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OPTIC NERVE SHEATH DIAMETER AS A TRIAGE TOOL IN PREDICTING RAISED INTRACRANIAL TENSION AND SEVERITY OF TRAUMATIC BRAIN INJURY.

Radio-Diagnosis

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ABSTRACT

Aims and Objectives

- To correlate increase in optic nerve sheath diameter and optic nerve sheath diameter/eyeball transverse diameter ratio with clinical Glasgow coma scale in traumatic brain injury.
- To correlate the relationship optic nerve sheath diameter and optic nerve sheath diameter /eyeball transverse diameter ratio with Rotterdam and Helsinki computed tomography scoring systems in traumatic brain injury.

Method and Materials: A prospective study comprised of 100 adult patients who underwent CT brain within 24 hours for assessment of traumatic brain injury at M. S. Ramaiah hospital, Bengaluru. Demographic details and relevant clinical data of the patients was documented. The ONSD and eyeball transverse diameters was measured on both sides using electronic callipers. The ONSD and ONSD / ETD ratio was correlated with GCS, Rotterdam and Helsinki CT severity scores.

Results

- In our study a total of 100 patients underwent non enhanced CT brain within 24 hours of traumatic event suspected for traumatic brain injury.
- The mean age of the subjects was 39.97+ 12.76 years with males accounting for 70% of the cases.
- The ONSD and ONSD / ETD ratio was calculated using the electronic calipers and severity scores calculated scoring their respective components.
- In our study the mean ONSD on the right and left side was 5.59 and 5.58 mm respectively and the mean ONSD / ETD ratio was 0.22 on either side. There was statistically significant correlation between the ONSD and ONSD / ETD ratio with Glasgow coma scale, Rotterdam and Helsinki CT severity scores. The study showed that ONSD and ONSD / ETD ratio can be reliably used as non-invasive parameters in prediction of raised intracranial tension on the initial CT scan of brain following a traumatic event.

Conclusion

- Optic nerve sheath diameter and Optic nerve sheath diameter / Eyeball transverse diameter Ratios should be documented in every report of the initial CT scan of brain with suspicion of traumatic brain injury.
- These ratios serve as important radiological tools in the assessment of the severity of the traumatic brain injury and in prediction of the intracranial pressure and thereby aid in appropriate timely interventions and thus help reduce the mortality associated with the raised intracranial pressure.

KEYWORDS

INTRODUCTION

Traumatic brain injury (TBI) is one of the most important causes of morbidity and mortality. High intracranial pressure, which is the pathophysiology in traumatic brain injury suggests poor prognosis. The gold standard for intracranial pressure (ICP) monitoring are the invasive methods such as external ventricular drainage, intra ventricular catheter and micro transducer devices that provide quantitative readings expressed in millimeters of mercury which are not used for initial assessment have risk of intra cerebral hemorrhage and infection. Raised intracranial pressure can also be predicted using various noninvasive techniques such as transcranial Doppler, tympanic membrane displacement and examination of the optic nerve. Optic nerve sheath is continuous with duramater, its contents and with the subarachnoid space. In the anterior part of the optic nerve, the sheath is distensible and can expand in response to raised cerebrospinal fluid pressure leading to increase in optic nerve sheath diameter (ONSD). Upon admission to the hospital, the severity of TBI is graded according to the Glasgow Coma Scale (GCS), a measure of level of consciousness. Computed tomography (CT) being the first imaging modality of choice in TBI not only helps in screening intracranial injuries but also in prognostication. The ONSD and optic nerve sheath diameter/eyeball transverse diameter ratio (ONSD/ETD ratio) readings can be obtained from the same CT images that were used to assess the head injury without the need for any additional imaging. Measuring ONSD and ONSD/ETD ratio and their utilization as a triage tool in diagnosing raised ICP and in predicting severity of TBI. Measuring ONSD can help identify patients who need early referral and treatment to prevent secondary brain injury. The present study aims to establish ONSD as a reliable tool to predict raised intracranial pressure and mortality in traumatic brain injury patients [1].

AIMS AND OBJECTIVES

1. To correlate increase in optic nerve sheath diameter and optic nerve sheath diameter/eyeball transverse diameter ratio with clinical Glasgow coma scale in traumatic brain injury.
2. To correlate the relationship optic nerve sheath diameter and optic nerve sheath diameter /eyeball transverse diameter ratio with Rotterdam and Helsinki computed tomography scoring systems in traumatic brain injury.

