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Research Article

A comparative study between dexmedetomidine and propofol for maintaining depth of anesthesia in elective craniotomy: a prospective randomized double blind study

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ABSTRACT

Background: The objective of present study was to assess the efficacy of dexmedetomidine over propofol in maintaining depth of anesthesia in patients undergoing elective craniotomy.
Methods: Ninety patients of American Society of Anaesthesiologists (ASA) physical status 1 or 2, of either sex, with Glasgow Coma Score (GCS) 14 or 15, scheduled for elective craniotomy, were allocated in two groups, Group D and Group P. Each group consisted of 45 patients. Anesthesia was induced with propofol and maintained with nitrous oxide in oxygen, atracurium and intermittent fentanyl. Patients in Group D received continuous infusion of dexmedetomidine 0.4 µg/kg/hour which was started after induction and stopped after closure of dura in and patients in Group P received continuous infusion of propofol 100 µg/kg/min in same manner. Heart Rate (HR), mean arterial pressure (MAP), and bispectral index (BIS) were recorded and compared at specific time points which are known to have hemodynamic alterations throughout the intraoperative period.
Results: Dexmedetomidine was comparable and even better (after intubation p 0.02, head pin fixation p 0.00, opening of dura p <0.00) than propofol in maintaining depth of anesthesia. It also attenuated HR and MAP at intubation, head pin fixation, skin incision, making of burr hole, opening of dura and at extubation (p 0.00). But Ramsay sedation score of patients after extubation in both groups did not differ significantly (p 0.36). No patient had recall.
Conclusions: Dexmedetomidine is comparable with propofol in maintaining depth of anesthesia during elective craniotomy. It can be used as a sole anesthetic agent during craniotomy.

Keywords: BIS, Dexmedetomidine, Craniotomy, Intraoperative awareness, Depth of anesthesia, Recall

INTRODUCTION

Intraoperative awareness is a rare (0.1%-0.2%) but known complication of anesthesia.[1] Although incidence of perioperative awareness in India is still unknown, the consequences are harmful to the patients as well as for the anesthesiologist. It results in physiological and psychological consequences in patients and medico legal implications in anesthesiologists.[2] Use of the bispectral index (BIS), a processed EEG in which depth of anesthesia is evaluated on a dimensionless scale from 0 to 100, is recommended.[2,3]

Anesthetic management during neurosurgery demands a stable hemodynamics and a good operating condition without sudden increase in brain volume and intracranial pressure. Thus prevention and control of hemodynamic responses to varying degree of nociceptive stimuli at critical moments of anesthesia and surgery which are known to cause hemodynamic alterations e.g.,

laryngoscopy and endotracheal intubation, head pin fixation, skin incision, traction on pain sensitive structures and extubation along with maintenance of adequate depth of anesthesia is must.[4] Rapid recovery from anesthesia is also essential here for early neurological evaluation which is possible if depth of anesthesia is monitored throughout the procedure and anesthetic agents are administered as per requirement.[4]

Dexmedetomidine, an α-2 adrenoreceptor agonist has been introduced in neuroanesthesia practice, having sympatholytic, sedative and hemodynamic stabilizing properties.[5,6] It has sedative properties comparable to natural sleep pattern when studied on normal healthy volunteers in both awake and sedated state.[7] It has also opioid and anesthetic sparing effect, for that it is a potentially useful anesthetic adjuvant for neurosurgical cases.[8] This study was designed to compare dexmedetomidine and propofol in maintaining BIS in patients undergoing elective craniotomy under general anesthesia.

METHODS

After getting approval from the institutional ethical committee and obtaining written informed consent, 90 patients, of 18-65 years, of either sex, with Glasgow Coma Scale of 14 or 15 and scheduled to have elective craniotomy under general anesthesia were enrolled in this study. The exclusion criteria were as follows: preoperative heart rate <45 beats/min, second or third degree heart block, uncontrolled diabetes mellitus, poorly controlled hypertension, antihypertensive medication with beta blocker, α methyl dopa, clonidine, or other α2 agonists, pregnant or nursing woman, morbid obesity, psychiatric diseases, renal and hepatic diseases.

