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Intravenous Dexmedetomidine as A Part of Balanced Anaesthesia for Controlled Hypotension and Sevoflurane-Sparing Effect in Prolonged Cancer Surgeries: A Randomised Controlled Trial

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ABSTRACT

Background: Excessive bleeding is a major concern during prolonged major cancer surgeries performed under general anaesthesia. Controlled hypotension can improve the surgical field and reduce the requirement for additional anaesthetic agents. Dexmedetomidine, a selective alpha-2 agonist, is increasingly used as an adjuvant in balanced anaesthesia because of its sympatholytic, sedative, analgesic and anaesthetic-sparing properties.Methods: In this prospective randomised controlled trial, 90 adults aged 40–65 years scheduled for elective maxillofacial cancer surgeries with free-flap reconstruction were allocated to two groups of 45 each. Group A received dexmedetomidine 100 microgram diluted in 100 mL saline over 30 minutes in addition to fentanyl before induction; Group B received normal saline with fentanyl before induction. Anaesthesia was induced with propofol and succinylcholine and maintained with oxygen, nitrous oxide, sevoflurane and vecuronium. Hemodynamic variables, surgical field quality, estimated blood loss, emergence profile, sedation, pain scores and sevoflurane requirement were recorded.
Results: Target mean arterial pressure of 60–70 mmHg was achieved in both groups. Mean arterial pressure and heart rate were lower and more stable in the dexmedetomidine group. Estimated blood loss was comparable between groups (400+/- 50 mL vs 500 +/- 50 mL). Sevoflurane consumption was lower in Group A than Group B (7.4 [1.6] vs 11.1 [1.9] mL/h). Group A also had lower postoperative pain scores and more prolonged conscious sedation. One young female patient developed severe hypotension after induction in the dexmedetomidine group; surgery was postponed, re-evaluation was unremarkable, and the procedure was completed uneventfully three days later without dexmedetomidine.
Conclusion: Intravenous dexmedetomidine is an effective component of balanced anaesthesia for prolonged cancer surgery, providing controlled hypotension, better hemodynamic stability, reduced sevoflurane requirement and improved postoperative analgesia. Careful titration is necessary because severe hypotension may occur in susceptible patients.

Keywords: *Dexmedetomidine; sevoflurane; balanced anaesthesia; controlled hypotension; cancer surgery.*

INTRODUCTION

Dexmedetomidine is a highly selective alpha-2 adrenergic receptor agonist that has gained significant prominence as an adjuvant in balanced anaesthesia. It possesses well-documented sedative, analgesic, sympatholytic, and anaesthetic-sparing actions, and is notably associated with minimal respiratory depression.1,2,19 In prolonged head and neck or maxillofacial cancer surgeries, excessive intraoperative bleeding remains a critical concern. Maintaining controlled hypotension is a valuable strategy to improve surgical visibility, minimise the risk of vital structure injury, and significantly reduce the overall transfusion burden.8,10,14,18

Several pharmacological agents have been employed to achieve controlled hypotension; however, dexmedetomidine presents unique advantages. A substantial body of Indian literature has consistently demonstrated that the perioperative use of dexmedetomidine reduces volatile anaesthetic requirements, improves hemodynamic stability, and facilitates better postoperative recovery and analgesia profiles across various surgical specialties.3,4,5,7,15 In oncological surgeries involving extensive free-flap reconstructions, the prolonged duration and profound physiological stress necessitate anaesthetic protocols that blunt sympathetic responses while preserving optimal tissue perfusion. Despite these documented benefits, concerns regarding severe bradycardia and profound hypotension underscore the need for continued evaluation in specifically tailored, controlled settings.6,20 Therefore, the primary objective of this study was to evaluate the effect of intravenous dexmedetomidine on achieving controlled hypotension, maintaining hemodynamic stability, and observing the sevoflurane-sparing effect in prolonged elective maxillofacial cancer surgeries with major reconstruction.

