

VALIDITY OF BISPECTRAL INDEX IN DIAGNOSIS OF MILD AND MODERATE HEAD INJURY

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ABSTRACT

Objective: The objective of the study is to determine the validity of bispectral in diagnosis of mild and moderate head injury keeping GCS as a gold standard.

Study Design: A cross sectional validation study.

Place and Duration of Study: This Study was conducted in main Intensive Care Unit of the Combined Military Hospital Rawalpindi and was carried out over eight months from Dec 2009 to Aug 2010.

Material and Methods: A minimum of 137 patients were included in study. At the time of admission, Glasgow coma score was calculated by 3 different anesthetists and mean was calculated. At the same time BIS reading was taken using Aspect BIS monitor.

Results: Mean age of the patients was 29.5 ± 6.2 . 108 (78.8%) patients were male while 29 (29.2%) patients were female. Mean glasgow coma score was 12.2 ± 0.9 and mean bispectral index score was 69.9 ± 8.4 . A 2 x 2 table was made between GCS and BIS. Sensitivity was found to be 95.65%, specificity 98.53%, positive predictive value 98.50% and negative predictive value 95.7%. ROC curve was drawn and demonstrated area under curve value of 0.999.

Conclusion: BIS monitor can prove to be a useful adjunct in the diagnosis and management of mild and moderate head injury patients in the intensive care units.

Keywords: Glasgow coma score, Bispectral index, Mild head injury, Moderate head injury.

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INTRODUCTION

Traumatic brain injuries (TBI) are caused by fall, firearms and motor vehicle accidents, fall or fire arms. They are considered as one of the major causes of death and lifelong misery and disability. In depth research has been done to investigate if correlations exist between variables in acute stage of injury and outcome measures in TBI patients. The glasgow coma scale (GCS) score has been the main scale used for evaluating impaired consciousness. It evaluates the patient's response under three headings. Eye response, verbal response and motor response. GCS has been used to stratify patients with TBI¹. Total GCS score precisely predicted outcome in patients having head injury (Total GCS Score sensitivity 92%, specificity 85%)². Bispectral index (BIS) analysis is a non-invasive monitoring

process that provides continuous electroencephalogram (EEG) readings. Its value ranges from 100 to 0, and it decreases linearly with increasing depth of sedation/hypnosis³. Recent evidence suggest that BIS may be useful in prognostication of outcome in TBI⁴. Initial BIS scores gives a sensitivity of 88% and a specificity of 74% for head computed tomography (CT) scans suggestive of TBI⁵. BIS has been studied extensively for its use in operating room and intensive care units (ICU) for monitoring level of sedation. In recent past, its use has been increased in predicting the neurological status of TBI patients in ICU. The incidence of head injuries is on the rise in developing countries, observed to be 30% (moderate head injuries) in Pakistan⁶. The rationale of the study was to determine the validity of BIS in diagnosis of mild and moderate head injury patients in ICU keeping GCS as a gold standard, so that it can prove to be a useful adjunct in addition to GCS while managing such patients.

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MATERIAL AND METHODS

This validation study was conducted in main ICU of the Combined Military Hospital Rawalpindi, which is a tertiary care hospital; from Dec 2009 to Aug 2010. Admitted head injury patients both male and female, age between 20 and 40 years were included in the study. Patients who were critically ill with unstable body temperature, with history of dementia, CVA, epilepsy, alcohol intoxication or drug abuse, mentally retarded patients, those with severe maxillofacial injuries or any comorbid like sepsis, meningitis or spinal cord injury were excluded from the study. Sample size was calculated to be 137 using sensitivity and specificity sample size calculator using:

- Sensitivity = 88% 5
- Specificity = 74% 5
- Expected prevalence = 30% 6

Table: Gross tabulation of GCS and BIS (n=137).

BIS	GCS		
		Moderate (9-12)	Mild (13-15)
	Moderate (41-60)	True Positive (TP) 66	False Positive (FP) 1
Mild (61-99)	False Negative (FN) 3	True Negative (TN) 67	

- Desired precision = 10%
- Confidence level = 95%

Total 137 patients were included in the study through non-probability consecutive sampling.

- The study was conducted after approval of the hospital ethical committee and all data was recorded after taking informed written consent from patient’s guardian.
- GCS was calculated by 3 different anaesthetists (one consultant and two registrars) at the time of patient’s admission, who were blinded to GCS calculated by each other as well as BIS index of the patient and recorded.
- Average of the 03 GCS readings was taken as final GCS.
- BIS was monitored using Aspect BIS Monitor. One electrode was placed in the centre of

forehead, second over temporal region and third over respective mastoid bone.

- The reading of BIS as well as the 03 GCS scores (+ Average) was recorded

Data Analysis

Data had been analyzed using statistical package for social Sciences (SPSS) version 14.0. 2x2 table was made between BIS and GCS for mild and moderate head injury. Sensitivity, specificity, positive predictive value and negative predictive value and accuracy of BIS were calculated using GCS as gold standard. ROC curve was drawn and area under curve was calculated for BIS using GCS as gold standard.