Balanced randomization using permuted blocks was applied. The patients were randomized into two (2) groups, each comprising of 45 patients (Figure 1). Routine medications were continued as clinically applicable. On arrival to operating room, standard monitors were attached and a central venous line in subclavian vein and a radial arterial cannulation were done under local anesthesia for central venous and arterial pressure monitoring as well as for blood sampling. BIS (Aspect Medical systems, Newtown, MA, USA) sensors and monitor were attached as per recommendations. Baseline BIS value was noted. Patients in both groups were premedicated with glycopyrrolate 0.2 mg, ondansetron 4 mg, fentanyl @ 2 µg/kg and preoxygenated for 3 minutes. Group D**,** the dexmedetomidine group received dexmedetomidine infusion 0.4 µg/kg/hour which was started after induction and discontinued after dura closure. Dexmedetomidine was supplied in 2-mL ampoules with a concentration 100 µg/ml and this volume was diluted with 48 mL of normal saline to yield a final concentration 4 µg/ml. Group P, the propofol group received propofol @100 µg/kg/min as same manner. Drugs were prepared and administered by one anesthesiologist who was completely unaware of the study and its objectives and data were recorded by the investigator. Patients in both groups were induced with propofol 1-2 mg/kg slow i.v and tracheal intubation was facilitated with atracurium 0.5 mg/kg as a bolus dose over 30 sec. Patients were moderately hyperventilated with oxygen and nitrous oxide (1:1) and adjusted to maintain $PaCO_2$ between 30 and 35 mmHg. The depth of anesthesia was maintained with infusion of dexmedetomidine in group D and propofol in group P. Both group received atracurium as intravenous infusion at a rate of 0.5 mg/kg/hour and. Bolus doses of fentanyl (2 µg/kg) were administered before head pin fixation. Mannitol (1 gm/kg) was administered to every patient during the first burr hole. Dexmedetomidine and propofol infusions were stopped after dura closure. Fluid resuscitation and maintenance fluids were provided with glucose free iso-osmolar crystalloid solutions 2-3 ml/kg/hour, and replacement of blood loss was done as per standard guideline. Urine output was monitored. All patients received ondansetron 4 mg approximate 30 minutes before extubation and underwent routine reversal of neuromuscular blockade. Patients were awakened and extubated in the operation theatre, assessed for sedation level by Ramsay sedation score and transferred to postanesthesia care unit after following simple commands (Table 1). After gaining full consciousness, every patient was interviewed with Brice questionnaire for any recall or intraoperative awareness (Table 2).

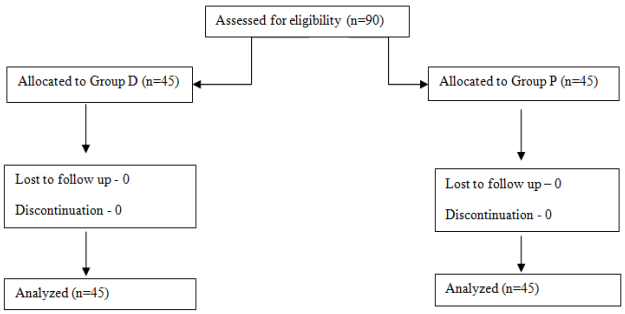

Figure 1: Study algorithm.

Table 1: Ramsay sedation scale.

Sedation level	Description
1	Anxious and agitated
2	Cooperative, tranquil, oriented
3	Responds only to verbal command
4	Asleep with brief response to light stimulation
5	Asleep without response to light stimulation
6	Nonresponsive

Heart rate, mean arterial pressure, and BIS were recorded and compared at the following time points - T0-baseline, T1-after intubation, T2-head pin fixation, T3-skin incision, T4-during burr hole, T5-at opening of dura and T6-at extubation.

