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Original Research Article

Bedside Ultrasonographic Measurement of Optic Nerve Sheath Diameter In Acute Haemorrhagic Stroke Patients

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Conflict of interest: Nil

Abstract:

Objective: The aim of this study was to measure the optic nerve sheath diameter using Ultrasonography (US) in acute hemorrhagic stroke patients, as a surrogate for detecting raised intracranial pressure.

Patients and Methods: This prospective observational study was undertaken from July 2020 to May 2021 in Radiology Department of IQ City Medical College, Durgapur, West Bengal.
ONSD was measured 0.3cm from the posterior aspect of the globe by US.

Result: A total of 48 patients have been studied. ONSD on Ultrasound shows a moderate positive correlation with midline shift and haemorrhagic volume in patients with acute haemorrhagic stroke.
From the Pearson's correlation results, we conclude that there exists a moderate positive correlation in between US ONSD with midline shift and US ONSD with haemorrhagic volume, r=0.67 and r=0.62 were respectively.
Consider the level of significance at 95% such that $p < 0.05$.

Conclusion: ONSD measured using Ultrasound shows moderate positive correlation with features of increased intracranial pressure in patients with acute haemorrhagic stroke.

Keywords: ONSD, CT, US, Optic Nerve Sheath Diameter, Computed Tomography scan, Ultrasound.

Introduction

Urgent diagnosis of patients presenting with features of increased intracranial pressure (ICP) is needed for better prognosis. Although there are invasive surgical procedures like ICP monitor probe which are inserted into the brain parenchyma or into the ventricles, they are related with complications such as infection, haemorrhage or catheter malfunction. Complications can be seen in 6-32% of the cases [1,2].

The feasibility of using ultrasonography to measure optic nerve sheath diameter (ONSD) to detect increased ICP is increasingly being reported [3-5]. ONSD measurement by ultrasound can reflect increase in ICP before the appearance of papilledema on fundus examination. The optic nerve sheath attaches to the globe on the posterior aspect. The optic nerve sheath is contiguous with the dura mater and has an arachnoid space in which cerebrospinal fluid percolates [6].

With increase in ICP, there is swelling of the optic nerve sheath space and can be appreciated on ultrasound. Wide variation is reported in the optimal cut-off values, when ONSD was compared with invasive ICP monitoring, ranging from 4.8 to 5.9 mm [7,8].

Through this study we intend to measure the optic nerve sheath diameter in acute hemorrhagic stroke patients, as a surrogate for detecting raised intracranial pressure.

Materials and Methods

Study design and subjects

This prospective observational study was undertaken from July 2020 to May 2021 in Radiology Department of IQ City Medical College and Hospital, Durgapur, West Bengal.

The ethics committee reviewed and approved the study protocol, and remitted the need for individual informed consent because of the non-interventional nature.

Table 1: Demographic Parameters

Demographic Parameters	
Name	
Age	
Sex	

Table 2: Clinical Parameters

Clinical Parameters	
SBP	
DBP	
GCS	

Table 3: CT Parameters

CT Parameters	
Hematoma Volume	
Infratentorial Location	
Intraventricular Extension	
Midline Shift	

Table 4: USG Parameters

USG Parameters	
ONSD (Right eye)	
ONSD (Left eye)	

Inclusion Criteria

Patients aged above 18 years with acute haemorrhagic stroke.

Exclusion Criteria

- Traumatic brain injury
- Brain SOL
- Meningoencephalitis.
- Hepatic, Uremic and other metabolic encephalopathy
- Hydrocephalus
- Pre-exiting ocular disease affecting the optic nerve and or orbital cavity
- Hyperthyroidism with exophthalmos

Duration of Study

July 2020 to May 2021 (11 months)

Study Variable

Outcome Variables

Optic nerve sheath diameter (ONSD) measured using ultrasonography (US)

Other Variables

Age-
Sex-
Comorbidities -
Haemorrhagic volume-
Midline shift-

Study Tools

The Ultrasound machine used in our study is Wipro GE Voluson S8BT18. The CT Machine is Philips Ingenuity 128.

