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Original Research Article

The correlation between the preoperative measurement of estimated cerebral perfusion pressure and estimated intracranial pressure as obtained by trans cranial doppler with modified fisher grade as seen in computed tomography scan head in patients with acute sub arachnoid hemorrahage undergoing surgical clipping

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ABSTRACT

Background: In Aneurysmal Sub Arachnoid haemorrhage, precise Cerebral Perfusion Pressure (CPP) and Intracranial Pressure (ICP) measurement can only be achieved by an invasive monitoring device. The study aimed at non-invasively estimating the preoperative values of CPP and ICP by use of validated formulae. These estimated flow velocities (estimated CPP or eCPP and estimated ICP or eICP) of the Middle Cerebral Artery were obtained by Trans Cranial Doppler ultrasound and comparing it with the preoperative CT Head Fisher Scale. In the Institute Rimed Digi-Lite Trans Cranial Doppler machine was used for research and Siemens (Somatom) 64 CT Scanner from GE (Signa) was used to perform CT scan of patients.
Methods: It is a prospective, observational study which was studied between July 2017 and December 2018 in Post Graduate Institute of Medical Education and Research, Chandigarh, India. This study is a secondary analysis of a prospective observational study which was primarily designed to evaluate the neurological outcome related to the effect of estimated Intracranial Pressure and estimated Cerebral Perfusion Pressure as measured by Trans Cranial Doppler in patients with a SAH. A total of 100 patients were recruited in this study.
Results: There was significant correlation between estimated CPP and Fisher Grading. There was no strong correlation between the modified Fisher Grade and estimated ICP.
Conclusions: This study was able to give a statistically significant correlation between eCPP and Fisher Grading (p value- 0.047), as the Modified Fisher grading increased, so did the eCPP, this observation was unique, and it went against the hypothesis. However, no statistically significant co-relation was seen during comparison of eICP and Fisher Grading (p value- 0.069).

Keywords: Estimated cerebral perfusion pressure, Estimated intracerebral pressure, Modified fisher scale, Trans cranial doppler

INTRODUCTION

Subarachnoid Hemorrhage (SAH) is defined as bleeding occurring within the subarachnoid space. It most commonly occurs due to rupture of intracranial aneurysm which is referred to as spontaneous Subarachnoid Hemorrhage (SAH). Spontaneous SAH most commonly affects population with a mean age of 55 years. The

incidence of SAH increases with increasing age, with a peak at 50-60 years and only about 20% of the cases occur in individuals who are younger than 45 years old.[1]

Precise Intracranial Pressure (ICP) measurement can only be achieved by an invasive intracranial pressure monitoring device. Cerebral Perfusion Pressure (CPP) is calculated as a difference of Mean Arterial Pressure (MAP) and the ICP. It produces a figure that gives us a direct estimation of the brain condition.[2]

The introduction of Trans Cranial Doppler (TCD) by Aaslid et al, in 1982 resolved this issue by making non-invasive monitoring of vasospasm possible.[3] Changes in the global Cerebral Blood Flow (CBF) can be monitored in a non-invasive continuous manner using the blood flow velocities obtained from TCD.[4]

The TCD machine was calibrated to measure and displays the velocities required to calculate the CPP. The time averaged mean (FVm), systolic (FVs) and diastolic values (FVd) of flow velocity were measured.

The non-invasive estimated CPP (eCPP) calculation was based on the formula previously published: eCPP= mean ABP x FV d/ FVm +14 mmHg.[5]

Where ABP is "Arterial Blood Pressure", FVd is "Diastolic Blood flow" and FVm is "Systolic Blood Flow" as measured by TCD. The non-invasive estimated Intra Cranial Pressure (eICP) calculation is based on the formula,

eICP= 10.93xPI - 1.28. Where PI is the Pulsatality Index.[6,7]

The Modified Fisher Scale categorizes the CT Scan of head into 5 definite grades. The higher grades do have poorer prognosis. The grades 0, 1 and 2 have been termed as good Fisher Grades, whereas Grades 3 and 4 are termed as poor Fisher Grades.

In this study it was hypothesize that the patients with aneurysmal SAH with poorer Fisher Scale should be having reduced CPP and increased ICP.

In the Institute Rimed Digi-Lite Trans Cranial Doppler machine was used for the research and Siemens (Somatom) 64 CT Scanner from GE (Signa) was used to perform CT scan of the patients.

