Original Article

# Bispectral Index Monitoring in Patients Undergoing Coronary Artery Bypass Grafting (CABG) under Cardiopulmonary Bypass

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**Abstract**

***Background:*** *Bispectral index (BIS) monitoring may assist reduction in utilisation of anaesthetic agents during cardiac surgical procedures. This study was designed to test whether the use of BIS monitoring reduces the anaesthetic requirements during on-pump coronary artery bypass grafting (CABG).*

***Methods:*** *This prospective observational randomized study was conducted in the department of cardiothoracic vascular anaesthesia and critical care of Apollo Hospitals,Dhaka on 35 patients undergoing elective CABG. The following patients were excluded from the study; patient with cerebrovascular accident (CVA), excessive alcohol intake and drug abuse.*

***Results:*** *The mean heart rate and CVP were statistically significant (p<0.05) when compared start at surgery vs different follow up, however mean MAP was significantly reduced when compared start at surgery vs different follow up. At induction mean BIS was 59.08±12.40%, at onset of CBP mean BIS was 27.43±13.51% and at end of anaesthesia mean BIS was 85.62±12.83%. Mean BIS was significantly decreased when compared induction vs onset of CBP. However, mean BIS was significantly increased when compared induction vs end of anaesthesia.*

***Conclusion:*** *Anesthesia maintained by bispectral index monitoring reduces the incidence of haemodynamic unstability and facilitates titration of anesthetic agents during cardiopulmonary bypass and thus may assist recovery from anesthesia.*

***Keywords:*** *Bispectral index, Coronary artery bypass graft, Cardiopulmonary bypass.*

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## Introduction

Bispectral index (BIS) monitoring may assist reduction in utilisation of anaesthetic agents during cardiac surgical procedures.[1] Optimal anesthesia depth is not easy in cardiovascular surgery patients where the haemodynamic reserve is limited, due to reasons such as not being able to give the desired dose of anesthetic agent, or the change in the pharmacokinetics of the agent in the heart-lung machine.[2] The depth of anesthesia in open heart surgery is difficult due to many factors. Deep anesthesia may cause hypotension and circulatory insufficiency[3] and for the risk of haemodynamic disturbance, keeping the anaesthesia superficial may increase the risk of awakening in this patient groupwith a restricted haemodynamic reserve. Besides, during the heartlung machine use, the pharmacokinetics of anesthetic drugs may change. For this reason, the same dose of drug used in different patients may be less or more.[4,5]

BIS monitor has been increasingly used in the operating room to monitor hypnosis during anesthesia and as a tool to “fast track” recovery of patients. We studied the utility of using a BIS monitor perioperatively for patients undergoing coronary artery bypass grafting (CABG) under cardiopulmonary bypass (CPB).[6] This study was designed to test whether the use of BIS monitoring reduces the anaesthetic requirements during on-pump coronary artery bypass grafting (CABG).

