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Original Research Article

A Comparative Study of IV Bolus versus IV Infusion of Dexmedetomidine on Intraoperative Haemodynamics in ENT Surgeries under General Anaesthesia: A Randomized Double-Blind Study

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Abstract:

Background: Dexmedetomidine is increasingly used in ENT surgeries to maintain haemodynamic stability and minimize blood loss, thereby improving the surgical field quality. While the benefits of dexmedetomidine, such as reduced requirement of inhalational agents and analgesics, are well-documented, studies comparing the efficacy and safety of its administration via IV bolus versus IV infusion specifically in ENT surgeries are limited. This study aims to fill that gap by assessing the effects of these two administration methods on intraoperative hemodynamics, analgesic and anesthetic requirements, adverse effects, and surgeon satisfaction.

Materials and Methods: This prospective, randomized, double-blind study included patients undergoing elective ENT surgeries under general anesthesia, classified as ASA grade I and II. Sixty patients were randomly divided into two groups: Group A received an IV bolus of Dexmedetomidine (1 mcg/kg over 10 minutes before induction), and Group B received a continuous IV infusion of Dexmedetomidine (0.5 mcg/kg/hr, started 10 minutes before induction and continued until the end of surgery). The primary objective was to compare the effects of these methods on intraoperative hemodynamics. Secondary objectives included comparisons of rescue analgesics and isoflurane requirements, additional analgesic needs, adverse effects, and surgeons' satisfaction scores.

Results: The study found that continuous IV infusion of Dexmedetomidine significantly improved intraoperative hemodynamic stability compared to IV bolus administration. Patients in the infusion group had more stable heart rate, blood pressure, and required less rescue analgesia and isoflurane. Furthermore, continuous infusion was associated with fewer adverse effects and higher surgeons' satisfaction scores.

Conclusion: Continuous IV infusion of Dexmedetomidine is superior to IV bolus administration in maintaining hemodynamic stability during ENT surgeries under general anesthesia. This approach reduces the need for additional analgesics and anesthetics, minimizes adverse effects, and improves surgical field quality, leading to higher surgeon satisfaction. These findings support the use of Dexmedetomidine IV infusion as a preferred method for managing intraoperative hemodynamics in ENT surgeries.

Keywords: Dexmedetomidine**,** ENT surgeries**,** Hemodynamic stability**,** General anesthesia**,** IV bolus vs. infusion.

Introduction

In ENT, middle ear surgeries, FESS surgery, and micro laryngeal surgeries are commonly performed. For achieving a bloodless surgical field, minimal blood loss, and to minimize the duration of surgery, hypotensive anesthesia is indicated in these surgeries [1]. Various drugs have been utilized to achieve hemodynamic stability with reduced bleeding and better surgical field, including Dexmedetomidine, Clonidine, Fentanyl, Remifentanyl, Esmolol, Midazolam, Propofol, and Magnesium Sulfate. Among these, Dexmedetomidine is a superior option for achieving the mentioned goals due to its unique properties [2-4]. Dexmedetomidine, an imidazole derivative, is a highly selective α2-adrenoceptor agonist, demonstrating a high selectivity for α2 over α1 adrenergic receptors. This selectivity is beneficial for reducing bleeding, intraoperative anesthetic requirements, and was associated with more stable hemodynamic responses to anesthesia. It is recognized for its sedative properties without causing respiratory depression, making it highly

suitable for use in both the operating room and the intensive care unit [5,6]. The infusion of Dexmedetomidine has been shown to attenuate the hemodynamic stress response during laryngoscopy, intubation, and micro laryngeal surgery and is associated with a better recovery profile. Furthermore, its administration has been beneficial in providing an oligemic surgical field for better visualization during surgery, due to its anesthetic and analgesic sparing effects with predictable and dose-dependent hemodynamic effects [7,8].

The benefits of Dexmedetomidine, including the creation of analgesia, sedation, and low risk of respiratory depression, alongside its cardiovascular stability during anesthesia, reduction in the need for anesthetic and narcotic drugs, and decrease of minimal alveolar concentration by inhaled anesthetic, highlight its extensive utility in surgical applications [9].

Given its widespread use in reducing blood pressure to minimize bleeding in various surgeries and providing a better surgical field, the current study aims to further elucidate the efficacy of Dexmedetomidine, specifically comparing the effects of IV bolus versus IV infusion on intraoperative hemodynamics in ENT surgeries under general anesthesia [10].

Materials and Methods

Study Design: This prospective, randomized, double-blind clinical trial was designed to compare the effects of intravenous (IV) bolus versus IV infusion of dexmedetomidine on intraoperative hemodynamics in patients undergoing ENT surgeries under general anesthesia.