MATERIALS AND METHODS

- **Source Of Data:** The study was conducted in the department of Radio diagnosis at M. S. Ramaiah Hospitals, Bengaluru who were referred to the department for non-enhanced CT Brain with head trauma within 24 hours of the traumatic injury.
- **Study Design:** Prospective analytical observational study.
- **Sample Size:** 40

- **Inclusion Criteria**

Patients above 18 years of age who undergo nonenhanced CT brain at M. S. Ramaiah Hospitals, Bengaluru within 24 hours of head injury.

- **Exclusion Criteria**

1. Pre-existing intracranial space occupying lesions.
2. Significant prior brain injury from trauma, infarction or surgery.
3. Prior orbital, ocular or optic nerve disease or surgery.
4. Periorbital trauma at the time of presentation which influences the reliability of optic nerve sheath or ocular diameter measurements.

Methods Of Data Collection

Patients undergoing nonenhanced CT brain for head injury in the department of Radio diagnosis at M. S. Ramaiah Hospital, Bengaluru.

Statistical Analysis

Descriptive statistics of ONSD, RCTS and Helsinki CT score will be analyzed and summarized in terms of mean with standard deviation. Pearson's correlation coefficient would be used to find the correlation between mean ONSD and RCTS and Helsinki CT scoring.

Study Method

Data was collected from all the patients with TBI undergoing non enhanced CT Brain for assessment of traumatic brain injury at M.S. Ramaiah Hospitals. The study was be carried out on patients based on inclusion and exclusion criteria mentioned above. The purpose of the study will be explained to the subjects / attendant and informed consent will be obtained. Demographic details and relevant clinical data of the subjects was documented.

Non enhanced CT Brain was performed using Siemens Somatom Perspective 128 slice CT scanner or Hitachi Supria 32 slice CT scanner.

Patients with head trauma at M.S. Ramaiah hospitals. Glasgow coma scale (GCS) was assessed at the time of admission.

Computed tomography (CT) being the first imaging modality of choice in TBI was performed as a part of standard of care to assess for intracranial injuries. The ONSD measurements in millimetres (mm) was obtained 3 mm behind the posterior limit of eyeballs on 1 mm thick slices using electronic callipers from one side of the optic nerve sheath to the other side in both axial and sagittal planes from the CT images.

Similarly eyeball transverse diameter (ETD) measurements was taken from one side of the eyeball to the other side using electronic callipers.

ONSD/ ETD ratio was calculated. CT severity scores was calculated according to the Rotterdam and Helsinki CT severity scoring system. The ONSD and ONSD/ETD ratio calculated on the CT was correlated with Glasgow coma scale, Rotterdam CT scoring and Helsinki CT scoring.

Glasgow Coma Scale

Eye opening response	Spontaneous - 4; To verbal stimuli - 3; To pain only – 2; No response - 1
Verbal Response	Oriented – 5; Confused conversation – 4; Inappropriate words – 3; Incomprehensible speech – 2; No response – 1;
Motor Response	Obeys commands – 6; Purposeful movement to painful stimulus - 5; Withdraws in response to pain – 4; Flexion in response to pain – 3; Extension response in response to pain – 2; No response -1
Total score	Sum (Range 1 to 15)

Rotterdam CT Severity Score

Basal Cisterns	0 – Normal; 1 – Compressed; 2 – Obliterated
Midline shift	0 – No shift or less than 5 mm; 1 – Shift more than 5 mm
Epidural mass lesion	0 – Present; 1 – Absent
Intraventricular blood or t SAH	0 – Absent; 1 – Present
Total Score	Sum + 1 (Range 1-6)

Helsinki CT Severity Score

Mass lesion type	2: Subdural hematoma; 2: Intracerebral hematoma; -3: Epidural hematoma
Mass lesion size	2: Hematoma volume > 25cm3
Intraventricular hemorrhage	3: Present
Basal cisterns	0: Normal; 1: Compressed; 5: Obliterated
Total Score	Sum (Range: -3 to 14)

Hitachi Supria 32 Slice CT Scanner And Siemens Somatom 128 Slice CT Scanner Used In The Study.