**Materials and Methods:**

This prospective observational randomized study was conducted in the department of cardiothoracic vascular anaesthesia and critical care of Apollo Hospitals,Dhaka on 35 patients undergoing elective CABG.Study period was (January-July), 2018.The following patients were excluded from the study; patient with cerebrovascular accident (CVA), excessive alcohol intake and drug abuse.Anti-hypertensive and anti-anginal medications were continued until the morning of surgery. Pre-anaesthesia medication consisted of oral 1 mg of clonazepam at bed time on the night prior to surgery and midazolam 7.5mg approximately 2 hours prior to anaesthesia and surgery. After arrival to the anaesthetic room, patients were administered oxygen (O2) by nasal canula and monitoring of ECG (5 lead) with automated ST segment analysis (Marquette Solar 5000, GE Medical System, Milwaukee, USA) and pulse oximetry was initiated. A 18-G intravenous cannula was inserted in the dorsum of right hand and an 20-G; 45 mm intra-arterial cannula was introduced into the right radial artery for monitoring of the arterial pressure and obtaining arterial blood for analysis. A trichannel 7fr central venous catheter was introduced into right internal jugular vein for measurement of central venous pressure and infusion of drug. General anaesthesia was induced, while patients breathed 100% O2 by facemask, using a combination of fentanyl (4-5) µg/kg, midazolam 100 µg/kg . Endotracheal intubation was performed after administration of pancuronium bromide 0.15 mg/kg and mechanical ventilation was initiated. Low-flow technique (fresh gas flow of 3 L/min) using anaesthesia machine (Aestiva/5,7900 Datex Ohmeda, Madison, MI, USA) to achieve end-tidal carbon-dioxide tensions of 32 ± 3 mm Hg was used. Haemodynamic parameters were maintained within 20% of the basal values with adrenaline,dopamine, phenylephrine, and glyceryltrinitrate, as required. Intraoperative hypothermia was prevented by the use of warm airflow at 400 (Bair Hugger warming unit, model 505, Augustine Medical Inc, Eden Prairie, MN, USA), warming blanket (Hemotherm, Cincinnati Sub Zero, Cincinnato, Ohio, USA), warm intravenous fluids. Filling pressures and fluid balance was maintained using normal saline 0.9% . Total amount of midazolam administered during entire procedure was restricted to 10mg . Perioperative analgesia was supplemented with the use of fentanyl infusion after anaesthetic induction in the operating room. Inhalational anesthetic isoflurane was given as required. A smoothing window of 15-second duration, which updates every 2 seconds was used, the impedance was maintained less than 5 kÙ. To minimize artifactual error, the BIS score was recorded only in the absence of possible confounding signals; the BIS values during use of the electrocautery were not taken into consideration during the study.

**Results**

Table I shows majority 16(45.7%) patients belonged to age 51-60 years and their mean age was found 57.63±14.1 years. Figure 1 shows males were predominant in this study 22(62.9%) and females were 13(37.1%). Male: female ratio was 1.7:1. Table 2 shows mean weight was 55.7 ±8.4 kg, mean height 158.2±9.5 cm and mean ejection fraction was 48.3±5.1%. Table 3 shows mean operative time was 300.0±30.0 minutes, mean anesthesia time 325.7±53.3 minutes, mean CPB time 90.0±20.0 minutes, mean cross lamping time 75.6±27.4 minutes, mean number of anastomosis was 2.8±0.9 and ratio of automatic heart beat recovery was 95.0%. Table 4 shows mean heart rate and CVP were statistically significant ($p<0.05$) when compared start at surgery vs different follow up, however mean MAP was significantly reduced when compared start at surgery vs different follow up. Table 5 shows at induction mean BIS was 59.08±12.40%, at onset of CBP mean BIS was 27.43±13.51% and at end of anaesthesia mean BIS was 85.62±12.83%. Mean BIS was significantly decreased when compared induction vas onset of CBP. However, mean BIS was significantly increased when compared induction vs end of anaesthesia.

**Table 1** *Distribution of the study patents by age (n=35)*

| Age (years) | Frequency | Percentage |
|---|---|---|
| 31-40 | 3 | 8.6 |
| 41-50 | 9 | 25.7 |
| 51-60 | 16 | 45.7 |
| >60 | 7 | 20.0 |
| Mean±SD | 57.63±14.1 | |

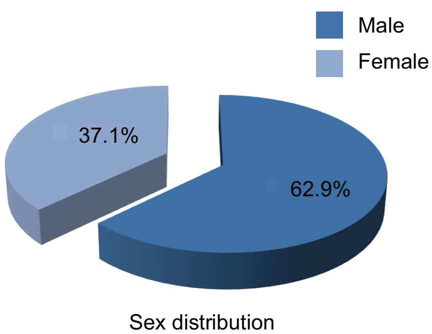


**Figure 1** *Pie chart showing sex distribution of the patients (n=35)*

**Table-II.** *Distribution of the study patients by height, weight and EF% (n=35)*

| | Mean ± SD |
|---|---|
| Weight (kg) | 55.7 ± 8.4 |
| Height (cm) | 158.2 ± 9.5 |
| EF (%) | 48.3 ± 5.1 |

