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DEXMEDETOMIDINE REDUCES MINIMUM ALVEOLAR CONCENTRATION (MAC) OF ISOFLURANE IN PATIENTS UNDERGOING LUMBAR LAMINECTOMY

Anaesthesiology

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ABSTRACT

Background: Dexmedetomidine, an alpha-2 agonist used as an adjuvant in general anaesthesia has anaesthetic sparing property.
Aims: To study the effect of dexmedetomidine on requirement of isoflurane during general anesthesia with bispectral monitoring of depth of anaesthesia .
Materials and Methods: One hundred patients were randomly divided into 2 groups of 50 each. In group F, fentanyl 2 mcg/kg was given while in group D, dexmedetomidine was given intravenously as loading dose of 1 mcg/kg over 10 min prior to induction. After induction with propofol in group B, dexmedetomidine was given as infusion at a dose of 0.2-0.7 mcg/kg/hour. Isoflurane was used as inhalation agent in both groups. Hemodynamic variables, BIS and minimum alveolar concentration (MAC) of isoflurane were continuously recorded. Statistical analysis was done by unpaired student's t-test and Chi-square test for continuous and categorical variables, respectively. p-value < 0.05 was considered significant.
Results: The use of dexmedetomidine was associated with a statistically significant decrease in MAC of isoflurane in group D (0.759±.012) as compared to group F (0.901±0.030).
Conclusion: Dexmedetomidine decreases isoflurane requirement for maintaining adequate depth of anaesthesia.

KEYWORDS

Depth of anesthesia, dexmedetomidine, BIS, fentanyl, isoflurane

INTRODUCTION

The induction of immobility in response to surgical stimulation is an essential feature of general anaesthesia. The capability of volatile anaesthetics to immobilize patients who are exposed to noxious stimulation is measured using the MAC which is defined as alveolar concentration of anaesthetic that prevents movement in 50% of subjects in response to a noxious stimulus.[1] The MAC is influenced by several drugs including fentanyl [2], midazolam [3], propofol [4], and clonidine.[5] Several brain-function monitors based on the processed electroencephalogram or evoked potentials have been developed to assess anaesthetic depth, bispectral index (BIS) being one among them. BIS value ranges from 100 to 0 reflecting the awake state and the absence of brain activity, respectively. BIS values between 40 and 60 indicate adequate general anaesthesia for surgery, and value below 40 indicates a deep hypnotic state.

The effect of intravenous anaesthetics and opioids on the MAC of various inhaled anaesthetics in a balanced anaesthesia setting have been studied.[6,7] In this study we aimed to study the effect of perioperative dexmedetomidine infusion on the MAC of isoflurane in a balanced anaesthesia technique by correlating it with the depth of anaesthesia as assessed by the Bispectral Index (BIS). The analgesic effect of dexmedetomidine is qualitatively different as compared to opioids and can be used as an alternative to opioids in general anaesthesia.[8-10]

MATERIAL AND METHODS

The study was a prospective, randomized double blind trial and included 100 patients who had to undergo laminectomy for prolapsed intervertebral disc in the lumbar region. Permission from the Institutional ethical committee was taken and due written informed consent from the participants of the study was taken. The consenting patients were randomly allocated into one of the two groups based on the simple randomization table generated: Group F (control group): Isoflurane-fentanyl and group D (test group): Isoflurane-dexmedetomidine.

Inclusion criteria

1. Patients of either gender above the age of 18 years.
2. ASA physical status I and II.
3. Duration of surgery less than or equal to 2 hours.

Exclusion criteria

1. Refusal to participate in the study.
2. Allergic to dexmedetomidine.
3. Pre-existing respiratory, renal, cardiovascular or hepatic disease.
4. Heart block on ECG
5. Morbid obesity
6. Pregnancy
7. History of drug abuse, poor comprehension and a psychiatric disturbance which limited proper patient cooperation.

