ORIGINAL RESEARCH PAPER
Volume - 9 | Issue - 7 | July - 2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ASSESSMENT OF ADEQUACY OF GENERAL ANAESTHESIA IN CESAREAN SECTION USING BISPECTRAL INDEX

Anaesthesiology

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ABSTRACT

Objectives : To study the adequacy of general anesthesia technique used in our centre to prevent awareness in patients undergoing cesarean section , to analyze effectiveness of BIS as a tool to monitor depth of anesthesia and its co relation with clinical signs of awareness.

Methods : 50 patients scheduled for elective cesarean section were included in the study . ECG, NIBP, HR and SPO2 were continuously monitored as well as end tidal isoflurane, nitrous oxide, carbon dioxide. The BIS was measured and recorded at following 16 designated points of sequential events during general anaesthesia. Clinical signs like HR, NIBP, SpO_2, $ETCO_2$ and end-tidal Isoflurane were noted down and recorded at same 16 designated points. Clinical assessment of depth of anaesthesia was also done at same designated points.Patients were monitored for clinical signs of awareness like sweating, lacrimation, abnormal movements and jerks at all the 16 designated points.

Results : The general anesthetic technique for cesarean section in our institution appears to be **adequate** to prevent awareness. Till delivery of foetus a **close correlation** was found between BIS and clinical signs of awareness from induction and after delivery of foetus and after patients having received opiates and NSAIDS to recovery of patient BIS values were consistantly higher inspite of no clinical signs of awareness thereby depicting a **poor correlation** between BIS and clinical signs of awareness.

Conclusion: In all the 50 patients some of the milestones were not associated with acceptable BIS score as an index of adequate depth of anesthesia but none of our patient had awareness or recall despite unacceptable BIS score so it is suggested that more studies are needed to evaluate the effectiveness of BIS as a tool to monitor depth of anesthesia in patients undergoing caesarean section under general anesthesia .

KEYWORDS

INTRODUCTION

Adequate anaesthesia to prevent awareness and recall during general anaesthesia is the major role of anaesthesiologist. This is achieved by a balanced administration of analgesic, hypnotic and amnesic drugs. Awareness with recall after surgery under general anaesthesia is an infrequent but well described adverse outcome [1]. Cesarean section (C/S) is one of the operations which renders patients at risk of inadequate anaesthesia [2,3]. The objectives of general anesthesia for cesarean delivery are to keep mother and fetus adequately oxygenated, while limiting fetal drug transmission and maintaining maternal comfort [4].

General anesthesia is selected more in emergency cases, such as, fetal distress and severe bleeding or in cases where local anesthetic is contraindicated.[5,6] The aim of general anesthesia includes preventing intraoperative pain and creating relaxation, sleep and anesthesia, so that the patient does not remember the surgery, but if the depth of anesthesia is not appropriate, it leads to awareness during surgery.[7]

Awareness during general anaesthesia includes consciousness and memory about intra operative events. Memory about intra operative events can be divided into explicit and implicit. Explicit is a controlled consciousness and patient can recall spontaneously or in a structured postoperative interview. Explicit or declarative memory is when the patient remembers facts, events or experiences that occurred during general anaesthesia.[8]

Different methods of monitoring depth of anesthesia can be classified as clinical techniques/conventional monitoring and monitoring electrical activity of brain. The clinical techniques and conventional monitoring include clinical sign, skin conductance, isolated forearm technique, spontaneous surface electromyogram (SEMG), lower oesophageal contractility and heart rate variability.

Regarding monitoring of electrical activity of brain, we have spontaneous EEG activity monitors and evoked brain electrical activity monitors. EEG activity monitors include EEG, compressed spectral analysis, EEG with compressed spectral analysis, cerebral function monitor (CFM), cerebral function analysis monitor (CFAM), bispectral index, entropy, narcotrend®, patient state analyzer, SNAP index and cerebral state monitor/cerebral state index. Evoked brain electrical activity monitors include somatosensory evoked potential (SSEP), visual evoked potential (VEP) and auditory evoked potential (AEP).

