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# Effectiveness of dexmedetomidine as an adjuvant on hemodynamic parameters and recovery profile of patients undergoing sitting position intracranial tumour surgeries with desflurane as maintenance agent: A randomized prospective comparative double blinded study

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**Abstract: Background:** We aimed to study the influence of low dose dexmedetomidine as an adjuvant on hemodynamic parameters and recovery profile of patients maintained on desflurane for sitting position intracranial tumor surgeries.
**Method:** 60 ASA class I to III patients undergoing elective sitting position intracranial tumor surgery were randomized to receive either Dexmedetomidine infusion at the rate of 0.25 $\mu$g/kg/hr (Group D) or normal saline infusion (Group C) from the time patient was taken on table and continued till the end of dura closure. Monitoring done for hemodynamic changes, minimum alveolar concentration, BIS, recovery endpoints and adverse events.
**Result:** The heart rate was comparable in both the groups at baseline and decreased significantly in patients of Group D. The mean MAC in patients of Group C was high. The Bispectral Index values decreased significantly in patients of Group C as compared to Group D till the end of the study. The recovery endpoints parameters were significantly lower in patients of Group D as compared to patients of Group C. Ramsay Sedation Score was significantly lower in Group D compared to Group C from the time of discontinuation of anesthesia delivery till the end of 120 mins. This difference was statistically significant as per Student t-test ($p<0.05$).
**Conclusion:** Dexmedetomidine infusion started in low dose before surgery maintains hemodynamic stability intraoperatively, reduces the amount of anaesthetic drug required for induction, decreases the requirement of analgesic drug without any residual sedation.

**Keywords:** Posterior fossa; Neuro anaesthesia; Desflurane; Dexmedetomidine.

## 1. Introduction

Evolving neurosurgical practice presents new challenges for the anesthesiologist, including providing optimal operative conditions, maintaining cerebral perfusion pressure and oxygenation, preserving neurocognitive function, and ensuring a rapid and high-quality recovery [1]. The sitting position, although ideal for surgical access to the posterior fossa, poses unique physiological challenges and carries the risk of serious complications [2]. The anesthesia goals for these surgeries are to create favorable operating conditions, maintain stable cerebral hemodynamics without sudden increases in intracranial pressure, and facilitate rapid recovery. Rapid recovery allows for immediate neurological evaluation, early detection of intracranial complications, and prompt reintervention if required [3].

Desflurane, characterized by low blood-gas solubility, offers a favorable recovery profile, but its impact on the heart limits its use in neurosurgical patients [4,5]. Dexmedetomidine, an alpha2 agonist, exerts its effects by reducing central nervous system activation mediated by the vasomotor center, resulting in sympatholysis, sedation, anxiolysis, and analgesia. It possesses anesthesia-sparing effects without significant

respiratory depression [6–8]. At low doses (0.25 $\mu$g/kg/hr), dexmedetomidine may be a suitable adjuvant for neurosurgical anesthesia.

Therefore, this study was conducted at our tertiary care center with the aim of investigating the influence of dexmedetomidine as an adjuvant on hemodynamic parameters and recovery profile of patients maintained on desflurane for sitting position intracranial tumor surgeries. The objectives of the study were to observe intraoperative hemodynamic changes, assess the effect on recovery endpoints, and evaluate the total analgesic requirement.

## 2. Material and methods

After obtaining approval from the Institutional Ethics Committee, the trial was registered in Clinical Trials Registry-India (CTRI/2019/11/022311). A tertiary hospital-based prospective, randomized double-blind comparative study was conducted on consenting adult patients belonging to both genders with ASA (American Society of Anesthesiologists) physical status I to III undergoing elective sitting position intracranial tumor surgery with a Glasgow Coma Scale (GCS) score greater than 9. We excluded patients refusing to participate, those with ASA IV status, pregnant patients, and patients with heart blocks and heart rate less than fifty-five. Sample size was calculated [9] with a Type I error of 0.05 and a Type II error of 0.80, to detect an intergroup difference of at least 10% in blood pressure and heart rate. Thus, 30 patients per group were required to detect a significant difference, and a sample size of 60 patients was selected for the study.

