

TRANSCRANIAL DOPPLER VERSUS COMPUTED TOMOGRAPHY IN EVALUATION OF BRAIN EDEMA IN PATIENTS WITH TRAUMATIC BRAIN INJURY

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Introduction

Traumatic brain injury (TBI) is a major cause of morbidity and mortality worldwide, often complicated by cerebral edema and elevated intracranial pressure (ICP), which can worsen neurological outcomes. Early detection and monitoring of cerebral edema are critical for timely intervention. While computed tomography (CT) is the standard imaging modality, it is not always feasible for frequent monitoring. Transcranial Doppler (TCD) ultrasonography is a noninvasive, bedside technique that enables real-time assessment of cerebral blood flow dynamics. Parameters such as mean flow velocity (MFV) and pulsatility index (PI) have shown potential in reflecting intracranial pathophysiological changes.

Aim of the work

to compare between transcranial doppler derived indices and computed tomography in assessment of brain oedema in patients with traumatic brain injury before and after receiving hyperosmolar therapy.

Patients and Methods

This was an observational comparative prospective study that was done in Critical Care Department of Alexandria University Hospitals on 70 critically ill studied cases. Demographic information and detailed clinical history were obtained for all participants. Baseline laboratory evaluations, including complete blood count, serum electrolytes, blood urea nitrogen, and serum creatinine levels, were conducted to assess the patients' physiological status. The severity of cerebral edema was determined through computed tomography (CT) imaging, interpreted in accordance with validated radiological scoring systems. Transcranial Doppler ultrasonography was performed utilizing a low-frequency (2 MHz) probe applied via the temporal acoustic window. Intracranial pressure was estimated using a standardized formula derived from peak systolic and end-diastolic velocity measurements. All assessments were conducted at the time of hospital admission and repeated 72 hours following the initiation of hyperosmolar therapy.

Results

a clear inverse relationship was observed between CT cerebral edema scores and mean flow velocity, while positive associations were noted with pulsatility index and intracranial pressure. These correlations persisted following 72 hours of hyperosmolar therapy. Moreover, all three parameters—mean flow velocity, pulsatility index, and intracranial pressure—were effective in predicting improvements in cerebral edema on CT, demonstrating high diagnostic sensitivity with moderate specificity.

Table (1): Comparison between TCD parameters in patients who showed improvement and patients who didn't improve after 72 hours of hyperosmolar therapy" (n = 70)

	No improvement (n = 13)	Improvement (n = 57)	Test of Sig.	p
PSV(cm/s)			t= 4.946	<0.001*
Min. – Max.	80.0 – 100.0	66.0 – 125.0		
Mean ± SD.	85.62 ± 6.49	99.02 ± 15.29		
Median (IQR)	85.0 (80.0 – 85.0)	99.0 (87.0 – 110.0)		
EDV(cm/s)			U= 107.000	<0.001*
Min. – Max.	15.0 – 40.0	15.0 – 70.0		
Mean ± SD.	24.15 ± 8.63	42.70 ± 14.58		
Median (IQR)	20.0 (17.0 – 30.0)	45.0 (31.0 – 55.0)		
MFV(cm/s)			t= 6.075	<0.001*
Min. – Max.	36.67 – 60.0	36.67 – 86.67		
Mean ± SD.	44.64 ± 7.28	61.47 ± 14.32		
Median (IQR)	40.33 (39.67 – 50.0)	65.0 (49.67 – 71.67)		
CPP(mmHg)			t= 3.744	<0.001*
Min. – Max.	45.43 – 82.89	42.64 – 101.6		
Mean ± SD.	62.25 ± 13.27	77.05 ± 12.78		
Median (IQR)	65.20 (48.09 – 71.93)	80.27 (67.33 – 86.33)		
PI			t= 5.068	<0.001*
Min. – Max.	0.90 – 1.83	0.54 – 1.77		
Mean ± SD.	1.42 ± 0.32	0.97 ± 0.28		
Median (IQR)	1.50 (1.14 – 1.71)	0.93 (0.75 – 1.14)		
ICP(mmHg)			U= 91.500	<0.001*
Min. – Max.	15.0 – 41.47	3.07 – 36.0		
Mean ± SD.	28.26 ± 8.37	15.46 ± 7.40		
Median (IQR)	27.90 (21.40 – 35.24)	15.08 (10.17 – 19.33)		

Table (2): Prognostic performance for TCD parameters (MFV, PI, ICP) to predict improvement (n = 57) from non-improvement of CT cerebral edema score (n = 13)

	AUC	p	95% C.I	Cut off	Sensi tivity	Specifi city	PPV	NPV
MFV(cm/s)	0.833	<0.001*	0.730 – 0.937	>41.67	91.23	61.54	91.2	61.5
PI	0.856	<0.001*	0.750 – 0.962	≤1.23	84.21	69.23	92.3	50.0
ICP(mmHg)	0.877	<0.001*	0.775 – 0.978	≤25.83	89.47	61.54	91.1	57.1

Conclusion

Transcranial Doppler (TCD) is a reliable bedside tool for assessing cerebral edema in TBI patients, correlating well with CT findings. TCD parameters like mean flow velocity and pulsatility index are sensitive but less specific than CT in detecting post-hyperosmolar therapy improvement.