Table 2: Brice questionnaire for assessing recall.

Brice questionnaire for assessing recall	
1	What is the last thing you remembered before going to sleep?
2	Which is the first thing you remembered on waking?
3	Do you remember anything between going to sleep and waking?
4	Did you dream during surgery?
5	Which is the worst thing about surgery?

Hemodynamic events that required treatment were defined as hypotension - mean arterial pressure (MAP) <60 mmHg, hypertension - mean arterial pressure (MAP) >120 mmHg, bradycardia - Heart Rate (HR) <50 beats/minute, and tachycardia - HR >100 beats/min.

Hypertension and or tachycardia with BIS >60 was managed with administration of isoflurane. But those events in spite of maintaining BIS 60 were managed with bolus i.v fentanyl 1-2 µg/kg. If not corrected then incremental doses of labetolol 10 mg was administered. Hypotension was proposed to be managed with fluid and an incremental dose of phenylephrine 100 µg. Symptomatic bradycardia was treated with 0.5 mg i.v atropine.

The numbers of interventions done when hemodynamic variables were outside the predetermined window were recorded.

Statistical analysis

According to statistical power analysis 90 patients were needed to provide a study power of 85% and probability of type 1 error of 5%. All statistical tests were done using computer programs Microsoft Excel spreadsheet version 2007 (Microsoft Corporation, New York, USA) and XLSTAT version 2015.4.01.20780 (Adinsoft) statistical program for Microsoft Windows. All tests were two tailed and p value less than 0.05 were considered statistically significant. Continuous data between groups were analyzed using Student's t test or Mann Whitney U test depending on the normality of the data. Dichotomous data were analyzed using Pearson's chi square test or Fisher's exact test as applicable. Data are expressed as mean ± Standard Deviation (SD) for continuous normally distributed variables, median and interquartile range for non-normally distributed data, and proportion or counts for categorical data.

RESULTS

After applying the inclusion and exclusion criteria, ninety patients, aged between 18-65 years, ASA grade I and II, scheduled to undergo elective craniotomy, were studied.

Both groups were comparable for demographic characteristics (Table 3).

Table 3: Demographic data.

Baseline demographic variables	Group D (n=45)	Group P (n=45)	p value
Age (years)	42.36±13.36	38.33±13.13	0.5
Sex (M/F)	22/23	19/26	0.817
Body weight (kg)	57.44±7.7	57.02±7.8	0.797
ASA grade 1 / grade 2	30/15	28/17	0.9
Type of brain tumour: Meningoma Glioma Astrocytoma	 23 16 6	 22 18 5	0.994
Presence of hypertension	12/33	13/32	0.973
Duration of surgery	275.82±24.25	275.56±22.63	0.957

Baseline demographics were comparable in both groups. No statistically significant differences seen between the groups.

Requirement of propofol as induction agent in group D and C was 10.84±1.47 ml and 10.35±1.43 ml respectively without significant difference (p 0.11) (Figure 2).

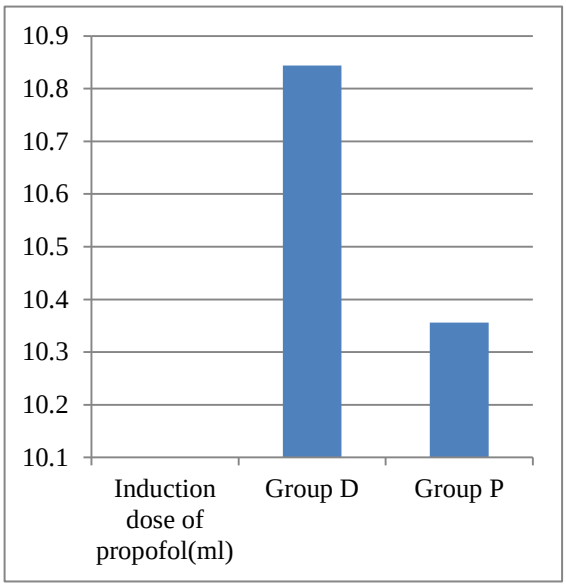

Figure 2: Comparison of induction dose of propofol between Group D and Group P.