RESULTS

Regarding age distribution, 44 (32.12%) patients were between 20-25 years, 48 (35.04%) patients were between 26-30 years, 15 (11.04%) patients were between 31-35 years and 30

(21.80%) patients were between 36-40 years. Mean age of patients was 29.5 ± 6.2 years. Regarding gender, majority of patients were male 108 (78.8%). Mean GCS score was 12.2 ± 0.9 while mean BIS index was 69.9 ± 8.4. A 2 x 2 table was made as shown above, and following results were obtained. ROC curve is shown in figure, and demonstrated Area under curve (AUC) value of 0.999.

- Sensitivity = 95.65%
- Specificity = 98.53%
- Positive Predictive Value = 98.51%
- Negative Predictive Value = 95.7%
- Accuracy of BIS is 97.08

DISCUSSION

BIS is basically derived from electroencephalogram, and it gives a value which ranges

from 0 (no cerebral activity) to 100 (fully awake). This is different than GCS, which basically takes in to account eye opening, verbal response and motor activity. BIS monitor helps in calculating the value, whereas GCS is measured by Physician. So BIS needs monitor, but element of bias is not there. Whereas in GCS, there is no need for monitor, but element of bias may be there. Monitoring plays a very important role management of patients in an intensive care unit. This is particularly important when patients are having traumatic brain injury. The rational use of monitoring depends on the comparison of benefits and pitfalls of a monitoring modality. BIS monitor were introduced in clinical practice for purpose of measuring depth of unconsciousness in 1996. Since its induction, many articles have tested the efficacy of the BIS monitor. Most of these articles support the use of BIS monitor to measure sedation, hypnosis or consciousness. According to our results, BIS permits to differentiate mild head injury from moderate head injury. BIS values were less in patients having moderate head injury, than those with mild head injury. This result is consistent with those of Rao et al⁴ who showed correlation of BIS with GCS. He measured BIS and GCS over 10 days in patient who clinical status was changing.

BIS scores are predictive of TBI and neurological outcome at discharge in patients of trauma, when recorded prior to administration of sedation, as per one study⁵. They had monitored BIS values at time of admission, prior to administration of sedation; and then correlated these with computed tomographic evidence of TBI.

Fabregas et al⁷ investigated probability of recovery from unconsciousness on the basis of BIS monitoring. He included 25 patients having brain injury. Statistically significant difference was noted in those who recovered, and those who did not; in regards to BIS max, BIS min and BIS mean. In his study, Gilbert et al⁸ used various spectral parameters of EEG including BIS, and then plotted these against different neurological measurements, including glasgow coma score,

modified ramsay sedation scale, APACHE-III. Neurologic score and reaction level scale. He observed that BIS correlated with these neurological scores significantly, and related to neurological status better than any other EEG spectral parameter. Our study revealed that in majority of cases BIS values increased progressively as the GCS score increased. There were two cases of road traffic accident in which GCS was 12 whereas the BIS monitor showed the reading of 69 in one case and 61 in second case. Similarly, in two other cases BIS value was lower than corresponding GCS Score. In one such case GCS was 13 whereas the BIS score was 59 which showed a moderate hypnotic state. In second case in which the patient had head injury secondary to

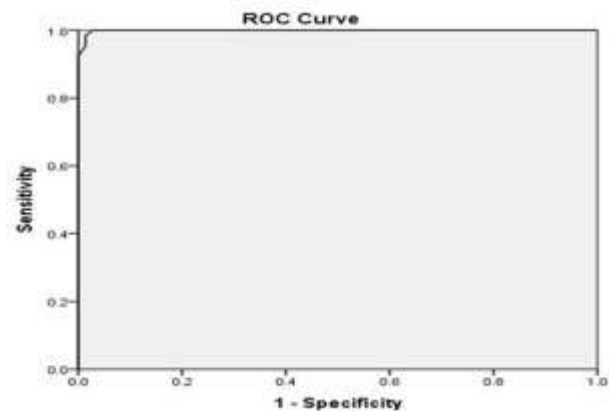


Figure: Diagonal segments are produced by ties.

syncopal attack, GCS score was 10 whereas the BIS score was 40 which corresponds to deep hypnotic state. Noise and artifacts affect EEG signals in frequency range similar to awake EEG. Its detection is a bit tricky as the frequency and amplitude of EEG varies. High Frequency artifacts may be physiological or non-physiological. Former is one which arises from sources other than brain, while later is result of generation by external devices, like cardiac pacing devices⁹, cardiopulmonary bypass machine¹⁰, warming blankets¹¹ etc. These later ones, falsely increase BIS. Patients own ECG interference with BIS reading has been documented rarely. Cases have been reported in patients with severe brain injury, where BIS monitoring system detected ECG, and did not recognize it as artifact^{12,13}.

This means that if BIS values seem clinically dubious, then EEG should be thoroughly investigated. EEG signals should be interpreted very carefully keeping in view the high frequency artifacts which can affect the EEG signal and hence BIS value. Bispectral Index monitor should be used wherever possible, in the neurointensive care unit especially to eliminate the element of bias secondary to subjective neurological assessment by the clinicians so that proper resource utilization can be done while managing such cases. Since, the BIS is new to intensive care unit, further studies are required to be done to establish the authenticity of this monitor regarding prediction of neurological outcome after head injury.

CONCLUSION

In conclusion, we found that EEG based BIS monitor can prove to be a useful additional method for helping the clinicians in the diagnosis and management of head injury patients. Furthermore.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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