TRANSCRANIAL ULTRASONOGRAPHY VERSUS COMPUTED TOMOGRAPHY IN ASSESSING BRAIN MIDLINE SHIFT AFTER HYPEROSMOLAR SOLUTIONS IN SEVERE TRAUMATIC BRAIN INJURY

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Introduction

Traumatic brain injury (TBI) presents a significant global health burden, with millions of new cases annually. It leads to major disability and considerable economic costs. TBI results from various external forces, including head impacts and acceleration-deceleration injuries. One serious complication is brain midline shift (MLS), often indicating increased intracranial pressure (ICP), which is associated with worse outcomes and higher mortality. Computed tomography (CT) is the gold standard for diagnosing MLS, but serial scans pose risks, particularly for critically ill patients. Transcranial ultrasonography (TCS), which uses ultrasound to measure MLS through the skull, is a safer, portable, and cost-effective alternative for real-time bedside monitoring of MLS in neurocritical care. However, the accuracy of TCS in comparison to CT is still under evaluation. The study compares these methods to determine the effectiveness of TCS in detecting MLS, particularly in TBI patients treated with hyperosmolar solutions to manage ICP

Aim of the Work

The aim of this work was to investigate the value of transcranial ultrasonography in assessment of brain midline shift in patient with severe traumatic brain injury receiving hyperosmolar solutions in comparison to CT brain.

Patients and Methods

The study included 40 patients admitted to the Critical Care Units of Alexandria Main University Hospital with severe traumatic brain injury (TBI) and brain midline shift (MLS). All patients had a Glasgow Coma Scale (GCS) score below 8 and were candidates for hyperosmolar therapy. Exclusion criteria included patients under 18 years, pregnant women, and those with brain tumors or decompres sivecraniectomy.

The study was a prospective observational comparative cohort. MLS was measured on admission and 48 hours later using both computed tomography (CT) and transcranial ultrasonography (TCS). The two CT measurement methods included the distance from the external bone table to the third ventricle, and from the ideal midline to the septum pellucidum. TCS was performed using a low-frequency ultrasound probe through the temporal bone window. Statistical analysis involved comparing MLS results from both modalities and assessing their diagnostic performance using sensitivity, specificity, and correlation with patient outcomes.

Results

Table 1: Comparison between MLS on admission and after 48 hours of using hyperosmolar solutions according to different parameters

	U/ S (mm)	CT (mm)	Wx	P
Admission				
Min.–Max.	2.8–11.5	2.75–11.5	0.281	0.084
Mean±SD	6.77±2.57	7.12±2.48		
Median	6.6	7.26		
After 48 hrs				
Min.–Max.	2–10.3	2.5–11.5	0.374	0.673
Mean±SD	6±2.65	6.8±2.68		
Median	5.67	6.3		

Wx, p: Wx and p values for wilcoxon signed ranks test
*: Statistically significant at $p \leq 0.05$

Table 2: Comparison between admission and after 48 hours of hyperosmolar therapy according to GCS

	Admission (n = 40)	After 48 hrs (n = 40)	T	P
GCS				
Min. – Max	3.0 – 8.0	4.0 – 11.0	20.060	<0.001*
Mean ± SD.	5.53 ± 1.72	6.56 ± 1.74		
Median	6	7		

t, p: t and p values for Paired t-test for comparing between the two periods
*Statistically significant at $p \leq 0.05$.

Conclusion

- The findings of this study confirm that transcranial ultrasonography (TCS) is an effective, non-invasive method for assessing brain midline shift (MLS) in patients with severe traumatic brain injury (TBI). When compared with computed tomography (CT), TCS demonstrated high sensitivity and specificity in detecting MLS, particularly at a cut-off value of 4mm. The results suggest that TCS can be reliably used alongside CT, offering significant benefits such as reduced radiation exposure and the convenience of bedside monitoring, especially in critical care settings where frequent evaluation of intracranial pressure (ICP) is crucial.
- Moreover, the study highlights that TCS can significantly reduce the need for repeated CT scans, minimizing the risks associated with patient transport in ICU settings. Early detection and intervention based on TCS findings can improve clinical outcomes by guiding the timely administration of hyperosmolar therapy to manage ICP. The incorporation of TCS into routine neurocritical care could enhance monitoring accuracy, reduce patient morbidity, and potentially lower mortality rates in TBI cases.