Study Methods

Sample Size

Based on the Confidence Interval formula for sample size calculation, the researcher in the present study justified that 48 samples are adequate to generalize the result.

The formula is

$$n = z_{\alpha}^2(p \times q)] / d2$$

n = Sample size
z_{α}= Level of confidence Interval At 95% Level of Significance is 1.96: it is Standard Deviation score for 95% set interval
p = assumed or estimated prevalence rate in West Bengal,
q = 1 – p
d = Confidence Interval, that is 10% (0.1) which is allowable error
So n = 48 Study participants.

Data Collection

After informed consent by each patient, GCS was assessed and the ONSD by ultrasonography (US) was determined within 24 hours of admission. ONSD is to be determined with a 7.5-MHz linear probe and US device. US examination for measurements of ONSD is to be implemented with the closed-eye method. The linear probe with gel is to be applied either within the protective cover or directly onto the closed eye. The

eyeball is then to be viewed in the sagittal and axial planes. Following the determination of the ONS through US imaging, the ONSD measurements are to be taken 0.3 cm posterior from the globe. Each optic nerve is to be measured three times and the mean number is to be recorded. The arithmetic mean values of right and left ONSDs are to be entered in the analysis.

Optic nerve sheath diameter shall be considered normal if it is 5mm or less and increased if it was more than 5mm [9].

Patients were screened using our departmental 128 slice thickness Phillips CT scan machine. The scan extent was done caudo-cranial from C2 to vertex with slice thickness of <1mm. The tube voltage was 120 kVp, mAs was 375 and scan time was 6-7 seconds. The CT Dose Index for the study was 48-90 mGy. Informed consent was taken from all patients before performing CT scan.

Result

This study was a prospective observational study done on patients older than 18 years old, with acute (less than 48 h) presentations of stroke referring.

This study was conducted in 2020 (for 11 months) in IQ City Medical College, a tertiary referral center of West Bengal. The ethics committee of the institute then approved the study. From the Pearson's correlation results, we conclude that there exists a moderate positive correlation in between US ONSD with Midline shift and US ONSD with hemorrhagic volume, r=0.67 and r=0.62 were respectively.

Consider the level of significance at 95% such that p <0.05.

Baseline and clinical characteristics of patients (N= 48)

Table 5:

Variable		Number	Percentage	
Gender	Male	26	54	
	Female	22	46	
Age	Mean± SD	56.36±1.59		
Hematoma Volume	Mean±SD	88±5.42		
USG Parameters				
ONSD (Right)	Mean±SD	6.42±1.57		
ONSD (Left)	Mean±SD	6.87±1.17		

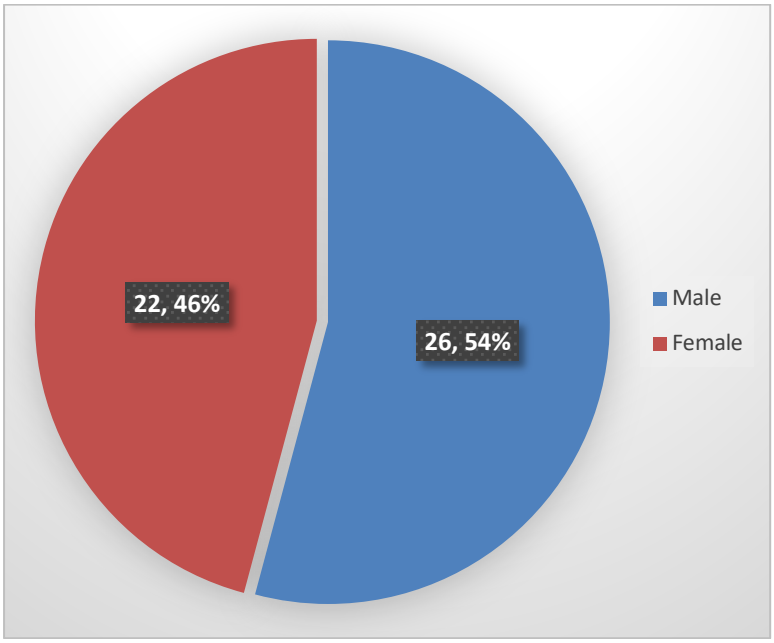

Figure 1:

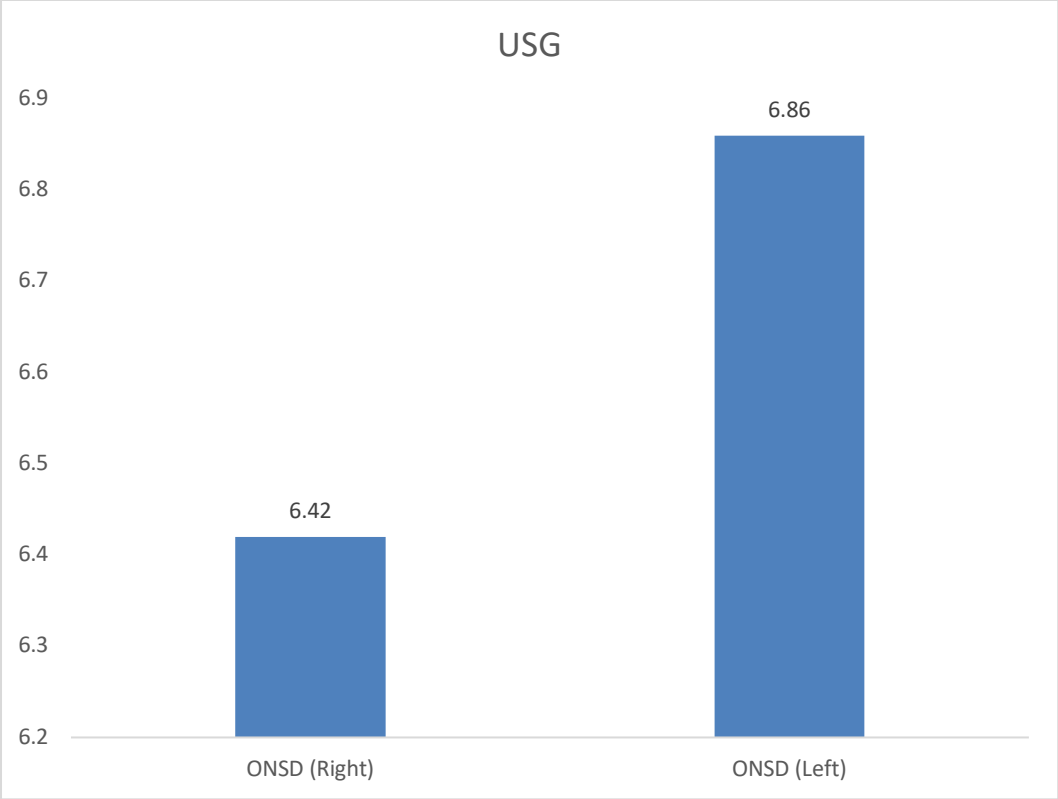

Figure 2: USG

Table 6:

Correlation	R value	Remarks
ONSD on US with hemorrhagic volume	0.62	Moderate Positive correlation
ONSD on US with midline shift	0.67	Moderate Positive correlation
ONSD with hemorrhagic volume and midline shift	0.621	Moderate Positive correlation

Table 7:

Parametric Test			
Statistical Test	Chi- Square value, DF	P value	Non-Significant
ONSD with hemorrhagic volume and midline shift	1.526, 47	2.361	

Consider at 95% level of significance, such that P<0.05

Finding

From the above table it is clear that, ONSD Ultrasound shows strong correlation with features of increased intracranial tension in patient with haemorrhagic stroke.

