Pilot Study to Assess Factors That Affect Accuracy of B-Mode Cranial POCUS for ICH Diagnosis

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Abstract

Introduction: Point of Care Ultrasound (POCUS) has several clinical applications. We performed an exploratory study to assess factors that affect the accuracy of cranial POCUS B mode for diagnosis of ICH.
Methods: We enrolled 11 patients and acquired cranial Ultrasound B mode images. One investigator blinded to pathology performed the ultrasounds and images were reviewed by a blinded neuroradiologist and then compared to CT scans for elucidating B-mode pathology.
Results: The sensitivity and specificity point of care diagnosis of ICH was 100% and 50% respectively. Comparing ultrasound images with CT scan/MRI, false-positive ICH diagnosis was attributed to intracranial tumors and choroid calcifications.
Conclusion: Our exploratory analysis yielded preliminary data on the use of cranial ultrasound for ICH diagnosis but is limited by small numbers. A current ongoing trial is exploring the accuracy of cranial ultrasound compared to CT scan for possible field diagnosis of ICH.

Introduction

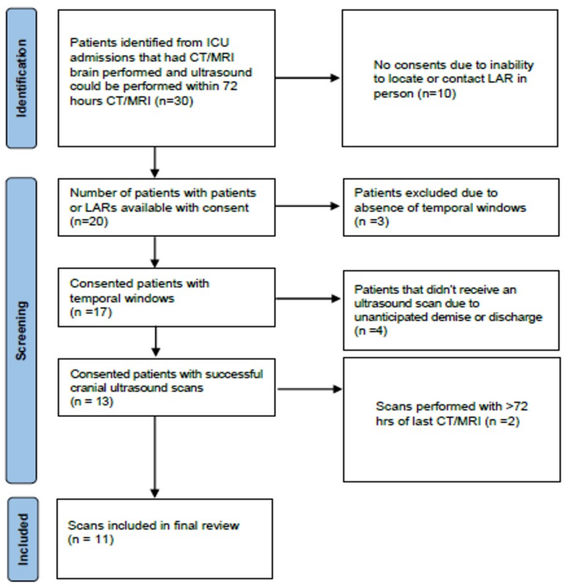
In this exploratory study, we looked for the feasibility of Intracerebral Hemorrhage (ICH) detection by using Point of Care Ultrasound Machines (POCUS).

On the ICH side, we are seeing an emerging need for early field diagnosis of ICH. A secondary goal was to map out optimal imaging techniques and brain topography that was likely to affect the sensitivity and specificity of ICH detection with POCUS.

Methods- Recruitment

We were able to consent 20 patients and scan 17 patients who had temporal windows. A 72-hour window was needed between ultrasound and CT scan in which we were able to fully include 11 patients

Table 1. Flow Diagram of Study Enrollment



Methods- POCUS

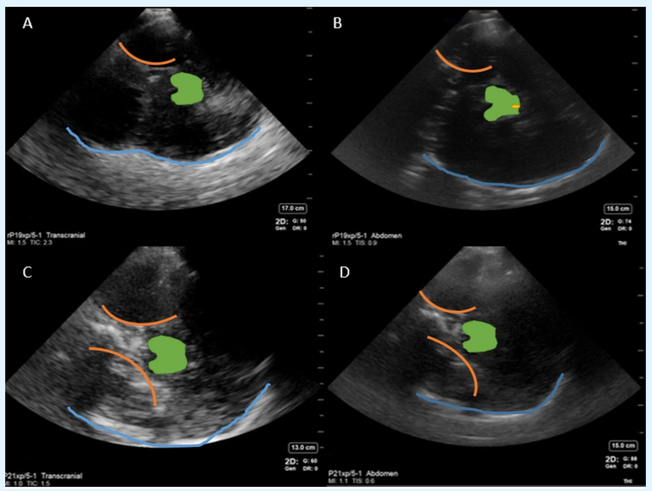
We used a point of care ultrasound machine with a 1–3 MHz phased array probe, the same probe used for echo, and used temporal windows in the skull, and the index marker pointed towards the patient's eyes and looked for cross-sections across the basal cistern level.

Results

The mean patient age was 57.45 years, and the mean time between CT and MRI scans was 3.3 hours. 7 patients presented with ICH, 3 patients had ischemic stroke, and 1 patient had a thalamic tumor. The sensitivity of this tool came out to be 100% for detection of ICH, but specificity was reported at 50% and accuracy was 81.82% for this study

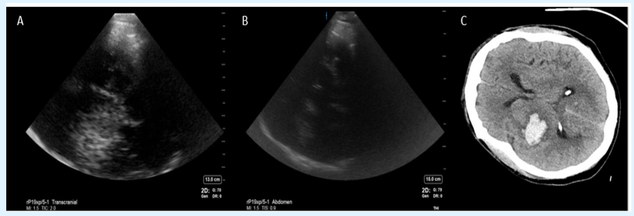
		Diagnosis by neuroimaging (head CT or MRI)		
		Condition positive (ICH present) 6 ICH 1 SAH with ICH	Condition negative (No ICH present) 4	
POCUS result outcome	Positive (ICH present)	True Positive 7	False Positive 2	Positive predictive value 77% =TP/(TP+FP)
	Negative (ICH not present)	False Negative 0	True Negative 2	Negative Predictive value 100% =TN(FN+TN)
		Sensitivity 100% =TP/ (TP+FN)	Specificity 50% =TN/(FP+TN)	

We were able to show the topography of the cranial ultrasound imaging on both the transcranial presets as well as the abdominal presets and show the opposite skull which is a landmark used for the presence of temporal windows. At certain times, we were able to identify the aqueduct and midbrain, along with the sphenoid wings on each side of the petrous portion being visible. In some patients, the falx cerebri and calcified choroid plexus were also visibly seen.

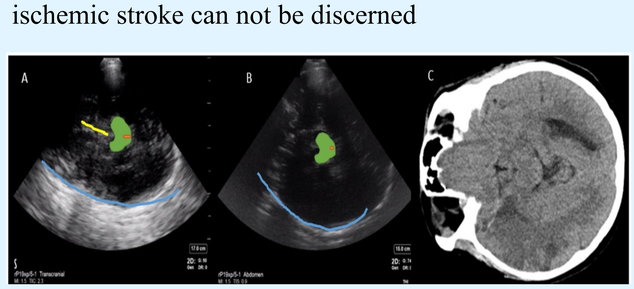


Discussion

The classical image where we saw ICH was seen as a hyperechoic signal and did not correlate to any known anatomical structures. The transcranial and abdominal presets of an intracranial hemorrhage are seen here in relation to a patient's CT scan.



Ischemic stroke could not be diagnosed as this is concordant with previously published studies. Here, this patient has the midbrain and falx cerebri present, but the ischemic stroke can not be discerned



Conclusion

In this pilot study, we had several limitations including the small sample size and the lack of reference material that made it difficult to train the investigator on cranial Pocus B mode imaging.

We used this study for sample size estimation for a future pilot study to assess sensitivity and specificity in which we anticipate using ~310 patients. In this study, we showed the potential feasibility of using cranial POCUS as a screening test method to identify presence of ICH and this can help us design further studies. We also elucidated imaging acquisition principles that can inform cranial B mode imaging in different presets, and we described these anatomical structures that create identifiable hyperechoic signals that can lead to false positivity.