Monitoring cerebral function to detect awareness has advanced considerably in recent years, but the perfect monitor has yet to be developed. The most widely studied brain function monitor, **Bispectral Index (BIS)** monitoring, is easy to initiate and is a proprietary algorithm that converts a single channel of frontal EEG into an index of hypnotic level . The BIS ranges from 0 (EEG silence) to 100 (Fully awake and alert) [9].A BIS range of 40-60 denotes an adequate level of anesthesia.[10]

MATERIAL AND METHODS:

50 patients scheduled for elective cesarean section were included in the study. A written informed consent was taken from the patients for participation in the study. Patients with the history of mental diseases or anticipated difficult intubation and high risk patients like placenta accreta, placenta previa and PIH were excluded from the study.

Pre-anaesthetic evaluation was done and noted down. In the operating room after securing IV line, standard multichannel monitor for monitoring baseline non invasive blood pressure (NIBP), heart rate (HR), oxygen saturation (SPO2) and electrocardiogram (ECG) was connected. After that BIS monitoring equipment was attached. After at least 3-5 minutes of pre-oxygenation in 10-15 degree left lateral tilt anaesthesia was induced by giving Propofol (1.5-2.5mg/kg IV) and suxamethonium (2mg/kg).Anaesthesia was then maintained with 50% nitrous ,50 % oxygen and isoflurane (1% before delivery and 0.5% subsequently).The inspired concentration of isoflurane was set at 1% until delivery,after which it was reduced to 0.5%.Muscle relaxation was acheived with atracuriun (0.1mg/kg).After delivery of fetus, analgesia was provided with paracetamol (15 mg/kg), fentanyl (2µg/kg) and morphine(0.1mg/kg). Isoflurane was stopped at the start of skin closure where as nitrous oxide was stopped at the end of skin closure. Reversal of muscle relaxation was acheived with neostigmine (60µg/kg) and glycopyrolate (10µg/kg).Extubation was done after patients were fully concious and responding to commands.

ECG, NIBP, HR and SPO2 were continuously monitored as well as end tidal isoflurane, nitrous oxide, carbon dioxide. The BIS was measured and recorded at following 16 designated points of sequential events during general anaesthesia.

1.Before induction 2.after giving propofol 3. Laryngoscopy 4.after intubation 5.skin incision 6.retraction of rectus muscle 7.uterine incision 8.fetal delivery 9.uterine closure 10.abdominal mopping 11.peritoneal closure 12.Subcutaneous closure 13.cessation of isoflurane 14.skin closure 15.after reversal and 16.eye opening

Clinical signs like HR, NIBP, SpO_2, $ETCO_2$ and end-tidal Isoflurane were noted down and recorded at same 16 designated points. Clinical assessment of depth of anaesthesia was also done at same designated points.Patients were monitored for clinical signs of awareness like sweating, lacrimation, abnormal movements and sjerks at all the 16 designated points. All the patients were interviewed for intra operative/post operative recall of events after 24 hours.

1. Could the patient be alerted during surgery?
2. Did patient recall any event during surgery?
3. Did the patient have any dreams during surgery?
4. Did the patient hear any conversation during surgery?

Stastistical Analysis

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS version 20.0.(SPSS Inc, Chicago Illinois, USA).Continuous data was summarized in the form of means and standard deviations where as categorical variables were summarised as percentages.Contiunous variables were further analysed by using independent t test.Graphically the data was presented by line diagrams. All the results were discussed at 5% level of significance.

OBSERVATION AND RESULTS

This study was conducted primarily to assess the adequacy of general anesthesia technique used in our center to prevent awareness in patients undergoing cesarean section, study effectiveness of BIS as a tool to monitor depth of anesthesia in patients undergoing caesarean section under general anesthesia and to correlate BIS with clinical signs of awareness.