RESULTS

Statistical Analysis

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Normality of the continuous data, was tested by Kolmogorov–Smirnov test and the Shapiro–Wilk test.

p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

RESULTS

Table1: Age Distribution Of Subjects

		Count	%
Age	18 to 20 years	6	6.0%
	21 to 30 years	19	19.0%
	31 to 40 years	28	28.0%
	41 to 50 years	28	28.0%
	51 to 60 years	14	14.0%
	>60 years	5	5.0%
	Total	100	100.0%

Mean age of subjects was 39.97 ± 12.76 years.

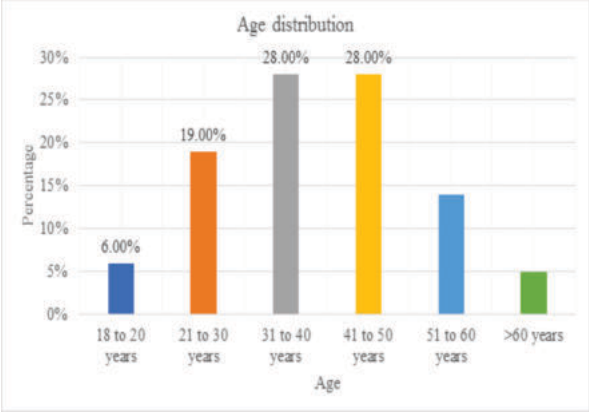


Figure1: Bar Diagram Showing Age Distribution Of Subjects

Table2: Sex Distribution Of Subjects

		Count	%
Sex	Female	30	30.0%
	Male	70	70.0%
	Total	100	100.0%

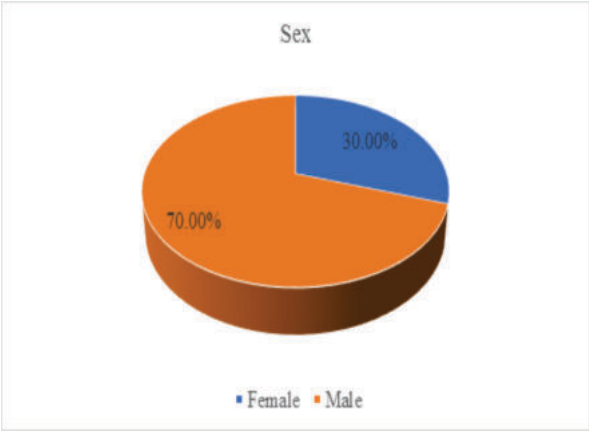


Figure2: Pie Diagram Showing Sex Distribution Of Subjects

Table3: Severity Distribution Of Subjects

		Count	%
Severity	Mild	41	41.0%
	Moderate	34	34.0%
	Severe	25	25.0%
	Total	100	100.0%

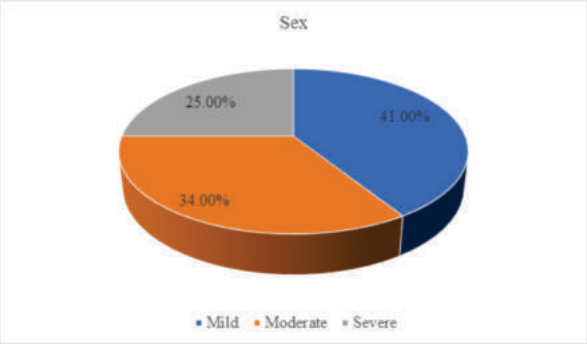


Figure3: Pie Diagram Showing Severity Distribution Of Subjects

Table4:ONSD and ONSD/ETD Ratio

	Mean	SD	Median
Right Mean ONSD	5.59	0.57	5.83
Right ONSD/ETD Ratio	0.22	0.02	0.23
Left Mean ONSD	5.58	0.58	5.82
Left ONSD/ETD Ratio	0.22	0.02	0.23