Figure 2 compares induction dose of propofol in both groups without any statistically significant difference (p >0.05).

The time from induction of anesthesia to extubation was 275.82±24.25 minutes and 275.56±22.63 minutes in group D and group C respectively and it was comparable (p 0.957) (Figure 3).

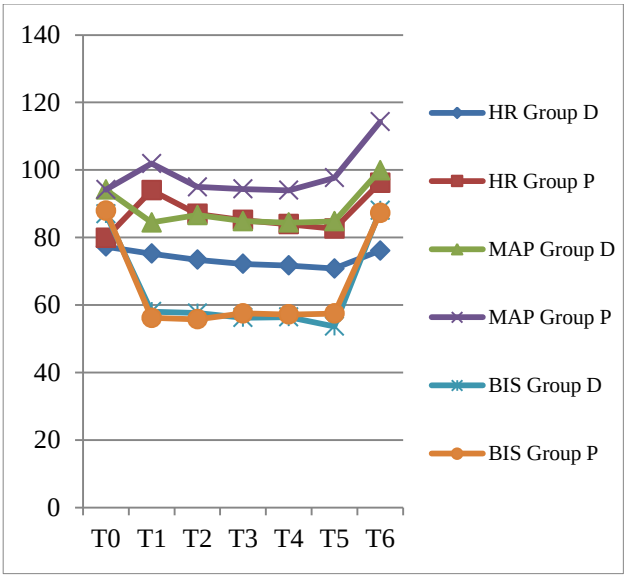

Figure 3: Comparison of HR, MAP and BIS in between Group D and Group P at different time points.

Figure 3 compares intraoperative HR, MAP and BIS between Group D and Group P. Data were collected at following specific time points: T0 - baseline, T1 - intubation, T2 - head pin fixation, T3 - incision, T4 - burr hole, T5 - at opening of dura, T6 - after extubation. It had been shown that though intraoperative hemodynamics was better maintained in Group D, it was comparable with Group P while considering maintenance of adequate depth of anesthesia.

Baseline heart rate, mean arterial pressure and BIS were comparable in both groups (p>0.05). Increase in heart rate and mean arterial pressure was attenuated better in group D (p <0.05) at the time of head pin fixation (p 0.001), skin incision (p 0.001), making of burr hole (p 0.001), opening of dura (p 0.001) and extubation (p 0.001) (Table 4, 5).

Table 4: Comparison of heart rate (beats per minute) at specific time points (mean±SD).

Specific time points	Group D (n=45)	Group P (n=45)	p value
T0	77.31±11.75	79.84±14.22	0.357
T1	88.78±17	93.96±14	0.107
T2	73.38±14.58	86.97±12.23	*0.0001
T3	72.18±13.66	85.15±14.89	*0.0001
T4	71.69±13.57	83.91±13.59	*0.0001
T5	70.8±12.64	82.6±13.73	*0.0001
T6	76.1±12	96.22±15.7	*0.0001

Table 4 shows intraoperative heart rate at specific time points mean±standard deviation. There were statistically significant differences between the groups. *Denotes statistically significant differences. Data were collected at following specific time points: T0 - baseline, T1 - intubation, T2-head pin fixation, T3-incision, T4 - burr hole, T5 - at opening of dura, T6 - after extubation.

Table 5: Comparison of mean arterial pressure (mmHg) at specific time points (mean±SD).