The demographic data and mean drug doses are reported in Table 1 .

TABLE 1:Demographics and drug doses

Parameter	Mean
1.Age	29.740±4.095
2.Weight	62.10±10.460
3.Endtidal concentration of Isoflurane at skin incision	0.69±0.10
4.Endtidal concentration of Isoflurane at skin closure	0.267±0.08
5.Endtidal concentration of N2O at skin incision	48.72±3.78
6.Endtidal concentration of N2O at skin closure	40.67±6.76

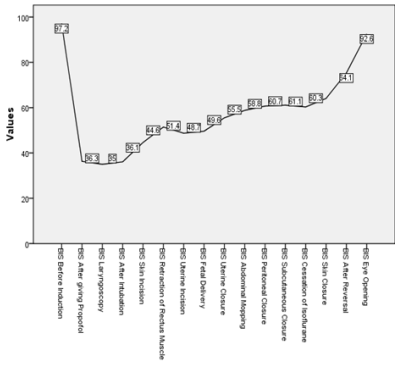

FIGURE 1:**Line diagram showing mean BIS at all 16 designated points.**

- The mean BIS before induction , after giving propofol ,at laryngoscopy and after intubation are 97.18, 36.28 ,35 and 36.08 respectively.
- On comparing BIS before induction with BIS after giving propofol ,at laryngoscopy and after induction there is significant decrease in BIS value ($p<0.001$).
- The mean BIS at skin incision ,retraction of rectus muscle uterine incision and delivery of foetus are 44.64, 51.44 , 48.7 and 49.62 respectively.
- On comparing baseline BIS value there is significant decrease in BIS at skin incision , retraction of rectus muscle , uterine incision and fetal delivery.
- The mean BIS values at uterine closure , abdominal mopping ,peritoneal closure ,sub cutaneous closure , cessation of isoflurane ,skin closure , after reversal , and eye opening are 55.52 , 58.8 , 60.7 , 61.1 , 60.32 , 64.08 , 75.34 and 92.56 respectively.
- There is significant increase in BIS value on comparing with BIS value after giving propofol ($p<0.001$).

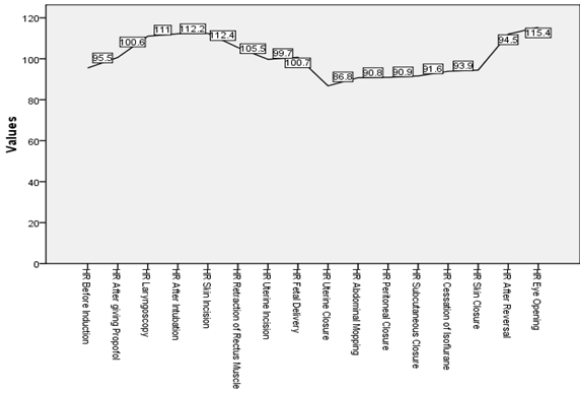

FIGURE 2:**Heart rate at all 16 designated points**.

- The mean heart rate before induction , after giving propofol , at laryngoscopy and after intubation are 95.5, 100.64 , 111.02 and 112.22 respectively.
- On comparing baseline heart rate with heart rate after giving propofol ,there is non significant increase ($p>0.05$).However there is significant increase in heart rate at laryngoscopy and after intubation ($p<0.001$).
- The mean heart rate at skin incision ,retraction of rectus muscle , uterine incision and delivery of foetus are 112.4 ,105.52 ,99.72 and 100.74 respectively.There is significant decrease in heart rate from skin incision to delivery of foetus ($p<0.001$).
- The mean heart rate at uterine closure, abdominal mopping , peritoneal closure ,sub cutaneous closure, cessation of isoflurane , skin closure, after reversal , and eye opening are 86.8 , 90.79 , 90.94 , 91.6 , 93.88 , 94 48 , 112.04 and 115. 38 respectively.
- There is no significant change in heart rate from uterine closure to skin closure($p>0.05$),however the heart rate increases significantly after giving reversal and at eye opening($p<0.001$).