The patients were randomized using a computer-generated random table. The patients were allocated into two groups, Group D and Group C, by senior anesthesiologists who were not involved in the study. Group D received a 4-6 ml/hr infusion of Dexmedetomidine from the time the patient was taken to the operating table until the end of dura closure. Group C served as the control group and received a 4-6 ml/hr infusion of normal saline.

Once the patients were wheeled into the surgery room, their fasting status was checked. Monitoring was conducted using a pulse oximeter (for SpO2), invasive blood pressure (IBP) monitoring for mean arterial pressure, ECG monitor, capnometer, respiratory gas monitor, bispectral index (targeted at 40-50), urine output, core body temperature, and neuromuscular monitoring using acceleromyographic train-of-four stimulus to the adductor pollicis. Baseline readings were noted after attaching the monitors. Intraoperative normothermia was actively maintained with a forced air warming system (Bair Hugger). Before anesthesia induction, 10 ml/kg of isotonic crystalloid solution was infused and continued throughout the procedure at a rate of 5 ml/kg/hr.

Dexmedetomidine was prepared in a 50 ml syringe, with each milliliter containing 4$\mu$g of the drug. The drug infusion rate was set in ml/hr on the infusion pump. All solutions were prepared by an anesthesiologist who did not participate in the study. All subjects were premedicated with IV Pantoprazole 40mg, diclofenac 75mg, followed by IV glycopyrrolate 0.004mg/kg and IV fentanyl 2$\mu$g/kg. The study drug infusion was administered through a dedicated intravenous access. Group D received Dexmedetomidine infusion at the rate of 0.25 $\mu$g/kg/hr, and Group C received normal saline infusion from the time the patient was taken to the operating table and continued until the end of dura closure. The patient was then induced with IV propofol 2 mg/kg, and IV vecuronium 0.1mg/kg was administered to facilitate tracheal intubation. The patient was mechanically ventilated with a tidal volume of 7 ml/kg, and the respiratory rate was adjusted to maintain an end-tidal CO2 level of 30-35 mm Hg using a closed circuit. Desflurane was introduced after mechanical ventilation was started. MAC was titrated to maintain a mean arterial pressure and heart rate within 20% of the baseline and to maintain a BIS value of 40-50. Intraoperatively, mean arterial pressure and heart rate were recorded at 5 time points: before anesthesia induction (baseline), at placement of the head frame, at dural incision, at the end of tumor resection, and at the end of dural closure. Hemodynamic monitoring was continued until the end of surgery. Additional boluses of fentanyl 1 $\mu$g/kg were given before pin insertion. Esmolol or Nitroglycerine bolus was used in case blood pressure was not controlled despite increasing desflurane up to 1 MAC and administering 0.5 $\mu$g/kg fentanyl. At the end of surgery, the patient was allowed to breathe spontaneously. Residual muscle relaxation was reversed at 60% recovery of the first train-of-four, and extubation was done at a TOF ratio of 0.9. Analgesics were administered postoperatively as per requirement.

Recovery endpoints measured were: emergence (time from discontinuation of anesthesia delivery, i.e., vaporizer turned off, to opening of eyes), response to commands (time from discontinuation of anesthesia delivery to correct response to verbal commands), and orientation (time from discontinuation of anesthesia delivery to stating name, date of birth, current location). The patient was monitored in recovery using the Ramsay Sedation Score.

Appropriate statistical software, including but not restricted to MS Excel and SPSS ver. 20, was used for statistical analysis. Graphical representation was done in MS Excel 2010. Quantitative data were presented with the help of Mean and Standard deviation. Association among the study groups was assessed with the help of Fisher's test, Student's t-test, and Chi-Square test. A 'p' value less than 0.05 was considered significant.