Figure 3: shows right sided thalamo-capsulo-ganglionic bleed with intraventricular and subarachnoid extension.

Figure 4: shows CT calculation of hematoma volume.

Figure 5: shows measurement of ONSD on US 3mm behind the globe.

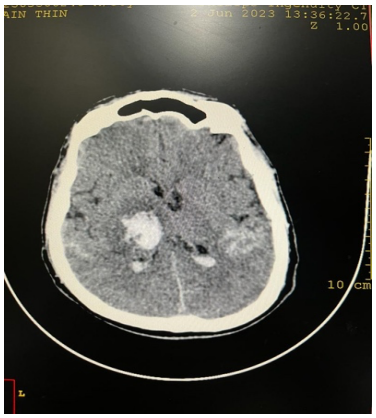

Figure 3:

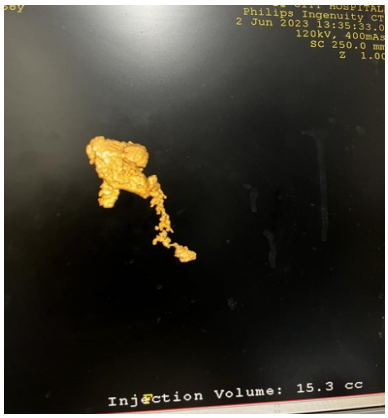

Figure 4:

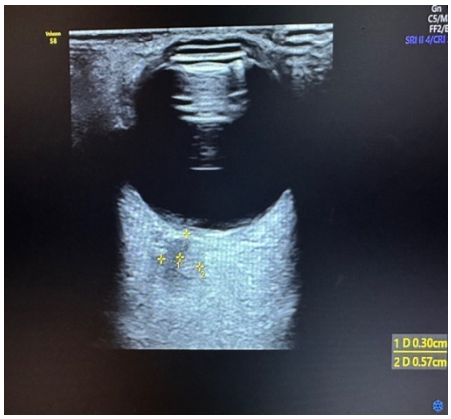

Figure 5:

Discussion

ONSD measurement on ultrasonography showed a good correlation with directly measured ICP using an External Ventricular Drain (EVD) catheter. For identifying raised ICP, the optimal cut-off point for ONSD was 5.6 mm with a sensitivity and specificity of 93.75% and 86.67% respectively.

Tests like Transcranial Doppler (TCD), Tympanic Membrane Displacement (TMD), and US which are non-invasive in nature, have been used to detect increased ICP[10-12] but unlike ultrasonography, the formerly mentioned tests require special equipment and are operator dependent with high percentage of unsuccessful measurements and are hence inadequate in urgent situations in ER or ICU. Ultrasonographic measurement of ONSD on the other hand is reproducible and is an easily learned procedure for physicians with little or no experience with ultrasonography [13-14].

Since optic nerve sheath is connected with the meninges, CSF can move freely between the intracranial and intraorbital subarachnoid spaces. Hence, patients suffering from intracranial haemorrhage or masses can experience an increase of ONSD due to CSF accumulation.

Amini and colleagues [15-16] used a descriptive prospective study to compare 50 non-trauma patients, who were candidates for lumbar puncture. Sonography was performed; immediately after, the lumbar puncture was initiated.Correlation tests were used, and the value of 20 cm H2O was set to define elevated ICP. In patients with ICP less than 20 cm H2O, the mean ONSD was 4.60 mm. Those with elevated ICPs had a mean ONSD of 6.60 mm.

The study concluded that ONSD greater than 5.50mm correlated with signs of raised ICP on CT scan.The researchers found that ONSD is a strong predictor of increased ICP, and ultrasound may be considered highly useful as a screening tool so that prompt therapeutic interventions can be instituted due to its availability, fast application, and high sensitivity.

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