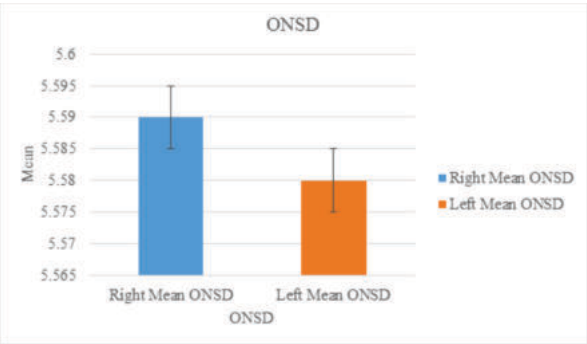


Figure 4: Bar Diagram Showing Mean OSND On Right And Left Side

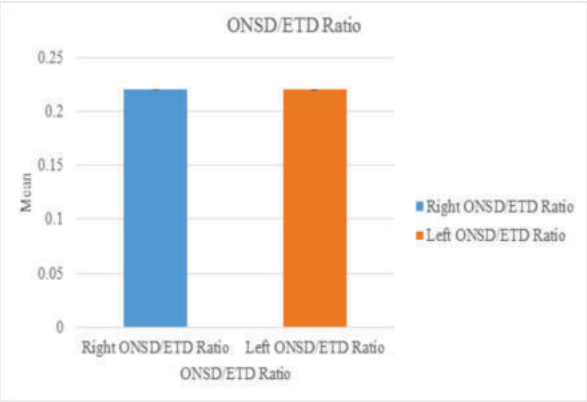


Figure5: Bar Diagram Showing Mean OSND/ETD Ratio On Right And Left Side

Table 5: Correlation Between ONSD and GCS, RCTS Score And Helsinki CT Score

		Mean ONSD
Right Mean ONSD	Pearson Correlation (r)	1
	P value	
	N	100
GCS	Pearson Correlation (r)	-0.875**
	P value	<0.001*
	N	100
RCTS Score	Pearson Correlation (r)	0.772**
	P value	<0.001*
	N	100
Helsinki CT Score	Pearson Correlation (r)	0.888**
	P value	<0.001*
	N	100
**. Correlation is significant at the 0.01 level (2-tailed).		

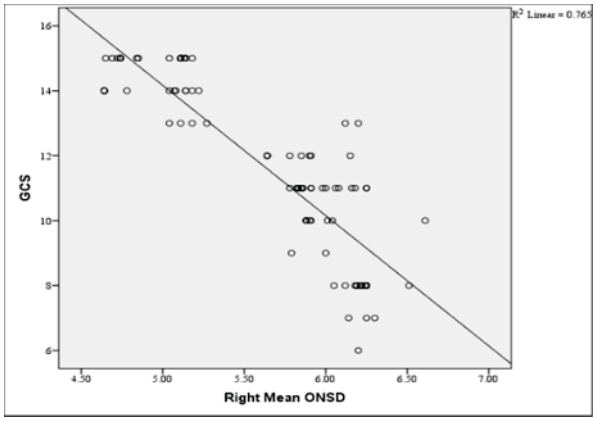


Figure 6: Scatter Plot Showing Negative Correlation Between Mean ONSD and GCS

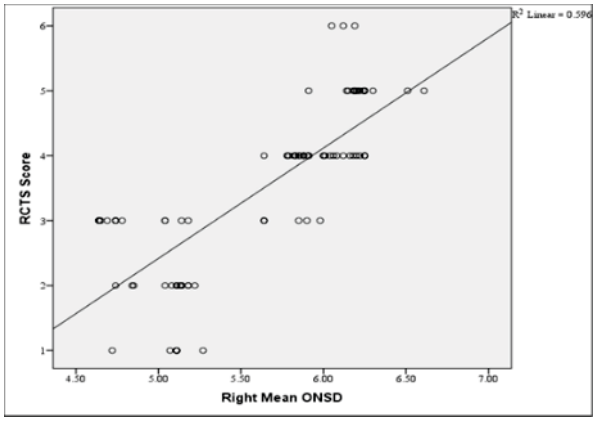


Figure7: Scatter Plot Showing Positive Correlation Between Mean ONSD and RCTS Score

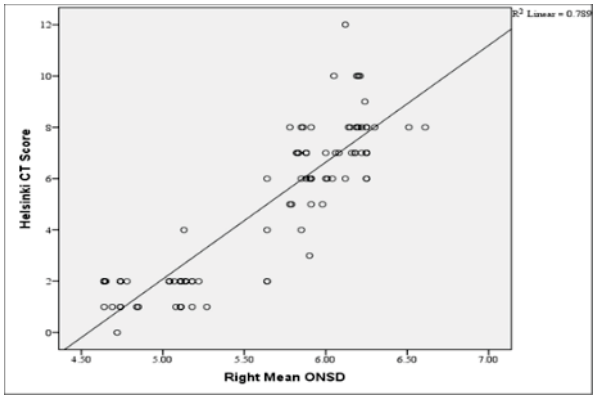


Figure8: Scatter Plot Showing Positive Correlation Between Mean ONSD and Helsinki CT Score