## 3. Results

There was no significant difference in the demographic data in both groups (Table 1). The heart rate and systolic blood pressure (SBP) values were comparable in both groups at baseline and decreased significantly in patients of Group D compared to Group C until the end of the study, while the diastolic blood pressure (DBP) values were comparable in both groups at baseline and increased significantly in patients of Group C compared to Group D until the end of the study. This difference was statistically significant as per Student t-test ($p < 0.05$) (Figures 1-3). Intraoperatively, throughout the study, the mean arterial pressure (MAP) value was comparable in both groups. There was no significant difference between the groups as per Student t-test ($p > 0.05$). The minimum alveolar concentration (MAC) values were comparable in both groups, and the mean MAC in patients of Group C was higher compared to Group D until the end of the study. This difference was statistically significant as per Student t-test ($p < 0.05$) (Table 2). The Bispectral Index (BIS) values were comparable in both groups at baseline and decreased significantly in patients of Group C compared to Group D until the end of the study. This difference was statistically significant as per Student t-test ($p < 0.05$) (Table 3). The recovery endpoints parameters of response to painful stimuli, spontaneous eye opening, obeying verbal commands, recall of name, squeezing of fingers, and place of stay were significantly lower in patients of Group D compared to patients of Group C as per Student t-test ($p < 0.05$) (Table 4). The Ramsay Sedation Score (RSS) was significantly lower in Group D compared to Group C from the time of discontinuation of anesthesia delivery until the end of 120 mins as per Student t-test ($p < 0.05$). There was no significant difference in the side effects between the two groups as per Chi-Square test ($p > 0.05$) (Figure 4). Four (13.3%) patients in Group D had drowsiness, while three (10%) patients each had nausea/vomiting and hypotension. Two (6.7%) patients had bradycardia. Three (10%) patients in Group C had drowsiness, while one (10%) patient each had nausea/vomiting and bradycardia. Two (6.7%) patients had hypotension. There was no significant difference between the groups as per Chi-Square test ($p > 0.05$).

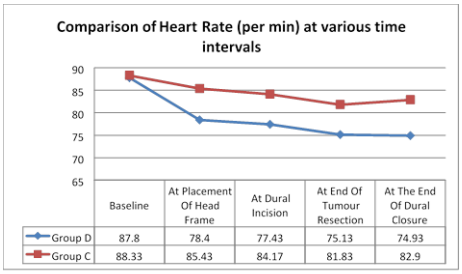


**Figure 1.** Comparison of Heart rate (beats/min) at various time intervals

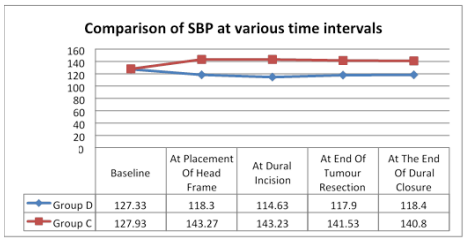


**Figure 2.** Comparison of Systolic Blood Pressure (mmHg) at various timeintervals

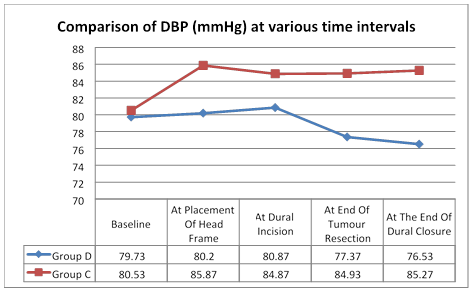


**Figure 3.** Comparison of Diastolic Blood Pressure (mmHg) at varioustime intervals

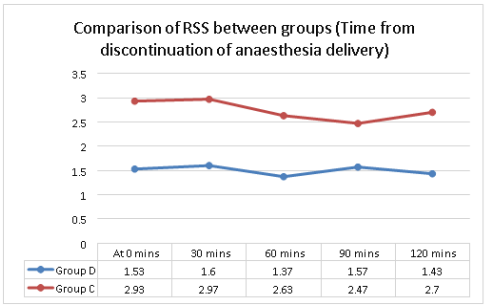


**Figure 4.** Comparison of RSS between groups

**Table 1.** Comparison of demographic data

| Variable | | Group D | | Group C | | p value |
|---|---|---|---|---|---|---|
| | | N | % | N | % | |
| Sex | Male | 19 | 63.3 | 21 | 70 | |
| | Female | 11 | 36.7 | 9 | 30 | |
| Age (Years) | | Mean ± SD | 35.77 ± 14.73 | Mean ± SD | 35.97 ± 16.79 | >0.05 |
| BMI (KG/M2) | | Mean± SD | 26.48 ± 3.62 | Mean± SD | 25.89 ± 3.97 | |
| ASA | I | 20 | 66.7 | 19 | 63.3 | |
| | II | 7 | 23.3 | 9 | 30 | |
| | III | 3 | 10 | 2 | 6.7 | |