Specific time points	Group D (n=45)	Group P (n=45)	p value
T0	94.16±10.65	94.16±11.2	1.000
T1	89.22±13.8	95±16	0.219
T2	86.64±9.98	95±10.2	*0.001
T3	84.84±8.72	94.38±11.4	*<0.0001
T4	84.4±10.54	94±13.4	*0.000
T5	84.78±11.25	97.69±10.9	*<0.0001
T6	99.89±9.61	114.29±6.9	*<0.0001

Table 5 shows intraoperative recording of mean arterial pressure at specific time points mean ±standard deviation. There were statistically significant differences between the groups which have been denoted by*. Data were collected at following specific time points: T0 - baseline, T1- intubation, T2 - head pin fixation, T3 - incision, T4 - burr hole, T5 - at opening of dura, T6 - after extubation.

Dexmedetomidine maintained depth of anesthesia better in group D throughout the intraoperative period (p <0.05) though it was comparable with propofol during certain noxious stimulations like skin incision (T3), burr hole (T4) and extubation (T6) (p >0.05) (Table 6).

Table 6: Comparison of BIS at specific time points (mean±SD).

Specific time points	Group D (n=45)	Group P (n=45)	p value
T0	87±3	87.91± 4.8	0.2
T1	58.04±3.6	56.2± 3.96	*0.02
T2	57.62± 3.09	55.75± 3.05	*0.004
T3	56.24± 3.62	57.49±2.23	0.050
T4	56.422±3.53	57.2±3.42	0.289
T5	53.66± 5.55	57.46±2.38	*<0.0001
T6	88.02± 2.41	87.29±4.44	0.330

Table 6 shows intraoperative recording of BIS at specific time points mean±standard deviation. There were statistically significant differences between the groups denoted by*. Data were collected at following specific time points: T0 - baseline, T1 - intubation, T2 - head pin fixation, T3 - incision, T4 - burr hole, T5 - at opening of dura, T6 - after extubation.

It was found that total seven (15%) patients suffered from tachycardia in group D whereas it was 28 patients (62%) in group P (p <0.001) (Table 7). Use of esmolol was significantly lower in group D (p < 0.00). Bradycardia occurred in 10 patients and 4 patients in group D and group P respectively (p 0.089) which had no significant difference (Table 7). Four (4 patients, 8.8%) patients in group D received intravenous atropine to combat unstable bradycardia while it was three (3 patients, 7.14%) in group P without having any significant difference (p 0.925) (Table 7). Significant difference in occurrence of both intraoperative hypertension and hypertension at

extubation was found (p 0.002 and p 0.021 respectively) (Table 7).

Table 7: Intraoperative adverse events in both groups.

Adverse events and interventions	Group D (n=45)	Group P (n= 45)	p value
Tachycardia (yes/no)	7/38	28/17	*<0.0001
Bradycardia (yes/no)	10/35	4/40	0.089
Hypotension (yes/no)	0/45	0/45	1.000
Intraoperative hypertension (yes/no)	1/44	11/34	*0.002
Hypertension at extubation (yes/no)	0/45	5/40	*0.021
Use of labetelol (yes/no)	2/43	11/34	*0.007
BIS>60 (yes/no)	14/31	9/36	0.227
Use of esmolol (yes/no)	5/40	27/18	*<0.0001
Use of atropine (yes/no)	4/41	3/42	0.925

Table 7 shows adverse intraoperative events and their management in both the groups. Lesser number of patients in Group D suffered from tachycardia than found in Group P (p <0.001). Also incidence of intraoperative hypertension, hypertension at extubation, intravenous Labetelol use for intraoperative hypertension, intravenous Esmolol administration for tachycardia was found to be lesser in Group D and it was statistically significant (p <0.05).
Incidence of bradycardia, hypotension, administration of atropine, BIS >60 were found as having no significant difference between both groups (p >0.05).
*Denotes statistically significant p value.