**Table-III** *Intra-operative data (n=35)*

| Intra-operative data | Mean±SD |
|---|---|
| Operation time (min) | 300.0±30.0 |
| Anesthesia time (min) | 325.7±53.3 |
| CPB time (min) | 90.0±20.0 |
| Cross lamping time (min) | 75.6±27.4 |
| Number of anastomosis | 2.8±0.9 |
| Ratio of automatic heart beat recovery (%) | 95.0% |

**Table-IV.** *Perioperative hemodynamic data (n=35)*

| Perioperative | Start at surgery | Pre-CBP | Post-CBP | End of surgery |
|---|---|---|---|---|
| hemodynamic Data | Mean ±SD | Mean ±SD | Mean±SD | Mean±SD |
| Heat rate (beats/min) | 77.15±15.35 | 73.91±17.53 | 75.16±16.27 | 76.21±18.51 |
| ***P value*** | - | $0.291^{ns}$ | $0.305^{ns}$ | $0.415^{ns}$ |
| MAP (mmHg) | 81.0±3.0 | 77.0±4.0 | 69.0±4.0 | 72.0 ±5.0 |
| **P value*** | - | $0.001^{s}$ | $0.001^{s}$ | $0.001^{s}$ |
| CVP (mmHg) | 12.0±2.0 | 11.0±3.0 | 12.0±3.0 | 11.0 ±3.0 |
| ***P value**** | - | *$0.095^{ns}$* | *$0.568^{ns}$* | *$0.095^{ns}$* |

s=significant; ns=not significant
*P value reached from paired t-test and compared with baseline vs follow up group.

**Table V** *Means BIS value during surgery (n=35)*

| Time | BIS value (%) Mean±SD |
|---|---|
| Before induction | 88.15± 11.48 |
| Induction | 59.08±12.40 |
| Onset of CBP | 27.43±13.51 |
| P value (Induction vs onset of CBP) | $0.001^{s}$ |
| End of anaesthesia | 75.62±12.83 |

*P value (Induction vs end of anaesthesia) $0.001^{s}$*
s=significant P value reached from paired t-test

