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OPTIC NERVE SHEATH DIAMETER IN PREDICTING THE OUTCOME OF PATIENTS WITH TRAUMATIC BRAIN INJURY

Neurosurgery

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ABSTRACT

Optic nerve sheath diameter measured by using ultrasound and its correlation with midline shift and outcome are independent predictors in patients with traumatic brain injury. Patients who satisfy the inclusion criteria were subjected to CT scan at admission, immediately after surgery and at discharge. With each CT scan, the corresponding optic nerve sheath diameter is measured 3mm behind the eye ball bilaterally and the mean value calculated using ultrasound.44 patients were included. On admission there were 47.7% abnormal ONSD measurements, and 52.3 % normal ONSD measurements taking cut off of ONSD as 4.5mm as normal. There was reduction in ONSD after surgery , the percentage reduction being from 47.7% to 26.7% after surgery and from 26.7% to 11.9% at the time of discharge. Higher ONSD was observed in patients with moderate and severe brain injury. ONSD showed a direct relationship with CT findings measured in terms of midline shift and inverse relationship with outcome. ONSD could serve as an initial tool in predicting the outcome of patients with raised intracranial tension.

KEYWORDS

ONSD, Ultrasound, midline shift, traumatic brain injury, intracranial tension.

INTRODUCTION:

Traumatic brain injury is the leading cause of morbidity and mortality in India and other developing countries. Road traffic accidents are the leading cause- 60% of traumatic brain injury followed by falls 20-25% and violence 10%[1][2][3]

Intracranial pressure monitoring is a standard tool to make therapeutic decisions in neurointensive care units[4]. The first advent in intracranial pressure monitoring was done by Lundberg[5]. There are both invasive and non invasive methods for intracranial pressure monitoring. The invasive methods include intraventricular catheter, EVD, intraparenchymal probes and subarachnoid bolts. The gold standard being intraventricular monitoring [6].The various non invasive methods include transcranial Doppler ultrasound, MRI,CT,ONSD,tympanic membrane displacement[7].

As an extension of central nervous system, the optic nerve is surrounded by subarachnoid membrane and cerebrospinal fluid .increasing CSF pressure results in increased ONSD. Multiple studies have demonstrated that ONSD correlates with ICP using ultrasound in neurosurgical patients[8] . ONSD measurements using ultrasound are reliable and readily taught to new operators, although it requires technical expertise. Multiple studies have also correlated the measurement of ONSD in relation to midline shifts in CTscan[9]

This study aimed to predict the outcome of patients with traumatic brain injury using ONSD measurements and its correlation with outcome.

MATERIALS AND METHODS:

The study was conducted on all patients with midline shifts and all patients with GCS less than or equal to 12 with or without midline shift. Patients with GCS above 12 were excluded from the study. The study was conducted for a 6 month period from January to June 2018. In all the patients who satisfied the inclusion criteria detailed history taking and examination was done. The patients were subjected to CT scan at admission, immediately after surgery if subjected for surgery and at the time of discharge. The corresponding optic nerve sheath diameter was measured and the results were correlated with GCS score and midline shift[10].

MEASUREMENT OF ONSD:

The ONSD was measured by an ophthalmic ultrasound with a frequency range between 5 and 10.5 MHz. The ONSD was measured exactly 3mm behind the posterior limit of the eyeball bilaterally and the mean ONSD was calculated

Fig 1

ANALYSIS:

The collected data were analysed with IBM.SPSS statistics software 23.0 version. To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & Standard Deviation were used for continuous variables. To find the significant difference between the bivariate samples in independent groups the unpaired sample t-test was used. In the above statistical tool the probability value .05 is considered as significant level.

RESULTS:

44 patients who fulfilled the inclusion criteria were included in the study. The majority of patients were male 37- 84.1%. Mean age was 41.52 years[Table 1]. The most common cause of head injury was road traffic accident followed by fall from height and assault.