MATERIALS AND METHODS

Study Design and Patient Selection

This was a hospital-based, prospective, randomised controlled study conducted at the DIMS Institute of Maxillofacial Surgery and Research Center from 2017 to 2020. The study protocol was approved by the institutional ethical committee, and written informed consent was obtained from all participating subjects. The inclusion criteria were patients of either sex, aged between 40 and 65 years, weighing between 60 and 75 kg, and classified as American Society of Anesthesiologists (ASA) physical status I or II. All included patients were scheduled for elective maxillofacial cancer surgeries with free-flap reconstruction expected to last 8–10 hours. Patients were excluded from the study if they had a history of hypertension treated with beta-blockers, coronary artery disease, heart block, autonomic neuropathy, renal or hepatic dysfunction, cerebral insufficiency, known coagulation abnormalities, or a documented allergy to the study drugs.

Randomisation and Pre-anaesthetic Evaluation : A total of 90 patients who fulfilled the inclusion criteria were randomly allocated into two equal groups of 45 patients each. Group A received dexmedetomidine 100 microgram diluted in 100 mL normal saline infused over 30 minutes. Group B received 100 mL of normal saline infused over 30 minutes. The infusion of the study drug or placebo was initiated 10 minutes prior to the induction of general anaesthesia. All patients underwent a routine pre-anaesthetic evaluation one day prior to surgery.

Anesthetic Technique and Intraoperative Monitoring

Upon arrival in the operating theatre, patients' fasting status and informed consent were reconfirmed. All patients were premedicated with intravenous injection glycopyrrolate 4 microgram/kg and injection fentanyl 1.5–2 microgram/kg (approximately 100 microgram). After preoxygenation with 100% oxygen, anaesthesia was induced using intravenous injection propofol (1.5–2 mg/kg) and injection succinylcholine (2 mg/kg). Nasal intubation was performed either blindly or with laryngoscopic assistance using a north-facing Portex endotracheal tube. Anaesthesia was maintained with a mixture of oxygen and nitrous oxide (40:60) and sevoflurane. The sevoflurane vaporiser dial setting was maintained between 1.5–3% with a fresh gas flow of 1–1.5 L/min. Neuromuscular blockade was maintained with intermittent boluses of vecuronium. Additional intraoperative analgesia was provided via intermittent intravenous fentanyl 100 microgram administered every 3 hours, bringing the average total fentanyl dose to 300 microgram during the surgery.

Intraoperative monitoring included heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), oxygen saturation (SpO2), integrated pulmonary index, and end-tidal carbon dioxide (EtCO2). These parameters were recorded at baseline and documented at regular 30-minute intervals (monitored every 10 minutes). Non-invasive blood pressure (NIBP) was targeted to remain within 30% of pre-induction values, with an overarching goal of maintaining a MAP of 60–70 mmHg. Hypotension (SBP <30% of baseline) was managed with intravenous fluids and, if required, intravenous mephentermine 3 mg. Bradycardia (HR <30% of baseline) was treated with intravenous atropine 0.3–0.6 mg.

Assessment of Surgical Field and Blood Loss : Intraoperative blood loss and surgical field visibility were graded using a standardised 6-point scale:

- Score 0: No bleeding
- Score 1: Slight bleeding, no suction required
- Score 2: Slight bleeding, occasional suction required
- Score 3: Slight bleeding, frequent suction required
- Score 4: Moderate bleeding, frequent suction required, threatens surgical field
- Score 5: Severe bleeding, constant suction required, surgical field severely compromised

Blood loss was quantitatively estimated by measuring the volume in the suction canister (subtracting the known volume of irrigation fluid used) along with a gravimetric assessment of blood-soaked gauze pieces. Sevoflurane consumption was estimated based on the vaporizer dial settings recorded at the beginning and end of the surgical procedure.

Recovery and Postoperative Monitoring

At the end of the surgery, neuromuscular blockade was reversed using intravenous injection neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg. Assisted ventilation was discontinued once the patient responded to verbal commands. Emergence time was defined as the interval between the discontinuation of anaesthetic agents and eye opening in response to verbal commands. Postoperatively, patients were shifted to the high dependency unit (HDU). Hemodynamic parameters, emergence time, and sedation scores were recorded every 30 minutes. Sedation was assessed using the Ramsay Sedation Score (RSAS), and pain was evaluated using the Visual Analogue Scale (VAS). The time to the first rescue analgesia request was noted, at which point patients received intravenous diclofenac 75 mg; this marked the endpoint of the study. Postoperative complications, including nausea, vomiting, shivering, dryness of mouth, hypotension, and bradycardia, were meticulously recorded. Patient identities were concealed throughout the study and data analysis.