## Discussion

In this study observed that the majority 16(45.7%) patients belonged to age 51-60 years and their mean age was found 57.63±14.1 years. In study of Ramamurthy et al.[7] observed similar observation they showed that the mean age of the group was 60.8 years. In study of Sinha et al.[8] The mean age of the group was 58.63 (SD± 13.08) years. Muralidhar et al.[1] study showed the mean age of the group was 50.0(SD±6.0) years. In this study males were predominant in this study 22(62.9%) and females were 13(37.1%). Male: female ratio was 1.7:1. In study of Ramamurthy et al.[7] showed males were found 14(70.0%) and females 6(30.0%). Muralidhar et al.[1] study also observed similar observation males were found 9(90.0%) and females 1(10.0%). Sinha et al.[8] males were found 22(66.7%) and females were 11(33.3%). Male: female ratio was 2:1. In present study showed the mean weight was 55.7 ±8.4 kg, mean height 158.2±9.5 cm and mean ejection fraction was 48.3±5.1%. Yang et al.[9] study observed that the mean weight was found 54.5±7.9 kg, mean EF 57.2%. Muralidhar et al.[1] the mean LV ejection fraction was 47.0±6.0%. In this study showed the mean operative time was 300.0±30.0 minutes, mean anesthesia time 325.7±53.3 minutes, mean CPB time 90.0±20.0 minutes, mean cross lamping time 75.6±27.4 minutes, mean number of anastomosis was 2.8±0.9 and ratio of automatic heart beat recovery was 95.0%. Similar observation was found Yang et al. they showed that the mean operative time was found 198.0±28.0 minutes, mean CBP time 95.0±18.0 minutes, Aortic clamp time was 62.0±21.0 minutes, Ratio of automatic heart beat recovery 83.3%. In this study showed that the mean heart rate and CVP were statistically significant ($p<0.05$) when compared start at surgery vs different follow up, however mean MAP was significantly reduced when compared start at surgery vs different follow up. Kabukcu et al.[10] study reported that the HRs were similar in both groups before the induction (76.6±14.1 beats/min in G1; 75.0±13.81 beats/min in G2). At the time of skin incision and sternotomy, the values were found to be less than the preoperative values ($P<0.05$). In G1, the HR was fast after the aorta cannula removal and until the end of the operation ($P<0.05$). In G2, there was no statistically significant difference ($P>0.05$). Intergroup comparison was statistically significant at the time of skin incision, after the thorax was closed and at the end of the operation ($P<0.05$). MAP courses were lower during the operation, compared to preoperative values in G1 and G2 ($P>0.05$. Intergroup statistical comparison showed significantly high MAP in G1 after cross-clamp removal. No significant difference was detected in the other periods of the operation ($P>0.05$). In present study observed that at induction mean BIS was 59.08±12.40%, at onset of CBP mean BIS was 27.43±13.51% and at end of anaesthesia mean BIS was 75.62±12.83%. Mean BIS was significantly decreased when compared induction vas onset of CBP. However, mean BIS was significantly increased when compared induction vs end of anaesthesia. Sinha et al.[8] From the BiS recordings of all the patients it was seen that before induction the BiS value was seen to be above so. At induction there was a fall in BiS to the anaesthetic values as expected with a mean value of 58.06. The BiS value was seen to vary between 40 and 60 in the pre-CPB period. The BiS value frequently showed variation which was an artefact due to use of electrocautery. However, in the immediate period of CPB there were no confounding variables such as no electrocautery was being in this period and the recording was dependable and it accurately reflected the neurological state. From the BiS recordings it was seen that there was marked dip in the BiS value immediately on going on CPB and lasting till application of the aortic cross clamp, a total duration 1.5 minutes approximately as seen from the BiS record. These observations were then analysed with the help of the Open Office Calc spreadsheet statistical formulae. This drop in the BiS was to a mean value of 25.35. The one tailed t test value for the fall of the BiS value from the post- induction to the CPB value is 0.0000000193 ($p < 0.05$), which is statistically significant The test hypothesis being that no change in BiS value should occur during CPB i.e. a comparison of the data points post-induction and with the onset of CPB in each patient. A study done in children undergoing CPB documented the drop in BiS value at onset of CPB, though this study correlated all episodes of cerebral hypoperfusion and concluded that reduction in BiS value correlated with cerebral hypoperfusion.[11] Thomas et al.[12] studied BiS in patients undergoing off pump coronary artery surgery (OPCAB) and found that the incidence of hypotension correlated with low values of BiS and proposed that BiS might be used as an indicator of cerebral hypoperfusion in OPCAB. Puri and Murthy[13] used BIS monitoring to control administration of anaesthetic agents in order to stabilize hemodynamics and promote recovery from anaesthesia in patients undergoing CPB. Lathi et al.[14] assessed BIS for intraoperative hemodynamic stability by allowing reduction in anaesthetic agents use, thus minimizing the adverse effects. Wong et al.[15] proved that BIS monitoring facilitated a 30% decrease in isoflurane use and 26% decrease in time to orientation. In comparative study Kabukcu et al.[10] also support our observation they showed BIS values were similar in both groups before the induction (97.1±1.5 in G1; 97.4±1.3 in G2; *P*>0.05). With induction, BIS values in both groups showed a decrease, without significant statistical difference (*P*>0.05).

**Conclusion:**

Anaesthesia maintained by bispectral index monitoring reduces the incidence of haemodynamic unstability and facilitates titration of anesthetic agents during cardiopulmonary bypass and thus may assist recovery from anesthesia.

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