Table 6: Correlation Between ONSD/ETD ratio and GCS, RCTS Score and Helsinki CT Score

		Right ONSD/ETD Ratio
Right ONSD/ETD Ratio	Pearson Correlation (r)	1
	P value	
	N	100
GCS	Pearson Correlation (r)	-0.870**
	P value	<0.001*
	N	100
RCTS Score	Pearson Correlation (r)	0.790**
	P value	<0.001*
	N	100
Helsinki CT Score	Pearson Correlation (r)	0.882**
	P value	<0.001*
	N	100
**. Correlation is significant at the 0.01 level (2-tailed).		

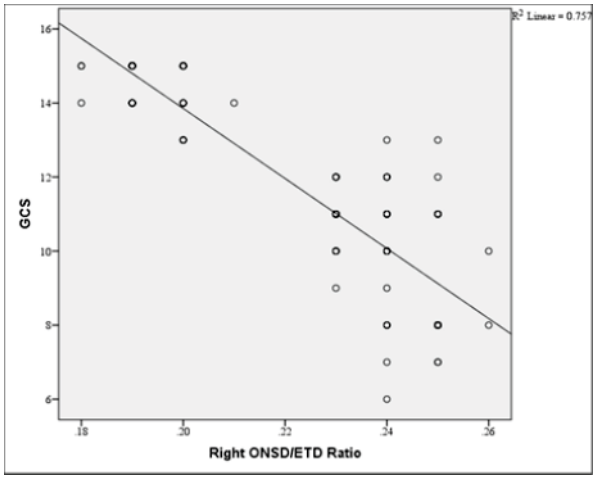


Figure 9: Scatter Plot Showing Negative Correlation Between Mean ONSD/ETD ratio and GCS

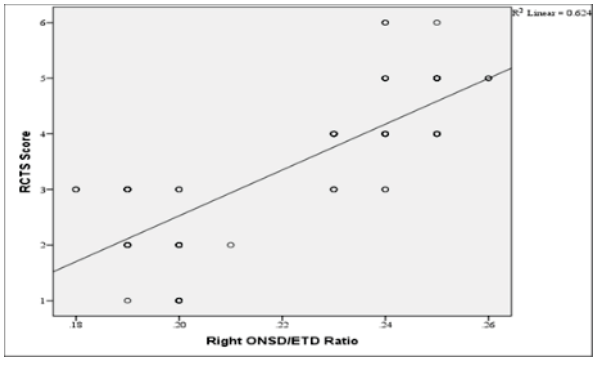


Figure 10: Scatter Plot Showing Positive Correlation Between Mean ONSD/ETD ratio and RCTS Score

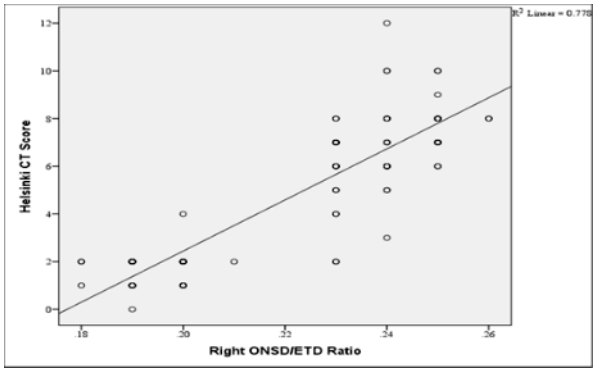
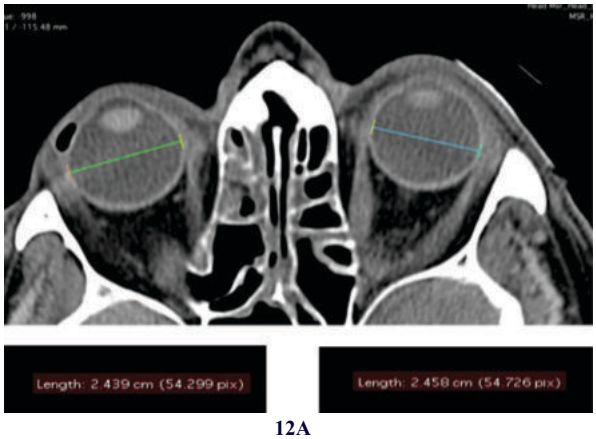