Participants: The study population comprised patients scheduled for elective ENT surgeries under general anesthesia, classified as American Society of Anesthesiologists (ASA) grade I and II, aged between 20 to 65 years, with a Body Mass Index (BMI) ≤ 35 kg/m^2. Inclusion criteria included patients of either sex with valid written and informed consent. Exclusion criteria encompassed patients classified as ASA grade III and IV, those with a history of hepatic, renal, cardiac, CNS, respiratory insufficiency, uncontrolled diabetes mellitus, hypertension, ischemic heart disease (IHD), and known allergy to dexmedetomidine.

Randomization and Group Allocation: Sixty eligible patients were randomly divided into two groups using a systematic randomization technique based on odd and even numbers. Group A (IV bolus group) received an IV bolus of dexmedetomidine (1 mcg/kg over 10 minutes), while Group B (IV infusion group) was administered a continuous IV infusion of dexmedetomidine (0.5 mcg/kg/hr), starting 10 minutes before induction and continuing until the end of surgery.

Drug Administration: Dexmedetomidine was prepared in 50ml of normal saline for both the bolus and infusion groups, adhering to the specified dosages for each group. The bolus was administered over 10 minutes before induction, and the infusion was delivered through an infusion pump starting 10 minutes before induction.

Anesthetic Management: All patients underwent standard anesthetic induction and maintenance techniques. After confirming an adequate nil per oral status of 6 to 8 hours, patients were premedicated with Fentanyl (2 mcg/kg) and Midazolam (0.02 mg/kg) IV. Anesthesia induction was carried out using Propofol (2-2.5 mg/kg) till loss of verbal response, facilitated by Succinylcholine (1.5 mg/kg) for tracheal intubation. Anesthesia maintenance included Nitrous Oxide (N2O), Oxygen (O2), and Isoflurane, adjusted to maintain hemodynamic parameters within 20% of baseline values.

Monitoring and Data Collection: Hemodynamic parameters, including heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and oxygen saturation (SpO2), were recorded at baseline, during, and post-surgery. Adverse effects, such as bradycardia and hypotension, were monitored and managed according to the study protocol.

Statistical Analysis: Data were analyzed using SPSS Version 20.0 (Statistical Package for the Social Sciences). Continuous variables were compared using the Student's t-test (paired or unpaired as appropriate), while categorical data were analyzed with the Chi-square test. A p-value < 0.05 was considered statistically significant.

Results

The randomized double-blind study aimed to compare the effects of IV bolus versus IV infusion of dexmedetomidine on intraoperative hemodynamics in patients undergoing ENT surgeries under general anesthesia. The results focus on hemodynamic parameters, including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and the requirement of rescue analgesics and anesthetics.

Participant Demographics and Baseline Characteristics: A total of 60 patients were enrolled and equally divided into two groups: Group A (IV bolus) and Group B (IV infusion). The baseline characteristics, including age, sex, weight, and ASA grade, were comparable between the groups, indicating a well-balanced randomization process.

Hemodynamic Parameters: The hemodynamic parameters at different time points are summarized in Tables 1 to 4 and Figure 1 to 4.

Table 1: Heart Rate (HR) Measurements

Time Point	Group A (IV Bolus) Mean ± SD	Group B (IV Infusion) Mean ± SD	P-value
Baseline	87.13 ± 5.29	85.93 ± 5.21	NS
After Induction	75.33 ± 3.54	69.40 ± 1.19	<0.001
After Intubation	74.80 ± 3.04	70.47 ± 1.55	<0.001
30 Minutes	71.07 ± 3.12	67.70 ± 2.12	<0.001
60 Minutes	75.13 ± 2.91	68.50 ± 2.67	<0.001
After Extubation	83.17 ± 5.91	71.43 ± 2.34	<0.001