**Table 2.** Comparison of MAC at various time intervals

| MAC | Group D | | Group C | | p value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| Baseline | 0.00 | 0.0 | 0.00 | 0.0 | >0.05 |
| At placement of head frame | 0.80 | 0.29 | 1.0 | 0.0 | <0.05 |
| At dural incision | 0.80 | 0.28 | 1.0 | 0.0 | <0.05 |
| At end of tumour resection | 0.78 | 0.31 | 0.99 | 0.03 | <0.05 |
| At the end of dural closure | 0.76 | 0.31 | 0.91 | 0.22 | <0.05 |

**Table 3.** Comparison of BIS at various time intervals

| BIS | Group D | | Group C | | p value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| Baseline | 92.03 | 4.27 | 91.53 | 3.69 | >0.05 |
| At placement of head frame | 61.60 | 5.49 | 50.63 | 6.07 | <0.05 |
| At dural incision | 59.97 | 6.20 | 51.33 | 6.51 | <0.05 |
| At end of tumour resection | 59.10 | 6.00 | 51.27 | 5.90 | <0.05 |
| At the end of dural closure | 60.13 | 5.88 | 52.17 | 6.70 | <0.05 |

**Table 4.** Comparison of Recovery Endpoints Parameters among study groups

| Parameters | Group D | | Group C | | p |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| Response to painful stimuli | 3.11 | 0.64 | 5.21 | 0.64 | Value |
| Spontaneous eye opening | 4.90 | 0.68 | 7.10 | 0.37 | |
| Obeying verbal commands | 6.31 | 0.39 | 8.20 | 0.54 | <0.05 |
| Recall of name | 5.41 | 0.73 | 7.83 | 0.49 | |
| Squeezing fingers | 6.81 | 0.36 | 9.30 | 0.32 | |
| Place of stay | 5.81 | 0.53 | 8.20 | 0.57 | |

## 4. Discussion

The sitting position is thought to be the best for surgical access to posterior fossa lesions. It facilitates surgical access but presents unique physiological challenges such as hemodynamic instability and venous air embolism. During surgery, abrupt increases in arterial blood pressure may cause bleeding or edema in the operating field. Conversely, low arterial pressures predispose patients to cerebral ischemia or venous air embolism [10]. The hemodynamic responses to intracranial surgery are often elicited at the beginning or end of the procedure, and manipulation of certain structures within the brain may produce cardiovascular changes.

The present study investigated the effects of low-dose dexmedetomidine in patients undergoing sitting position intracranial surgery to identify a clinically feasible anesthetic combination that would ensure perioperative hemodynamic stability and fast recovery without respiratory depression. We conducted a hospital-based prospective, randomized double-blind comparative study on 60 patients undergoing sitting position intracranial tumor surgeries to evaluate the influence of dexmedetomidine as an adjuvant. An infusion of 0.25 $\mu$g/kg/hr dexmedetomidine was started pre-emptively before induction and continued until the end of dura closure.

During neurosurgery, patients are prone to hemodynamic variations in heart rate and blood pressure at various time intervals such as placement of head frame, dural incision and closure, and tumor resection. Adverse hemodynamic responses can significantly affect patient outcomes. In our study, it was observed that the heart rate was significantly reduced in the dexmedetomidine group compared to the control group, while remaining within 20% of the baseline. This difference was statistically significant. This finding is consistent with the study conducted by Batra et al. [11], who observed a progressive decrease in heart rate in patients receiving dexmedetomidine infusion, with intraoperative heart rate remaining within 20% of the baseline. In the present study, systolic blood pressure (SBP) was comparable in both groups at baseline, but the decrease was statistically significant in patients receiving dexmedetomidine infusion.