METHODS

This study is a secondary analysis of a prospective observational study which was primarily designed to evaluate the neurological outcome related to the effect of estimated intracranial pressure and estimated cerebral perfusion pressure as measured by trans cranial doppler in patients with aSAH.

Study period was from July 2017 to December 2018. The study was conducted at PGIMER, Chandigarh, Punjab, India.

Inclusion criteria

After Institutes Ethics Committee approval and written informed consent, following patients were included in the study

- Patient admitted for undergoing clipping of aneurysm,
- Age - 18 to 80 years,
- ASA grade I, II, III and IV patients,
- All grades of aneurysms according to (H and H, WFNS (Appendix Va and Vb) and Modified FISHER.

Exclusion criteria

- Age <18
- Unable to create a window by TCD
- Patient's refusal

Statistical analysis

- The study was conducted in all patients who were undergoing surgical clipping for Sub Arachnoid Haemorrhage between July 2017 to Dec 2017.
- Statistical analysis was done using Statistical Package for Social Sciences (SPSS Inc. 2013, version 22.0 for Windows, Armonk, NY, USA)
- Normality of quantitative data was checked by measures Kolmogorov Smirnov tests of normality.
- The continuous data was presented as Mean±SD or median and inter quartile range, as appropriate.
- All measurable normally distributed data were expressed as mean and Standard deviation.
- Categorical and classified data was compared by χ^2 test or Fischer exact test.
- Data correlation was analyzed by Pearson's or spearman's correlation based on distribution of data.
- A p-value less than 0.05 was considered significant.

RESULTS

A total of 100 patients were included and analyzed in the study. These patients were included after obtaining standard, written, informed consent.

Out of the study cohort of 100 patients with good Grade aneurysm SAH (WFNS and H and H) who had come to PGIMER, Chandigarh between July 2017 and December 2018, the patients with good Fisher grading (0,1,2) were 15 and the patients with poor Fisher grading (3 and 4) were 85 as seen in (Table 1).

Out of 100 patients, the Modified Fisher Grading (MFG) of patients with aneurysmal SAH most of the patients

were of poor grade (Fisher grade 3 and 4) while, only 15 patients were of good Fisher grade (0,1 and 2) as depicted in (Table 2).

Table 1: Modified fisher grading.

Fisher grading	No. of patients
0	2
1	1
2	12
3	45
4	40

Table 2: Modified Fisher grading categorization (good and bad).

		Frequency	Percent	Valid percent
Valid	Good	15	15.0	15.0
	Poor	85	85.0	85.0
	Total	100	100.0	100.0

Out of the study cohort of 100 patients with good Grade aneurysm SAH (WFNS and H and H) who had come to PGIMER, Chandigarh between July 2017 and December 2018, 76 patients had normal eICP (<15 mmHg) whereas, 24 patients had elevated eICP (>15 mmHg) as tabulated in (Table 3).

Table 3: eICP values categorized dichotomously.

		Frequency	Percent	Valid percent
Valid	Normal	76	76.0	76.0
	Elevated	24	24.0	24.0
	Total	100	100.0	100.0

In patients with aneurysmal SAH, the eCPP values were elevated in 71 patients (>70) and 29 patients had normal CPP (<70) (Table 4).

Table 4: eCPP values categorized dichotomously.

		Frequency	Percent	Valid percent
Valid	Not Elevated	29	29.0	29.0
	Elevated	71	71.0	71.0
	Total	100	100.0	100.0

When the co-relation was done between eCPP and Modified Fisher grading it was seen that poorer grade of Modified Fisher grading in a case of aneurysmal SAH, the eCPP was elevated in my study population. This co-relation is statistically significant as per Pearson's Chi square test (p value- 0.047) as highlighted in (Table 5). This table depicts that in patients whose eCPP was not elevated (total being 29), only 4 patients had good Modified Fisher Grading (MFG) and 25 had poor MFG. Similarly, patients with elevated e CPP (total 71), 11 patients had good MFG and 60 patients had poor MFG.

Table 5: Association between eCPP and modified fisher.

			Modified fisher grading		p value
			Good	Poor	
eCPP	Not Elevated	Count	4	25	0.047
	Elevated	Count	11	60	

When the co-relation was done between eICP and Modified Fisher grading it was seen that poorer grade of Modified Fisher grading in a case of aneurysmal SAH, the eICP was elevated in my study population. This co-relation is not statistically significant as per Pearson's Chi square test (p value- 0.069) as depicted in (Table 6). This table depicts that in patients whose e ICP was normal (76 patients), 11 patients had good Modified Fisher grading (MFG) and 65 had poor MFG. Similarly, patients with mildly elevated e ICP (total 24), 4 patients had good MFG and 20 patients had poor MFG.