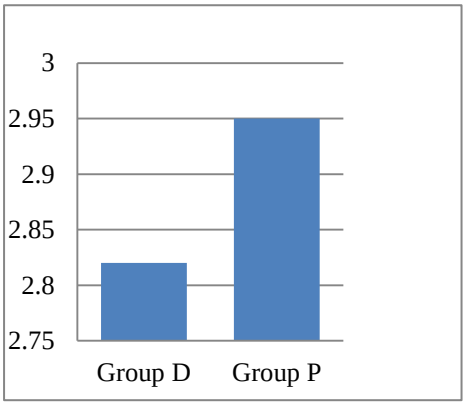

Figure 4: Comparison of Ramsay sedation score after extubation in between Group D and Group P.

Figure 4 showing comparison of Ramsay sedation score after extubation in both the groups. There was no significant difference.

No patient suffered from intraoperative hypotension. Every cases of altered hemodynamics received medical intervention as per protocol. Intravenous labetelol was used to treat hypertension only in 2 patients in group D, whereas it was administered in 11 patients in group P (p 0.007). Total 14 patients in group D (31%) had BIS >60 at some time points during intraoperative period whereas it was 9 patients (20%) in group P (p 0.227). After extubation every patient was assessed with Ramsay sedation scale for their post extubation sedation level without any significant difference (p 0.363) (Figure 4). All of them maintained SpO_2 in the range of 95-100% and received supplemental O_2 40% via face mask postoperatively. They were shifted to neuro intensive care unit after extubation. No patient in both groups had recall when interviewed with modified Brice questionnaire.

DISCUSSION

We conducted the prospective randomized double blind study to examine whether dexmedetomidine is comparable with propofol in maintaining depth of anesthesia during elective craniotomy or not by measuring BIS values at specific time points which are common noxious stimulus during craniotomy. It demonstrated that both the drugs are comparable though dexmedetomidine maintained the BIS value better sometimes (Table 5). As a secondary outcome measure, better maintenance of intraoperative hemodynamic stability and comparable incidence of recall was observed with dexmedetomidine.

Intraoperative awareness is a result of imbalance between the depth of anesthesia and the stimulus to which patient is exposed. Awareness can be complicated by a spectrum of psychological symptoms ranging from anxiety, fear of surgery and anesthesia, sleep disturbances to flashbacks, nightmares and post-traumatic stress disorder or depression.[2] There are also consequences for the anesthesiologist too as medico-legal implications. An analysis of the ASA closed claim project showed that 2% claims were for awareness and blamed substandard anesthetic care.[9] Despite the relatively low frequency, the problem is quite serious if we consider that 50-54% of the patients are afraid that they will wake up during surgery.[10,11] Traditionally cardiovascular parameters are usually relied upon to assess the depth of anesthesia. It is assumed that lighter plane of anesthesia will manifest itself by causing hypertension and tachycardia, as well as other signs of sympathetic nervous system stimulation such as lacrimation, pupillary dilatation and sweating along with movement with surgical stimulus. But during neurosurgery, no patients are allowed to have movement or above mentioned autonomic responses. And also, measuring the depth of anesthesia by raw EEG is not practical.[12] Here comes the utilization of bispectral index (BIS), a noninvasive processed EEG as a monitor for assessing anesthetic depth in our study. Bispectral index is determined by the weighted parameters of measurements of brain's electrical activity, i.e. the frequency, amplitude, and the sequence of fast Fourier analysis. The model was developed by recording and studying this type of data from more than 1000 EEG from normal volunteers (both when awake and when under sedation by hypnotic drugs); the data are then transformed into a linear dimensionless scale from 0 to 100, known as BIS value where BIS value of 100 denotes fully awake state of mind and a value of zero (0) denotes

no electrical activity at all.[13] Recall of words or pictures is depressed at BIS values of 70 to 75. Explicit recall is significantly diminished as BIS decreases below 70, and BIS of 40 to 60 correlates with general anesthesia, EEG burst suppression occurs at BIS below 20. Increasing concentrations of hypnotic agents predictably lower BIS.