Figure 11: Scatter Plot Showing Positive Correlation Between Mean ONSD/ETD ratio and Helsinki CT Score

REPRESENTATIVE CASE



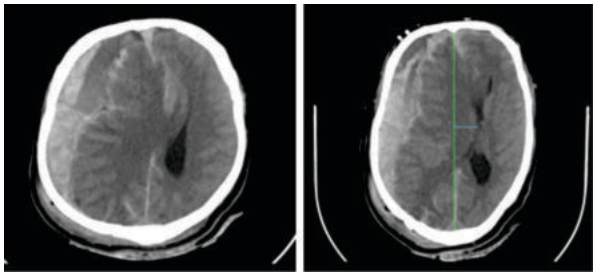
12A

12B

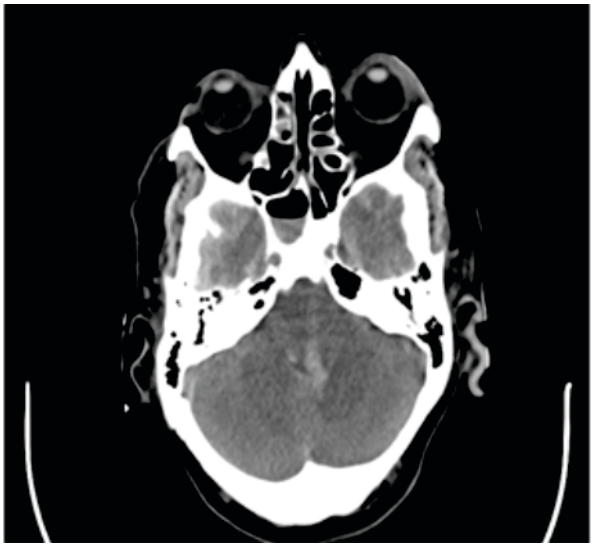
Figure 12a And 12b : CT Brain Showing Measurements Of Right And Left Eyeball Transverse Diameters And ONSD 3 MM Behind The Eyeball.

Grade of head injury	Severe
Right ONSD	6.21 mm
Left ONSD	6.17 mm
Right ETD	24.3 mm
Left ETD	24.5 mm
Right and left ONSD / ETD ratio	0.25

Representative Case 1:



12 C **12D**



12E

Figure 12 : CT Brain C,D And E Showing Subdural Haematoma, Subarachnoid Haemorrhage, Midline Shift And Effacement Of Basal Cisterns.

Rotterdam CT score	6
Helsinki CT score	12

CONCLUSION

- Optic nerve sheath diameter and Optic nerve sheath diameter / Eyeball transverse diameter Ratios should be documented in every report of the initial CT scan of brain with suspicion of traumatic brain injury.
- These ratios serve as important radiological tools in the assessment of the severity of the traumatic brain injury and also in prediction of the intracranial pressure and thereby aid in

appropriate timely interventions and thus help reduce the mortality associated with the raised intracranial pressure.

REFERENCES

1. Das et al.[1] conducted a retrospective cohort study on 150 patients and found that mean ONSD in moderate and severe TBI (RCTS score 4 and above) was 4.83 mm and above. There was subsequent increase in ONSD with increase in severity of TBI and RCTS. ONSD could be used as a triage tool in early detection of raised intracranial pressure.
2. Legrand et al.[2] conducted a prospective observational study on 77 patients with severe traumatic brain injury patients observed that ONSD was higher in non survivors compared to survivors indicating ONSD as good tool for predicting mortality. ONSD of > 7.3 mm was associated independently with mortality in severe traumatic brain injuries.
3. Jenjitranant P et al. [3] conducted a retrospective study on 271 head trauma patients and reviewed for ONSD on CT observed that imaging signs of raised intracranial pressure were significantly associated with higher ONSD concluding significant association between ONSD and signs of raised intracranial pressure.
4. Jie du et al.[4] conducted a prospective study on 52 adults who underwent craniotomy for traumatic brain injury and ONSD, ETD was measured on ultrasound and CT observed that there was diagnostic consistency with the gold standard intra ventricular manometry indicating ONSD as a reliable tool in indicating raised intracranial pressure.