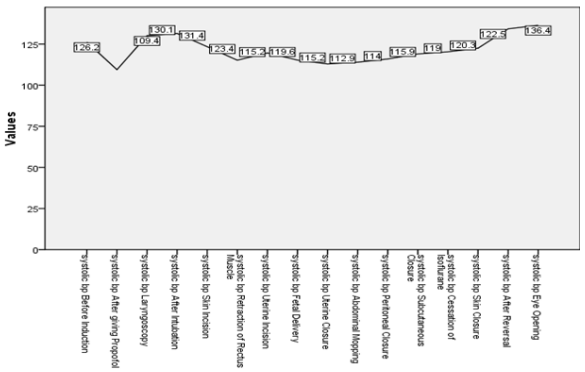

FIGURE 3: **Line diagram of systolic blood pressure at 16 designated points**

- The mean systolic blood pressure before induction , after giving propofol , at laryngoscopy and after intubation are 126.2 , 109. 44 , 130.08 , 131. 44 respectively.
- On compairing with baseline there was a significant decrease in systolic blood pressure after giving propofol ($p<0.001$), however the increase in systolic blood pressure at laryngoscopy and intubation was not significant ($p>0.05$) when compared with

baseline.

- The mean systolic blood pressure at skin incision , retraction of rectus muscle ,uterine incision and delivery of foetus are 123.38 , 115.18 ,119.6 and 115.24 respectively.
- There is significant decrease in blood pressure from skin incision to delivery of foetus.($p<0.001$).
- The mean systolic blood pressure at uterine closure , abdominal mopping ,peritoneal closure ,sub cutaneous closure , cessation of isoflurane ,skin closure , after reversal , and eye opening are 112.9 ,113.98 .115.92 ,119 ,120.28 .122.48 , 134.26 and 136.42 respectively.
- There is no significant change in systolic blood pressure from uterine closure to skin closure($p>0.05$),however the systolic blood pressure increases significantly after giving reversal and at eye opening($p<0.001$).

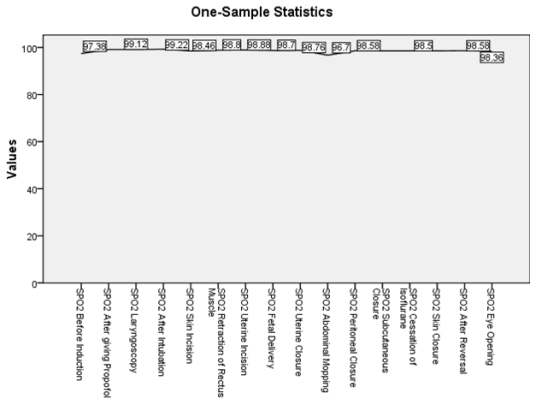

FIGURE 4: **Line diagram for saturation at 16 designated points**.

There is no significant change in saturation from start to end of anesthesia.($P>0.05$)

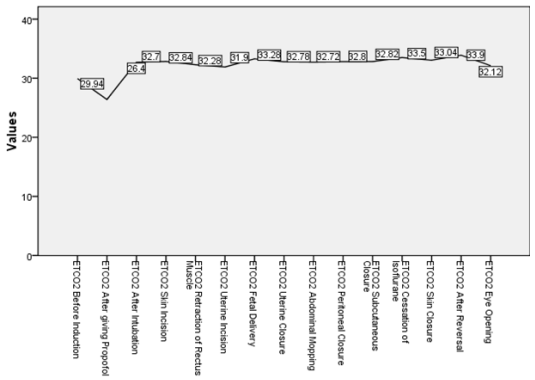

FIGURE 5:**Line diagram showing Endtidal carbon dioxide at 16 designated points.**

There is no significant change in Endtidal carbon dioxide from start to end of anesthesia.