Other than inhalational agents, propofol is commonly used for sedation and maintaining anesthetic depth. Dexmedetomidine, a newer α2 agonist, has been introduced to neuroanesthesia practice because of it's sedative, anesthetic and analgesic sparing properties and simultaneously maintaining the hemodynamic stability and preserving cerebral homeostasis.[5,6,14] But in present study, attenuation of heart rate and mean arterial pressure during intubation is not demonstrated though it was observed at other known noxious stimulations during surgery. Probably starting the dexmedetomidine infusion after induction of anesthesia was the cause. When compared with propofol and midazolam, dexmedetomidine was found to be equally effective in maintaining adequate sedation for prolonged mechanical ventilation.[15] Analysis of sleep spindles shows that dexmedetomidine produces a state closely resembling physiological S2 sleep in human.[7] Yusuke, et al. studied on volunteers and compared BIS value with OAA/S scoring both with propofol and dexmedetomidine and observed that equivalent dose of dexmedetomidine produced lower BIS value than propofol.[16] In another study, it has been concluded that dexmedetomidine is comparable with propofol as maintenance anesthetic agent and it can produce better control of hemodynamic variables and BIS values.[17] It was also proposed as a sole anesthetic agent for maintaining depth of anesthesia in one study.[17] But there were paucity of data regarding maintenance of anesthetic depth and incidence of awareness with use of dexmedetomidine in neurosurgery. In view of the above observations, our study was done to assess whether dexmedetomidine is as effective as propofol in maintaining intraoperative depth of anesthesia in patients undergoing elective craniotomy or not. Our study corroborates with the previous studies.[15-17] In our study intraoperative adverse events in the form of tachycardia, hypertension - both during intraoperative period and at extubation, use of labetelol and esmolol was significantly more in group P which demonstrated that hemodynamic stability was significantly better in dexmedetomidine group. There was no difference in occurrence of bradycardia and hypotension in between groups. HR was better attenuated in dexmedetomidine group at different times which are known nociceptive stimulus. Cases when BIS was out of range (>60) for general anesthesia were noted and it was more in group D though statistically not significant.

In the 'B-aware' study, comparing BIS to standard practice in high risk of awareness patients, BIS monitoring reduced the incidence of awareness, but two cases of awareness among 1225 patients were observed in the BISTM-monitored group.[18] Brice questionnaire is accepted tool for detecting recall. Patients in our study were asked for any recall, i.e., explicit memory, which may not be equal to the incidence of actual awareness. In our study, dexmedetomidine was found to be comparable with propofol when intraoperative BIS and postoperative recall was considered. Depth of anesthesia during intraoperative period was maintained in both groups though dexmedetomidine maintained intraoperative depth better at certain points of time. There was no significant difference in occurrences of BIS more than 60 during intraoperative period.

There were some limitations of our study. We did not administer loading dose of dexmedetomidine. As we selected a constant dexmedetomidine infusion rate of 0.4μg/kg which was started after induction of anesthesia, attenuation of heart rate and mean arterial pressure during intubation was not demonstrated in our study and there was no difference in propofol requirement during induction. We did not use target controlled infusion and selected a midrange continuous infusion dose. So with a study design in which the anesthesiologist would be permitted to titrate the dexmedetomidine and propofol dose, further improvements in knowledge of dose to maintain adequate depth of anesthesia with shorter awakening times might be demonstrated.

CONCLUSION

In conclusion, a continuous infusion of dexmedetomidine maintained adequate depth of anesthesia, hemodynamic stability which was comparable with propofol in patients undergoing craniotomy without increasing the incidence of hypotensive episodes or bradycardia. It may be used as a sole anesthetic agent for maintenance of anesthesia during elective craniotomy.