Table 1

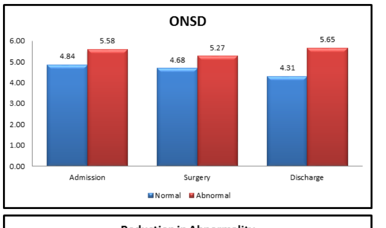
	N	Minimum	Maximum	Mean	Std. Deviation
AGE	44	9	80	41.52	15.710
	44				

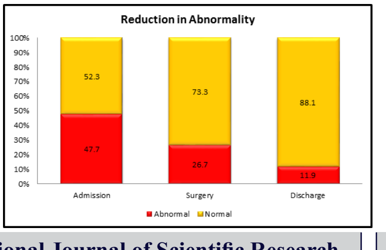
Table 2

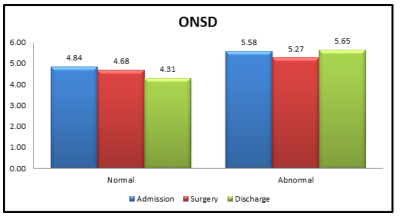
SEX	Frequency	Percent
F	7	15.9
M	37	84.1
Total	44	100.0

On admission there were 47.7% abnormal ONSD measurements, and 52.3 % normal ONSD measurements taking cut off of ONSD as 4.5mm as normal[Graph 3]. There was reduction in ONSD after surgery, the percentage reduction being from 47.7% to 26.7% after surgery and from 26.7% to 11.9% at the time of discharge [Graph 1,2,3] and the results were found to be significant p value 0.001. [Table4,6 and 8]

GRAPH 1,2







GRAPH 3

The mean ONSD on admission, after surgery and after discharge were calculated and the results correlated with outcome GCS score and midline shift. The bar diagram highlights the correlation of ONSD with the outcome.[Graph 3][table3]

Table 3 T-Test

Group Statistics					
OutcomeA		N	Mean	Std. Deviation	Std. Error Mean
ADMISSION	Normal	23	4.8435	.17471	.03643
	One or Both Abnormal	21	5.5810	.47657	.10400

Table 4 Samples Test

Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ADMISSION	Equal variances not assumed			-6.693	24.869	.001	-.73747	.11019	-.64480	-.51047

Table 5 T-Test

Group Statistics					
OutcomeS		N	Mean	Std. Deviation	Std. Error Mean
SURGERY	Normal	22	4.6773	.30540	.06511
	One or Both Abnormal	8	5.2688	.39182	.13853

Table 6

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
SURGERY	Equal variances assumed	1.334	.258	-4.353	28	.001	-.59148	.13589	-.86983	-.31312

Table 7 T-Test

Group Statistics					
	OutcomeD	N	Mean	Std. Deviation	Std. Error Mean
DISCHARGE	Normal	37	4.3054	.29245	.04808
	One or Both Abnormal	5	5.6500	.18708	.08367

Table 8 Independent Samples Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
DISCHARGE	Equal variances assumed	.462	.501	-9.948	40	.001	-1.34459	.13516	-1.61777	-1.07142

DISCUSSION:

ONSD measurement using ultrasound is an independent predictor of outcome in patients with traumatic brain injury. There are several studies which correlated ONSD with CT findings and GCS score. In this study the cutoff of ONSD was 4.5 mm. All patients with ONSD above or equal to 4.5 mm were considered abnormal. The higher the ONSD the lesser the GCS score and there was midline shift. As the ONSD was normalizing the GCS was improving and there was reduction in the midline shift.

Cranial CT findings of shift, edema or effacement suggestive of elevated ICP were used to evaluate ONSD accuracy. In the recent studies, ONSD was correlated with clinical symptoms and CT abnormalities [10]. Auduayi et al demonstrated a good reliability of optic nerve ultrasound in predicting raised ICP [11].A recent systematic review and meta analysis has confirmed that ocular ultrasound exhibits good diagnostic accuracy for detecting raised ICP than CT[12].

ONSD measured using ultrasound was used in critical care units to estimate the fluctuations in ICP and its usefulness was validated in several studies , including a meta analysis[13]. Karakitsos et al looked at ocular sonography in patients with severe head injury[14].

Even though the major limitation of ONSD in clinical practice is lack of specificity, the high sensitivity it offered as a rapid predictor for changes in ICP has made it a good diagnostic tool for not only tailoring the management of patients but also in prognostication in both emergency department as well as in critical care set up[15].

Several studies have examined variables affecting the accuracy of ultrasound in measuring ONSD. ultrasound is subject to artifacts, and measuring the ONSD in off axis may result in erroneous value. Romagnuolo et al showed that the ONSD does not change with patient position [16]. Interobserver variation is quite low , and the measurements are highly reproducible , even for novice operators taught in a single training session[17].

CONCLUSION:

ONSD is a reliable indicator of intracranial pressure tat can be easily done a neurosurgeon at the bedside and help therapeutic decisions and repeated measurements can be done to keep a watch on trends in ICP. A cut off of 4.5 mm precisely indicates raised intracranial pressure and can be used to plan further intervention when ICP monitoring is unavailable or contraindicated.

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