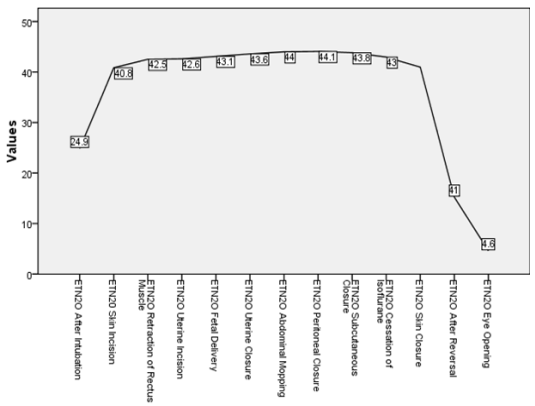

FIGURE 6: Line diagram for Endtidal Nitrous Oxide at 16 designated points.

- The mean Endtidal concentration of N_2O at intubation , skin incision ,retraction of rectus muscle ,uterine incision , delivery of foetus, uterine closure, abdominal mopping , peritoneal closure, subctaneous closure ,cessation of isoflurane, skin closure , after reversal and eye opening are 24.9, 40.8, 42.5, 42.6, 43.1, 43.6, 44, 44.4, 43.6, 43, 21, and 4.6 respectively.
- There is significant increase in Endtidal N_2O from intubation to skin incision ($P<0.001$) and after skin closure there is significant decrease in Endtidal N_2O ($p<0.001$).

TABLE 2: Clinical signs of awareness.

Intra operative recall of events	Result
1.Number of patients which could be alerted during surgery.	Nil
2.Number of patients who recall any event during surgery.	Nil
3.Number of patients who had any dreams during surgery.	Nil
4.Number of patients who heard any conversation during surgery.	Nil
5. Number of patients who had lacrimation during surgery.	Nil
6. Number of patients who had sweating during surgery.	Nil
7 Number of patients who had movements during surgery.	Nil
8 Number of patients who had jerks during surgery.	Nil

None of the patients was alerted during surgery ,none had recall or dreams during surgery and none of the patients heard any conversation during surgery. Also none of the patients had sweating , lacrimation , abnormal movements and jerks during surgery.

DISCUSSION

The major role of anesthesiologist is to prevent awareness and recall during genaral anesthesia.This is achieved by a balanced administration of analgesic, hypnotic and amnesic drugs. Awareness with recall after surgery under general anaesthesia is an infrequent but well described adverse outcome. In spite of the remarkable trend toward the use of regional anesthesia in Western Europe and USA, many Cesarean section patients still undergo the operation under general anesthesia elsewhere in the world [11,12,13,14].Some of these patients are frightened of the prospect of a needle in their back or wakefulness during major abdominal surgery [14]. Choosing the anesthesia technique in Cesarean section cases depends on several factors, such as, the nature of surgery (emergency or elective), the status of the mother and fetus, and mother's request.General anesthesia is selected more in emergency cases, such as, fetal distress and severe bleeding or in cases where regional anesthesia is contraindicated. [5,6]

Cesarean section (C/S) is one of the operations which renders patients at risk of inadequate anaesthesia. The factors which contribute to inadequate anesthesia during cesarean section include "rapid sequence" induction, avoidance of opioids and benzodiazepines before delivery, and a limited inspired concentration of the volatile anesthetic used [2,3].Other reasons include physiological changes during pregnancy such as higher cardiac output resulting in wider distribution of drugs and thus lower blood level of inducing agents and volatile anesthetics and omission or decrease in dose of some drugs to minimize their effect on uterine tone and to avoid fetal exposure. [15]

Keeping all these things in mind this study was carried in Obstetric Division of Department of Anesthesia and Critical Care SKIMS to assess the awareness in cesarean section and to ascertain the effectiveness of our anesthetic technique in preventing awareness during cesarean section under general anesthesia

The determination of awareness in patients under general anaesthesia remains a problem in spite of modern anaesthetic techniques at present [16]. It was stated that intraoperative awareness under general anaesthesia occurs at a rate ranging from 0.1% to 0.9%. Caesarean sections have been defined as a risk factor for the development of awareness under general anaesthesia [17,18].