RESULTS

A total of 90 patients successfully completed the initial randomisation. The baseline demographic and clinical characteristics of the patients were comparable between the two groups, with no statistically significant differences in age, sex distribution, weight, ASA physical status, or duration of surgery (Table 1).

Table 1: Patient baseline characteristics and duration of surgery

Variable	Group A :mean (SD) (Dexmedetomidine, n=45)	Group B mean (SD) (Control, n=45)
Age (years)	54.5 (8.8)	53.5 (8.5)
Sex (male/female)	38/7	33/12
Weight (kg)	65.2 (9.2)	62.9 (6.8)
ASA status (I/II)	23/22	24/21
Duration surgery (hours)	9 (1.5)	9 (1.5)

Values are number of patients or mean (SD). ASA = American Society of Anesthesiologists.Target mean arterial pressure (MAP) of 60–70 mmHg was successfully achieved in both study groups. However, the requirement for beta-blockers and/or nitroglycerine to achieve targeted hypotension was significantly greater in Group B compared to Group A. Both MAP and heart rate were observed to be statistically lower and more stable in the dexmedetomidine group. The average category score for surgical field visibility ranged between 1 and 3 in Group A and between 2 and 3 in Group B; this difference in the average category scale was statistically insignificant, indicating that surgical field visibility was highly acceptable and comparable in both groups.The mean estimated blood loss was statistically comparable between Group A and Group B (400 +/- 50 mL vs 500 +/- 50 mL). Intraoperative anaesthetic requirements differed significantly; the mean induction dose of propofol was lower in Group A (90 mg vs 120 mg), and the overall requirement of sevoflurane was markedly reduced in the dexmedetomidine group (Table 2).

Table 2: Induction dose of propofol, Riker sedation-agitation score, visual analogue score, HDU-to-ward time and sevoflurane consumption

Variable	Group A (n=45)	Group B (n=45)	p value
Induction dose propofol (mg)	90 (15)	120 (15)	-
RSAS	3.5 (0.6)	4.1 (0.9)	0.001
VAS	2.7 (1)	6.1 (1.3)	0.001
HDU to ward time (hours)	13.7 (1.2)	13.1 (0.8)	0.001
Sevoflurane consumption (mL/h)	7.4 (1.6)	11.1 (1.9)	-

Values are mean (SD). RSAS = Riker sedation-agitation score; VAS = visual analogue score; HDU = high dependency unit.

The mean emergence time was not significantly prolonged in a clinically problematic manner in either group. While the sedation scores (RSAS) indicated that sedation was deeper in Group A than in Group B, the depth of sedation corresponded to conscious sedation; patients appeared to be asleep but were readily arousable. Furthermore, Group A demonstrated a longer duration of postoperative analgesia, as evidenced by significantly lower VAS scores (P = 0.001). Overall postoperative complications were statistically comparable between the two groups. Notably, none of the patients in either group experienced severe, unmanageable adverse effects, with one significant exception. One young female patient in the dexmedetomidine arm developed severe, non-responding hypotension immediately following the induction of anaesthesia. The procedure was postponed on that day. Comprehensive cardiac and systemic reevaluation revealed no underlying abnormalities, and the event was labelled as severe hypotension secondary to dexmedetomidine administration. The surgery was successfully performed three days later without the use of dexmedetomidine, and the intraoperative and postoperative course was entirely uneventful.