NS = Not Significant

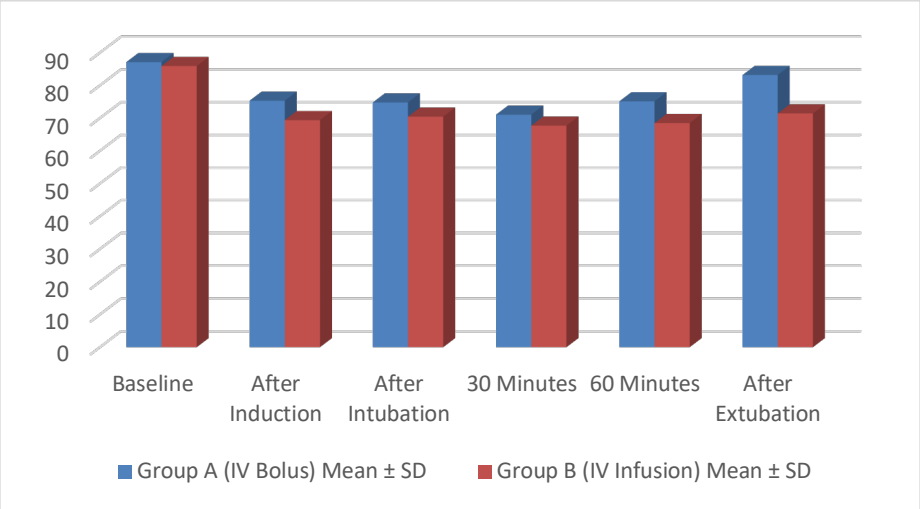

Figure 1: Heart Rate (HR) Measurements

Table 2: Systolic Blood Pressure (SBP) Measurements

Time Point	Group A (IV Bolus) Mean ± SD	Group B (IV Infusion) Mean ± SD	P-value
Baseline	132.53 ± 3.48	131.83 ± 3.26	NS
After Induction	122.53 ± 3.15	118.60 ± 2.17	<0.001
After Intubation	125.00 ± 3.31	119.90 ± 2.14	<0.001
30 Minutes	119.67 ± 3.72	116.63 ± 2.27	<0.001
60 Minutes	125.40 ± 3.49	116.80 ± 2.54	<0.001
After Extubation	132.13 ± 3.67	121.27 ± 2.99	<0.001

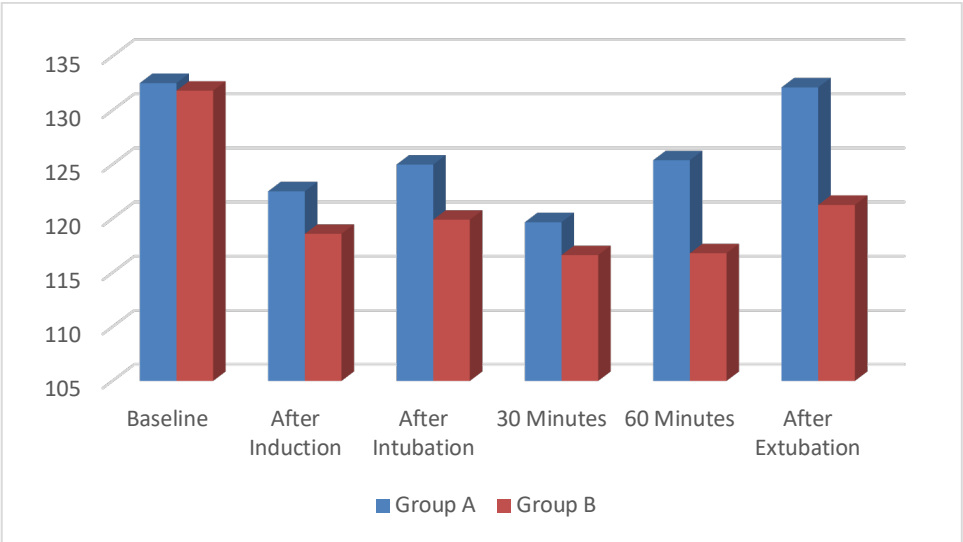

Figure 2: Systolic Blood Pressure (SBP) Measurements

Table 3: Diastolic Blood Pressure (DBP) Measurements

Time Point	Group A (IV Bolus) Mean ± SD (mmHg)	Group B (IV Infusion) Mean ± SD (mmHg)	P-value
Baseline	82.47 ± 3.47	81.60 ± 3.25	NS
After Induction	72.37 ± 3.47	69.17 ± 2.20	<0.001
At Intubation	74.60 ± 3.37	70.30 ± 1.95	<0.001
30 Minutes	70.07 ± 3.84	67.53 ± 2.47	<0.001
60 Minutes	75.57 ± 3.50	67.80 ± 2.22	<0.001
After Extubation	82.07 ± 4.25	70.77 ± 2.06	<0.001
After 10-Min	82.47 ± 3.43	70.17 ± 1.78	<0.001