In our study none of the patients remembered the event from induction of anesthesia until 24 hours following the surgery**.** None of our patient

remembered any dream during surgery and none of our patients heard any conversation during surgery.

In the present study according to trends in BIS and hemodynamic parameters the course of general anesthesia technique was divided into 3 different phases:

1.Induction to Intubation:
The mean BIS in our study before induction was 97.18±1.32.There was a significant fall in BIS values at the time of induction which continued till laryngoscopy and intubation.None of our patients had sweating ,lacrimation, abnormal movements and jerks during this period.The BIS values from induction until intubation never went above 60 and on an average remained 36.3±6.830 ,35±6.276 and 36.1±8.559 after giving propofol ,at laryngoscopy and after intubation respectively.

So a **significant correlation** was found between BIS and clinical signs of awareness during this period, however the initial increase in heart rate and blood pressure at laryngoscopy and intubation was probably due to autonomic response rather than inadequate depth of anesthesia.

The mean heart rate before induction in our study was 95.50±14.342.The mean heart rates after giving propofol ,at laryngoscopy and after intubation were 100.64±12.371, 111.02±10.247 and 112.22±12.711 respectively.On comparing heart rates, there was no significant change in heart rate after giving propofol ($p>0.05$) when compared to the baseline,however there was a significant change on comparing heart rate at laryngoscopy and after intubation ($p<0.001$) when compared with the baseline.

Our results were in accordance to the study conducted by Cakirtekin V ,Yildirim A et al. "Comparison of the Effects of Thiopental Sodium and Propofol on Haemodynamics, Awareness and Newborns During Caesarean Section Under General Anaesthesia".In their study it was found that, in Group P, a statistically significant increase in heart rate was observed at the 2nd, 3rd, 4th and 5th minutes ($p<0.05$), and a statistically significant decrease was seen at the 9th, 10th, 15th, 20th, 25th, 30th, 35th and 40th minutes ($p<0.05$) [11].

In our study, the mean systolic blood pressures before induction was 126±11.344. After giving propofol,at laryngoscopy and after intubation the respective systolic blood pressures were 104.44±12.848, 130.08±19.318 and 131.44±15.501. On comparing with baseline there was a significant decrease in systolic blood pressure after giving propofol ($p<0.001$) however then blood pressure significantly increased at laryngoscopy and intubation ($p<0.001$).

The initial increase in the heart rate and blood pressure at laryngoscopy and intubation was probably an autonomic response to intubation rather than inadequate depth of anesthesia.The metabolic and endocrine responses associated with the nociceptive stimulation trigger sympathetic overactivity resulting in increase in oxygen consumption and and even uterine vasoconstriction[19].Hypovolemia ,hypoxia , hypercapnia or inadequate analgesia rather than inadequate depth of anesthesia may lead to such manifestation of sympathetic stimulation.

None of the patient in our study had a fall in oxygen saturation and all patients had normal $ETCO_2$.

Endtidal volatile agent monitoring has also been used to indicate adequate anaesthesia, with end tidal isoflurane concentration of 0.2 to 0.7% combining with nitrous oxide proving satisfactory [20] .The median End tidal isoflurane after intubation in our study was 0.538 %. However this measure of adequacy of anesthetic depth has pitfalls [21] .Pregnant women have lower isoflurane requirements as reflected by concentration required for hypnosis based on electroencephalogram [22-24]

2. Skin incision to delivery of foetus.
In our study the BIS had a downward trend from intubation until delivery of fetus .This trend **correlated well** with the heart rate and blood pressure. None of the patient exhibited sweating, lacrimation, movements and jerks, which denotes that BIS correlated well with the clinical signs of awareness.