A reliable intravenous access was secured on the non-dominant hand. Group D received dexmedetomidine in a loading dose of of 1 mcg/kg over 10 min prior to induction. After induction with propofol in group D, dexmedetomidine was given as infusion at a dose of 0.2-0.7 mcg/kg/hour till the end of surgical procedure or upto a maximum of 2 hours (whichever was earlier). Group F was given 2 mcg/kg fentanyl intravenous slowly two miutes before induction. Group allotments were done at random and by research personnel not directly involved with patient care. The same research personnel prepared syringes labelled with the study drug to blind subjects enrolled in the study, anaesthesia providers, and investigators collecting the data. All the subjects were premedicated with 0.25 mg Alprazolam tablet and 40 mg of pantoprazole tablet. The patients were shifted to the operating room on a trolley with oxygen facility and SpO_2 monitor. BIS electrodes were attached and a baseline reading of BIS was taken. Anaesthesia was induced with 2 mg/kg body weight of propofol. Atracurium 0.5mg/kg was used to induce a neuromuscular block. Bag and mask ventilation was done for 3 minutes. Tracheal intubation was performed by a qualified anaesthetist. Anaesthesia maintenance was achieved using oxygen, nitrous, isoflurane and atracurium titrated to maintain a blood pressure within 20% of the baseline and a BIS (bispectral index) between 40 and 60. Gas flows were kept constant between the two groups. During the intraoperative period measurements of MAC of isoflurane used to maintain anaesthesia within the prefixed limits were taken at regular intervals.. Neuromuscular blockade was reversed at the end of the surgical procedure using 60 mcg/kg of Neostigmine and 10 mcg/kg of Glycopyrrolate. Ondensetron 0.1 mg/ kg was used as an anti-emetic in both the groups. For analgesia the subjects in both the groups were given 30 mg of IV ketorolac, 1 gm IV paracetamol and local infiltration of wound with ropivacaine at the end of the surgery.

STATISTICAL ANALYSIS

The data was entered in Microsoft Excel spreadsheet and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were summarized in the form of means and standard deviations and categorical variables as percentages.

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Student's independent t-test was used for parametric data. Chi-square test or Fisher's exact test was used for categorical variables. A P-value of less than 0.05 was considered statistically significant.

RESULTS

The two groups were comparable with reference to age (Table 1), gender (Table 2), body weight (Table 3) and duration of anaesthesia (P>.05) (Table 4) Pre-induction heart rate, systolic and diastolic blood pressures were similar between two groups (P > 0.05) .During anaesthesia maintenance, group D showed a statistical significant decrease in heart rate(figure 1), systolic and diastolic blood pressure(figure 2,3) from baseline at all time points as compared to the group F (P < 0.05). No significant respiratory depression was reported in any patient in this study and none of the patients had a SpO_2 value of < 99% on pulse oximetry. The depth of anesthesia as assessed by bispectral index (BIS) was comparable between two groups at all time points during maintenance period (P > 0.05)(figure 4). The BIS was maintained between 40 and 60 during the surgery. It was found overall average MAC of isoflurane in Group D was (0.759±0.012) and in control group it was (0.901±0.030)(figure 5). The two groups showed statistically significant difference (p=0.001). Two patients in the dexmedetomidine group had bradycardia where atropine 0.5 mg iv bolus had to be given and they responded to it.

DISCUSSION

Alpha-2 adrenoceptor agonists have been used as adjuvant to anaesthetic agents in peri-operative period for several beneficial actions. These drugs improve hemodynamic stability during endotracheal intubation and surgical stress by central sympatholytic action, and thus reduce anaesthetic and opioid requirements.[11] Dexmedetomidine is highly selective and specific alpha-2 adrenoceptor agonist.[12,13] The analgesic effect of dexmedetomidine is qualitatively different as compared to opioids and can be used as an alternative to opioids in general anesthesia.[8-10].

The main finding in our study was that dexmedetomidine as an adjuvant in general anesthesia causes reduction in requirement of isoflurane without compromising adequate depth of anaesthesia. Hence it has anaesthetic-sparing property. Anaesthetic–sparing effect of dexmedetomidine in our study is consistent with earlier studies. A study done on patients undergoing hysterectomy showed a 30% reduction in maintenance concentration of isoflurane.[14]. Similarly, a reduction in 35% to 50% in isoflurane concentration with low or high dose of dexmedetomidine was found in a study on healthy human volunteers.[15] .Similar results were seen by Fragen, et al.[16] in elderly patients who showed a 17% reduction in isoflurane concentration requirement.

Dexmedetomidine causes a reduction in heart rate and blood pressure by its sympatholytic action, thus assessing the depth of anaesthesia by hemodynamic parameters would be unreliable in evaluating its effect on requirement of inhalational agent. Various electroencephalogram-dependent indices like bispectral index and entropy have been used to measure the depth of anaesthesia.[17] BIS is a useful for measurement of the electroencephalographic effects of increasing and decreasing sevoflurane concentration and assessing the depth of anesthesia.[17,18] .Using bispectral index to assess the depth of anaesthesia, Magalhães et al. showed decreased requirement of sevoflurane with continuous infusion of dexmedetomidine during general anaesthesia[19]. In our study, we used BIS to measure the depth of anaesthesia, thereby eliminating the bias of evaluation by hemodynamic variables Use of fentanyl reduces minimum alveolar concentration (MAC) of sevoflurane significantly.[20] Use of opioids along with dexmedetomidine would confound its effect on requirement of inhalation agent. Hence, in our study, fentanyl was not administered in group D.

