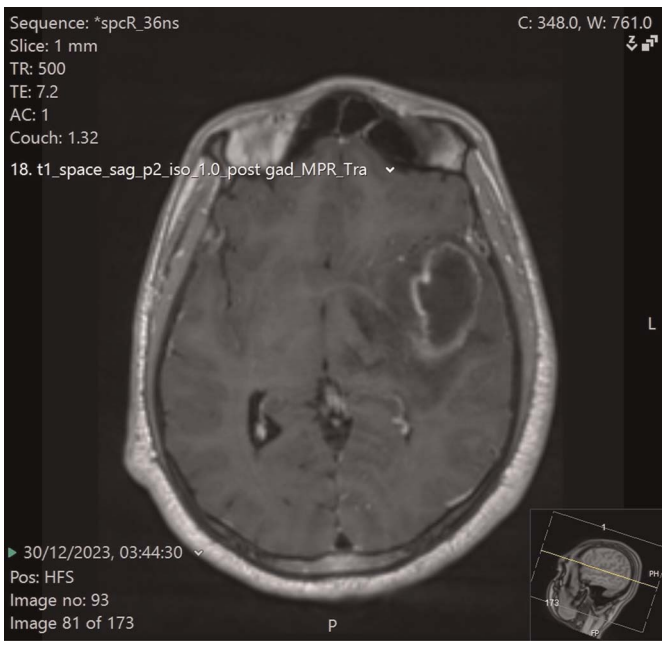

Figure 2. MRI image of left temporal brain abscess. MRI, magnetic resonance imaging.

Conflict of interest statement

Giles N. Cattermole is an Editorial Board Member of *Emergency Critical Care Medicine*. The article was subject to the journal's standard procedures, with peer review handled independently of this Editorial Board Member and their research groups. The authors declare no conflict of interest.

Author contributions

Mbanjumucyo G was the attending clinician. Both authors participated in the writing of the paper.

Funding

None.

Ethical approval of studies and informed consent

King's College Hospital research office does not require ethics committee approval for case reports. A signed consent form was obtained from the patient for this report and has been submitted with this article.

Acknowledgments

The authors thank the patient for allowing us to present his case.

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How to cite this article: Mbanjumucyo G, Cattermole GN. Brain abscess diagnosis with transcranial ultrasound: a case report. *Emerg Crit Care Med*. 2025;5(3):161–163. doi: 10.1097/EC9.0000000000000142