Table 6: Association between eICP and modified fisher.

			Modified Fisher grading		p value
			Good	Poor	
eICP	Normal	Count	11	65	0.069
	Mildly elevated	Count	4	20	

DISCUSSION

The present study was conducted in patients of aneurysmal SAH to find the co-relation between the estimated Cerebral Perfusion Pressure (e CPP) and estimated Intracranial Pressure (e ICP) with preoperative Modified Fisher Grade as seen in CT Scan Brain. The CPP and ICP were calculated by validated formulae from the velocities of the MCA which were measured by TCD preoperatively. Most of the studies have focused on TCD as a tool for prediction of vasospasm. It has also been used extensively in measuring cerebral blood velocities in head injury patients and also calculate the estimated ICP and CPP through validated formulae. However, in the study authors have been able to non- invasively attain the values of ICP and CPP in non-traumatic aneurysmal SAH and correlate it with the pre-operative Modified Fisher Grade.

Estimated Cerebral Perfusion Pressure (eCPP)

Cerebral perfusion pressure is one of the determinant factors for prevention of ischemia and aggravation of secondary brain insults. My hypothesis stated that the poorer Fisher Grades would have higher ICP and Lower CPP. CPP can be measured after obtaining the values of MAP and ICP and then calculating its difference. In most

studies ICP was measured invasively. This study aimed at non-invasively measuring the values of CPP by use of flow velocities of the MCA obtained by Trans Cranial Doppler ultrasound.

For categorizing the values of CPP was defined. Below 70 mmHg it was termed as reduced and more that 70 mm of Hg it was increased.

It was noted that as the Fisher grading increases (Poor Grade), the eCPP is increased. This correlation was significant (p value of 0.047). This observation was contrary to the hypothesis.

Estimated Intracranial Pressure (eICP)

Hypothesis states that the poorer Modified Fisher Grades should have increased Intracranial Pressure. As the eICP rises, there would be a reduction in the CPP and would give rise to ischemia, hypoperfusion, brain oedema and poorer outcome. TCD a tool was made for measuring the eICP indirectly by using formulae. ICP was categorized into Normal (5-15 mmHg) and increased ICP (>15 mmHg).

Correlation between eICP and Modified Fisher

Modified Fisher Scale is an indirect measure of the volume of SAH. Strong correlation between the modified Fisher Grade and eICP was not found (p value- 0.069). Xiang et al, in their study also concluded that volume of SAH does not correlate with the increase in ICP.[8] They however concluded that ICP positively correlates with H and H and WFNS which are predictor of consciousness.

A positive correlation with Modified Fisher Scale and GOSE was observed in this study. The correlation was moderately significant (p-0.05). The study conducted by Peter Lindvall et al, showed strong correlation between Modified Fisher Scale, H and H grading and outcome.[9]

The study by BG Carter et al, showed a strong correlation of ICP and CPP on outcome but this study was done in children with TBI.[10] In this study ROC curve was drawn and it showed unfavourable outcome prediction when ICP> 40 mmHg and CPP<49 mmHg

Correlation between eCPP and Modified Fisher

Modified Fisher grading was also co-related with e ICP and e CPP as a part of my objective. It was hypothesized that if the Fisher Grade increases, the eCPP should be reduced. However, research had contradictory results. It was noted that as the Fisher grading increases (Poor Grade), the eCPP is increased. This correlation was significant (p value of 0.047).

Despite extensive search, no similar published literature stating the correlation between CPP and Fisher Grading in Aneurysmal Subarchnoid hemorrhage was found.

CONCLUSION

The increase in the Fisher grading should be associated with decreased CPP and increased ICP. However, research had contradictory results. As per the study, as the Fisher Grading increased, so did the eCPP which was statistically significant. No statistically significant co-relation was seen during comparison of eICP and Fisher Grading on CT scan head.

After a through literature search, there was no evidence of increase in ICP with poor Fisher scale, though all those studies were done in Traumatic Subarachnoid Haemorrhage not aneurysmal. However, no literature was found regarding the co-relation between Fisher Grading and CPP in either aneurysmal or traumatic SAH.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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