CONCLUSION

Dexmedetomidine infusion in general anaesthesia, significantly decreases the requirement of isoflurane for maintaining adequate depth of anaesthesia. Studies measuring plasma concentration of dexmedetomidine should be undertaken to establish the accurate correlation between its dose and inhalational agent's requirements.

Table 1: Age distribution of studied patients

Age (Years)	Mean	SD	Range	P-value
Group D	37.1	10.23	18-59	0.553
Group F	38.2	9.30	19-58	

Table 2: Gender distribution of studied patients

Gender	Group D		Group F		P-value
	No.	%age	No.	%age	
Male	26	52.0	30	60.0	0.533
Female	24	48.0	20	40.0	
Total	50	100	50	100	

Table 3: Distribution of weight (kg) in studied patients

Weight (kg)	Mean	SD	Range	P-value
Group D	62.4	9.14	46-80	0.667
Group F	62.7	7.39	48-79	

Table 4: Showing duration of anaesthesia (minutes) of studied patients

Operative time (minutes)	Mean	SD	Range	P-value
Group D	143.3	34.25	84-180	0.567
Group F	141.5	33.66	85-180	

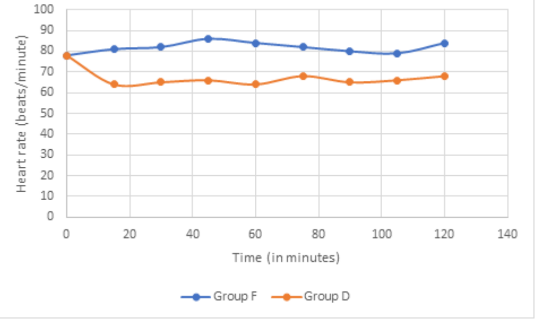

Figure 1: Showing post induction heart rate in the two groups

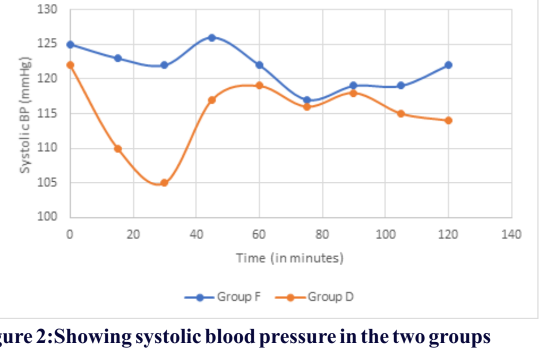

Figure 2:Showing systolic blood pressure in the two groups

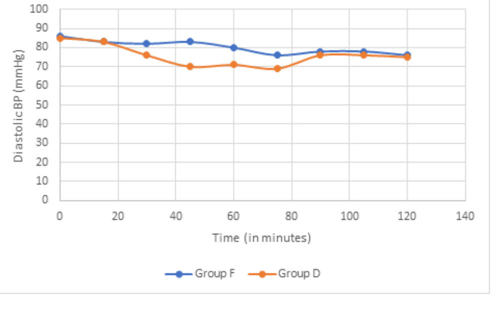

Figure 3:Showing diastolic blood pressure in the two groups

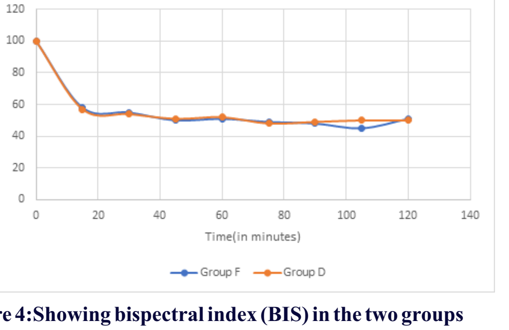

Figure 4:Showing bispectral index (BIS) in the two groups

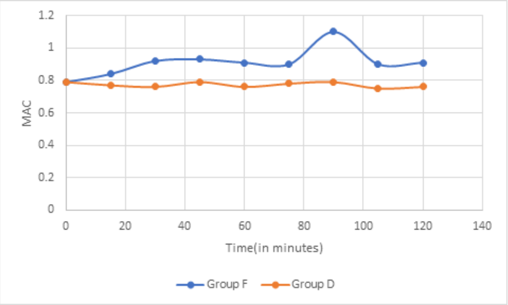

Figure 5:Showing minimum alveolar concentration (MAC) in the two groups

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