Point-of-Care Ultrasound

Many studies have explored the possibility of using cranial ultrasound for discerning intracranial pathologies like tumors, hemorrhagic stroke, or subdural hemorrhage in clinical scenarios where computer tomography may not be accessible or feasible. The visualization of intracranial anatomy on B-mode ultrasound is challenging due to the presence of the skull which limits insonation to a few segments on the temporal bone that are thin enough to allow transcranial transmission of sound. Several artifacts are produced by hyperechoic signals inherent in brain and skull anatomy when images are created using temporal windows.

While the literature has investigated the accuracy of diagnosis of intracranial pathology with ultrasound, we lack a reference source for images acquired on cranial topography on B-mode ultrasound to illustrate the appearance of normal and abnormal structures of the brain and skull. Two investigators underwent hands-on training in Cranial point-of-care ultrasound (c-POCUS) and acquired multiple images from each patient to obtain the most in-depth images of the brain to investigate all visible anatomical structures and pathology within 24 hours of any CT/MRI imaging done.

Results: Most reproducible structures visible on c-POCUS included bony parts and parenchymal structures. Transcranial and abdominal presets were equivalent in elucidating anatomical structures. Brain pathology like parenchymal hemorrhage, cerebral edema, and hydrocephalus were also visualized.

Conclusions: We present an illustrated anatomical atlas of cranial ultrasound B-mode images acquired in various pathologies in a critical care environment and compare our findings with published literature by performing a scoping review of literature on the subject [1)].

Limited studies have evaluated the use of ultrasound for the detection of intracerebral hemorrhage (ICH) using diagnostic ultrasound Transcranial Doppler machines in adults. The feasibility of ICH detection using Point of care Ultrasound (POCUS) machines has not been explored. We evaluated the feasibility of using cranial POCUS B mode imaging performed using an intensive care unit (ICU) POCUS device for ICH detection with a secondary goal of mapping optimal imaging technique and brain topography likely to affect sensitivity and specificity of ICH detection with POCUS.

Materials and methods: After obtaining IRB approval, a blinded investigator performed cranial ultrasound (Fujifilm, Sonosite® Xporte, transcranial and abdominal presets) through temporal windows on 11 patients with intracerebral pathology within 72 h of last CT/MRI (computed tomography scan/magnetic resonance imaging) brain after being admitted to a neurocritical care unit in Aug 2020 and Nov 2020-Mar 2021. Images were then compared to patient's CT/MRI to inform topography. Inferential statistics were reported.

Results: Mean age was 57 (28-77 years) and 6/11 were female. Six patients were diagnosed with ICH, 3 with ischemic stroke, 1 subarachnoid hemorrhage, and 1 brain tumor. The sensitivity and specificity of point of care diagnosis of ICH compared to CT/MRI brain was 100% and 50%, respectively. The mean time between the ultrasound scan and CT/MRI was 13.3 h (21 min-39 h). Falx cerebri, choroid calcification, and midbrain-related artifacts were the most reproducible hyperechoic signals. Abdominal preset on high gain yielded less artifact than Transcranial Doppler preset for cranial B mode imaging. False positive ICH diagnosis was attributed to an intracerebral tumor and midbrain-related artifact.

The exploratory analysis yielded preliminary data on the use of point-of-care cranial ultrasound for ICH diagnosis to inform imaging techniques, cranial topography on B mode, and sample size estimation for future studies to evaluate the sensitivity and specificity of cranial POCUS in adult patients. This pilot study is limited by the small sample size and over-representation of ICH in the study. Cranial POCUS is feasible using POCUS machines and may have potential as a screening tool if validated in adequately powered studies [2].

A 60-year-old male presented to the emergency department with acute change in mental status while recovering from a recent hemicraniectomy. During evaluation by the emergency physician, a point-of-care ultrasound (POCUS) was performed using the patient's existing craniectomy site as a sonographic window. Multiple areas of intracranial hemorrhage were visualized on POCUS and head computed tomography scan ultimately requiring urgent neurosurgical intervention. This case report demonstrates an innovative application of POCUS in the emergency department- setting that has potential to expedite diagnosis and management of life-threatening neurosurgical etiologies, such as hemorrhage and midline shift, in a unique patient population [3].

1)
Kapoor S, Offnick A, Allen B, Brown PA, Sachs JR, Gurcan MN, Pinton G, D'Agostino R Jr, Bushnell C, Wolfe S, Duncan P, Asimos A, Sarwal A. Brain topography on adult ultrasound images: Techniques, interpretation, and image library. J Neuroimaging. 2022 Aug 4. doi: 10.1111/jon.13031. Epub ahead of print. PMID: 35924877.
2)
Sarwal A, Patel Y, D'Agostino R, Brown P, Wolfe SQ, Bushnell C, Glass C, Duncan P. Exploratory study to assess feasibility of intracerebral hemorrhage detection by point of care cranial ultrasound. Ultrasound J. 2022 Oct 17;14(1):40. doi: 10.1186/s13089-022-00289-z. PMID: 36251105.
3)
Zakharchenko S, Hansen A, Ibikunle A, Devasagayaraj R, Charles P. Intracranial hemorrhage detected through a craniotomy site with point of care ultrasound. J Am Coll Emerg Physicians Open. 2021 Jun 18;2(3):e12419. doi: 10.1002/emp2.12419. PMID: 34179872; PMCID: PMC8212560.