The mean BIS at skin incision ,retraction of rectus muscle uterine incision and fetal delivery were 44.6, 51.4, 48.7 and 49.6 with end tidal isoflurane concentration of 0.69%, 0.76%, 0.74% and 0.71% respectively.We had acceptable BIS score at all these points.

In a study conducted by Yeo S. N, Lo W.K. etal, the median BIS value at skin incision was 70 suggesting that an endtidal isoflurane concentration of 0.5% had not been adequate.But in our study we had mean BIS of 44.6 at skin incision.There may be three reasons for this difference. First we have high endtidal isoflurane concentration (0.69%) at skin incision .Second in our setup there is a short time interval between induction and skin incision and third we have used propofol at induction.

In a study conducted by Cakirtekin V,Yildirim A,Bakan N etal," comparison of the effects of thiopentone and propofol on hemodynamics and awareness during cesarean section under genaral anesthesia" found that mean BIS at skin incision in group T (thiopentone group) was 67.11±9.17 and in group P (propofol group) was 55.94±16.13 and the BIS at skin incision was significantly increased ($p<0.002$) in thiopentone group than propofol group.

3.Delivery of fetus to end of anesthesia:
BIS values showed a persistant upward trend after deivery of fetus until end of surgery inspite of patient receiving adequate analgesics in the form of opiates and NSAIDS.This could be due to the reason that opoids have not been reported to significantly decrease BIS but have additive effect on hypnosis and sedation.

None of the patients during this period had any clinical signs of awareness.So in our study inspite of giving opiates and NSAIDS after delivery ,BIS showed an upward trend thereby substantiating the fact that opiates have no effect on depth of anesthesia and thereby BIS.

In this period of our study although BIS continued to be on higher side , however no patient had clinical signs of awareness thereby suggesting that our anesthetic technique adopted was sufficiently adequate to prevent awareness during this period.But in this period a **poor correlation** was found between BIS and clinical signs of awareness.

The mean BIS value at uterine closure,abdominal mopping,peritoneal closure,subcutaneous closure,cessation of isoflurane, skin closure, after reversal and eye opening were 55.52, 58.60, 61.10, 60.30, 61.08, 75.34 and 92.56 respectively.This was a predictable response due to the decrease in inspiratory isoflurane concentration from 1% at delivery to 0.5% subsequently.The percentage of patients having BIS ≥60 was 50% at abdominal mopping,50% at subcutaneous closure and 60% at skin closure,but none of our patient had awareness or recall despite unacceptable BIS score .This could be due to the reason that the opoids given after fetal delivery do not significantly decrease BIS score but have additive effect on hypnosis and sedation. In a study conducted by Lysakowski C,Dumont L,Pellegrini M etal. "Effects of fentanyl, alfentanil, remifentanil and sufentanil on loss of consciousness and bispectral index during propofol induction of anaesthesia", they found that in the presence of an opioid, loss of conciousness occurred at a lower effect-site concentration of propofol and at a higher BIS 50 (i.e. the BIS value associated with 50% probability of loss of conciousness) ,compared with placebo. Although clinically the hypnotic effect of propofol is enhanced by analgesic concentrations of μ-agonist opioids, the BIS does not show this increased hypnotic effect. [25]

The hemodynamic parameters did not show a significant change as compared to the baseline. This was due to decrease in the intensity of pain stimulus (as laryngoscopy and intubation are most painful procedures in the coarse of anesthesia)[26] and secondly due to adequate analgesia given after delivery of fetus.

CONCLUSION

- The general anesthetic technique for cesarean section in our institution appears to be **adequate** to prevent awareness.
- A **close correlation** was found between BIS and clinical signs of awareness from induction till delivery of fetus. After delivery of fetus and after patients having received opiates and NSAIDS to recovery of patient BIS values were consistantly higher inspite of no clinical signs of awareness .
- On the basis of these facts it is suggested that more studies are needed to evaluate the effectiveness of BIS as a tool to monitor depth of anesthesia in patients undergoing caesarean section under general anesthesia.

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