The diastolic blood pressure (DBP) increased significantly in patients of the control group, especially during the placement of the head frame and at the end of dura closure, compared to patients receiving dexmedetomidine infusion. This difference was statistically significant. The mean arterial pressure (MAP) remained stable intraoperatively. This finding is consistent with the study conducted by Tanskanen et al. [12], who observed no differences between the groups in systolic blood pressure. After extubation, the mean increase in systolic blood pressure was the smallest in the Dexmedetomidine group. The minimum alveolar concentration (MAC) values were higher in the control group compared to the patients who received dexmedetomidine infusion. The Bispectral Index (BIS) values decreased significantly in patients of the control group compared to the study group. This difference was statistically significant as per Student t-test ($p<0.05$). Similar observations were noted in the studies conducted by Tripathi et al. [9], Batra et al. [11], and Mogahed et al. [13].

Tanskanen et al. [12], in their double-blinded, randomized, and parallel-group study, reported that all the patients were immediately able to obey commands, and 2 hours after extubation, there was no difference in the Hudes class or subjective sedation score between the groups. Batra et al. [8] observed in their study that the time to extubate was significantly higher in the control group ($8.60 \pm 1.61$ min) compared to the dexmedetomidine group ($5.32 \pm 1.46$ min) ($P < 0.001$). Although this difference of a few minutes may not be clinically relevant, it signifies that dexmedetomidine does not cause respiratory depression, and the patient remains readily arousable. The requirement for post-operative analgesia was higher in the control group, and this difference was found to be statistically significant.

One of the main goals after craniotomy is rapid awakening from anesthesia to allow neurosurgical assessment of the patient and early detection of cerebral complications. Dexmedetomidine is a drug that has been studied for awake craniotomy, and it has been found that the use of dexmedetomidine infusion is associated with shorter arousal time compared to propofol without causing any respiratory depression [14]. Ilhan et al. [15] and Tanskanen et al. [12] observed that dexmedetomidine infusion results in faster recovery after general anesthesia without causing any respiratory depression. In our study, the Ramsay Sedation Score (RSS) was significantly lower in patients receiving dexmedetomidine compared to the control group. Similar observations were noted in the studies conducted by Mogahed et al. [13], Tanskanen et al. [12], Tripathi et al. [9], and Batra et al. [11].

In our study, the requirement for analgesia was found to be higher in the control group compared to patients who received dexmedetomidine. This finding is similar to the studies conducted by Batra et al. [11] and Mogahed et al. [13]. Batra et al. [11] observed in their study that in the dexmedetomidine group, a lower number of patients required intraoperative fentanyl, and the time to rescue analgesic was also longer in patients receiving dexmedetomidine infusion. Mogahed et al. [13] found in their study that the need for analgesia was significantly higher in the control group compared to the dexmedetomidine group.

In the present study, it was observed that 4 (13.3%) patients in the dexmedetomidine group experienced drowsiness, while 3 (10%) patients each had nausea/vomiting and hypotension. 2 (6.7%) patients had bradycardia. In the control group, 3 (10%) patients experienced drowsiness, while 1 (10%) patient each had nausea/vomiting and bradycardia. 2 (6.7%) patients had hypotension. There was no significant difference between the groups as per the Chi-Square test ($p>0.05$).

Our study has the following limitations. The results may not be generalizable to high-risk patients with significant cardiac problems as they were not included in the study. We used a control group for comparison; therefore, superiority over a higher dose of dexmedetomidine infusion cannot be established.

## 5. Conclusion

Patients who received dexmedetomidine had more stable hemodynamic parameters compared to patients who received normal saline infusion during the course of anesthesia. Ventilation time and extubation time were found to be longer in patients who received dexmedetomidine, and analgesia was also found to be better in the dexmedetomidine group. However, hypotension and bradycardia were more common with dexmedetomidine.

During neurosurgery, the infusion of dexmedetomidine started before surgery helps maintain hemodynamic stability intraoperatively. It reduces the amount of anesthetic drugs required for induction and decreases the requirement for analgesic drugs without causing any residual sedation.

**Author Contributions:** All authors contributed equally to the writing of this paper. All authors read and approved the final manuscript.

**Conflicts of Interest:** "Authors declare no conflict of interests."

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