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Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Sandin RH, Enlund G, Samuelsson P, Lennmarken C. Awareness during anaesthesia: a prospective case study. Lancet. 2000;355:707-11.
2. Akavipat P, Sookplung P, Muansaiyart P. The Thai anesthesia incident monitoring study (Thai AIMS): an analysis of 21 awareness events. J Med Assoc Thai. 2009;92:335-41.
3. Akavipat P. Bispectral index. Thai J Anesth. 2001;26:261-7.
4. Jagia M, Prabhakar H, Dass HH. Comparative evaluation of spectral entropy and bispectral index during propofol/thiopentone anaesthesia in patients with supratentorial tumours - a preliminary study. Indian J Anaesth. 2008;52(2):175-8.
5. Gunes Y, Gunduz M, Ozcengiz D, Ozbek H, Isik G. Dexmedetomidine-remifentanil or propofol-

remifentanil anesthesia in patients undergoing intracranial surgery. Neurosurg Q. 2005;15:122-6.
6. Tanskanen P, Kytta J, Randell T, Aantaa R. Dexmedetomidine as an anaesthetic adjuvant in patients undergoing intracranial tumor surgery: a double-blind, randomized and placebo-controlled study. Br J Anaesth. 2006;97:658-65.
7. Huupponen E, Maksimow A, Lapinlampi P, Sarkela M, Saastamoinen A, Snapir A, et al. Electroencephalogram spindle activity during dexmedetomidine sedation and physiological sleep. Acta Anaesthesiol Scand. 2008;52:289-94.
8. Scheinin B, Lindgren L, Randell T, Scheinin H, Scheinin M. Dexmedetomidine attenuates sympathoadrenal response to tracheal intubation and reduces the need for thiopentone and peroperative fentanyl. Br J Anaesth. 1992;68:126-31.
9. Domino KB, Posner KL, Caplan RA, Cheney FW. Awareness during anesthesia - a closed claim analysis. Anesthesiology. 1999;90:1053-61.
10. Sandlin D. A closer look at bispectral index monitoring. J Perianesth Nurs. 2001;16:420-2.
11. Ishizawa Y. Mechanisms of anesthetic actions and the brain. J Anesth. 2007;21:187-99.
12. Ropcke H, Konen- Bergman M, Cuhls M, Bouillon T, Hoeft A. Propofol and remifentanil pharmacodynamic interaction during orthopaedic surgical procedures as measured by effects on bispectral index. J Clin Anesthesiol. 2001;13:198-207.
13. Rosow C, Manberg PJ. Bispectral index monitoring. Anesthesiol Clin North Am. 2001;19:947-66.
14. Roy A, Sarkar S, Santra S, Banerjee A, Ganguly S. Role of dexmedetomidine on hemodynamics and anesthetic requirement during elective intracranial tumor surgery - a prospective randomized double blind placebo controlled study. J Clin Sci Med Res. 2015;3(8):7236-47.
15. Jakob SM, Ruokonen E, Grounds RM, Sarapohja T, Garrat C, Pocock SJ, et al. Dexmedetomidine vs. midazolam or propofol for sedation during prolonged mechanical ventilation: two randomized control trials. JAMA. 2012;307:1151-60.
16. Kasuya Y, Govinda R, Rauch S, Mascha EJ, Sessler DI, Turan A. The correlation between bispectral index and observational sedation scale in volunteers sedated with dexmedetomidine and propofol. Anaesth Analg. 2009;109:1811-5.
17. Chattopadhyay U, Mallik S, Ghosh S, Bhattacharya S, Bisai S, Biswas H. Comparison between propofol and dexmedetomidine on depth of anesthesia: a prospective randomized trial. J Anaesthesiol Clin Pharmacol. 2014;30:550-4.
18. Myles PS, Leslie K, McNeil J, Forbes A, Chan MTV. Bispectral index monitoring to prevent awareness during anaesthesia: the B-Aware randomised controlled trial. Lancet. 2004;363:1757-63.

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