DISCUSSION:

Controlled hypotension plays a definitive role in major reconstructive oncologic surgeries, as it effectively reduces intraoperative bleeding, improves surgical field visibility, and mitigates the need for blood transfusions, thereby potentially decreasing the overall duration of surgery and anaesthesia. Dexmedetomidine, acting via the inhibition of central sympathetic outflow and stimulation of presynaptic alpha-2 adrenoceptors, successfully reduces both blood pressure and heart rate while conferring potent sedative and analgesic effects.1

Our findings indicate that intravenous dexmedetomidine as an adjuvant significantly reduced MAP and HR fluctuations, markedly reduced sevoflurane requirements, improved postoperative analgesia, and provided safe, cooperative conscious sedation. In the present study, although induced hypotension was achieved in the control group using alternative pharmacological agents (beta-blockers and nitroglycerine), dexmedetomidine produced a more stable hemodynamic profile. The requirement for primary induction and maintenance agents was substantially reduced; the induction dose of propofol was lower in the dexmedetomidine group (90 mg vs 120 mg), and the mean sevoflurane consumption was 7.4 mL/h compared to 11.1 mL/h in the control group. These results align robustly with existing Indian literature. Harsoor et al.5 and Sharma et al.7 similarly demonstrated substantial sevoflurane-sparing effects with dexmedetomidine, reporting significant percentage reductions in volatile anaesthetic consumption when dexmedetomidine was infused intraoperatively. Furthermore, Keniya et al.2 and Patel et al.3,4 have previously reported that dexmedetomidine successfully attenuates sympatho-adrenal responses during general anesthesia, mirroring the haemodynamic stability we observed. The efficacy of dexmedetomidine in providing controlled hypotension has been validated across multiple surgical subspecialties. In functional endoscopic sinus surgeries (FESS), studies by Chhabra et al.,8 Mahajan et al.,9 Bafna et al.,10 Sujay et al.,11 Sahu et al.,12 and Gupta et al.13 have consistently shown that dexmedetomidine provides superior surgical field visibility and better haemodynamic control when compared to agents like clonidine, labetalol, metoprolol, magnesium sulphate, esmolol, and propofol. Our findings in prolonged maxillofacial surgeries corroborate these principles. Even though the mean estimated blood loss in our study was statistically comparable between the two groups (400 +/- 50 mL vs 500 +/- 50 mL), this likely reflects the multifactorial nature of bleeding control in prolonged, complex oncologic reconstructions involving free flaps.18 Bista et al.18 similarly noted the safety and efficacy of dexmedetomidine in head and neck free flap surgeries without detrimental effects on flap survival.

In addition to intraoperative benefits, dexmedetomidine exerts a profound positive influence on the recovery profile. Our patients exhibited significantly better postoperative analgesia (VAS 2.7 vs 6.1) and a favourable conscious sedation profile, an observation strongly supported by Prem Raj Singh et al.15 and Mohanty et al.17 in their evaluations of post-operative analgesic efficacy in head and neck cancer surgeries. Furthermore, the sedative properties of dexmedetomidine do not compromise airway safety, as demonstrated by its effective use in awake fiber-optic intubations in difficult airway scenarios by Sachan et al.14 and Arora et al.16 Despite these advantages, the use of dexmedetomidine warrants strict vigilance. Nair et al.19 reviewed the present status of dexmedetomidine in cancer surgeries, noting its widespread benefits but also highlighting physiological consequences. In our cohort, one patient experienced severe, unyielding hypotension necessitating the postponement of surgery. This isolated but critical event underlines the absolute necessity for careful patient selection, meticulous dose titration, and continuous haemodynamic monitoring, particularly in younger or highly susceptible individuals.

Limitations

Our study has several limitations. First, it was a single-centre trial with a moderate sample size, which may limit the broader generalisability of the findings. Second, the grading of the surgical field is inherently subjective, despite the use of a standardised scale. Third, we relied on non-invasive blood pressure monitoring; continuous invasive arterial pressure data would have provided a more precise haemodynamic profile. Fourth, prolonged oncologic reconstructive procedures are anatomically and surgically heterogeneous, which can independently influence blood loss and surgical duration.

Conclusion: Intravenous dexmedetomidine is a highly effective and useful adjuvant as part of balanced anaesthesia in prolonged maxillofacial cancer surgeries. It safely facilitates controlled hypotension, ensures superior hemodynamic stability, significantly reduces the consumption of sevoflurane and propofol, and provides an excellent postoperative recovery profile characterised by prolonged analgesia and cooperative conscious sedation. However, clinicians must remain vigilant and practice careful dose titration to prevent severe hypotensive episodes in susceptible patients.

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