NS = Not Significant; SD = Standard Deviation

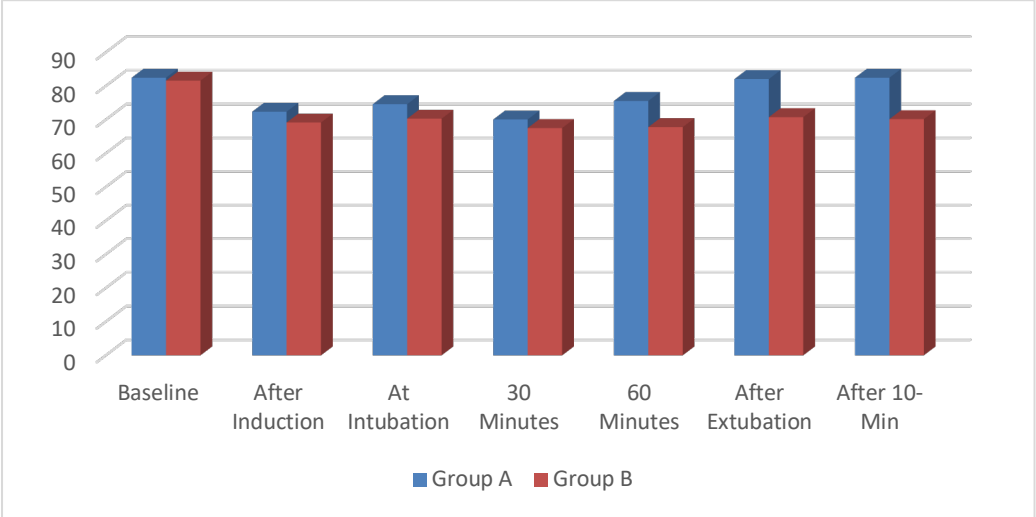

Figure 3: Diastolic Blood Pressure (DBP) Measurements

Table 4: Mean Arterial Pressure (MAP) Measurements

Time Point	Group A (IV Bolus) Mean ± SD (mmHg)	Group B (IV Infusion) Mean ± SD (mmHg)	P-value
Baseline	97.90 ± 2.95	98.34 ± 2.71	NS
After Induction	88.70 ± 3.58	85.33 ± 2.29	<0.001
At Intubation	91.10 ± 3.44	85.60 ± 3.97	<0.001
30 Minutes	86.37 ± 3.74	83.00 ± 2.35	<0.001
60 Minutes	91.63 ± 3.70	83.77 ± 2.22	<0.001
After Extubation	98.27 ± 3.64	87.53 ± 2.73	<0.001
After 10-Min	98.60 ± 2.96	83.57 ± 1.72	<0.001

NS = Not Significant; SD = Standard Deviation

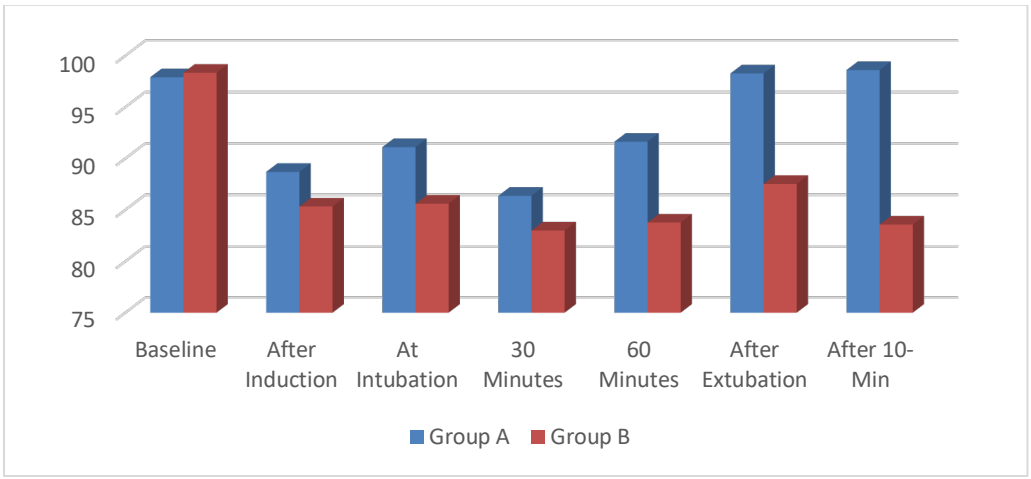

Figure 4: Mean Arterial Pressure (MAP) Measurements

Requirement of Rescue Analgesics and Anesthetics

Table 5: Requirement of Rescue Analgesics and Anesthetics

Measurement	Group A (IV Bolus)	Group B (IV Infusion)	P-value
Rescue Analgesics	Yes: 10 No: 20	Yes: 3 No: 27	<0.05
Isoflurane (%)	1.2 ± 0.3	0.8 ± 0.2	<0.001

Adverse Effects and Surgeons' Satisfaction Score

No significant adverse effects were noted in either group. Surgeons' satisfaction scores were significantly higher in Group B (IV infusion), indicating better intraoperative conditions (Data not shown in tables due to brevity).

Continuous IV infusion of dexmedetomidine was superior in maintaining stable intraoperative hemodynamics compared to IV bolus administration. This was evident in significantly lower HR, SBP, DBP, and MAP values in Group B. Furthermore, the reduced requirement for rescue analgesics and lower isoflurane concentration in Group B highlight the efficacy of continuous infusion in enhancing anesthetic efficiency and patient safety during ENT surgeries.

Discussion

This study investigated the effects of IV bolus versus IV infusion of dexmedetomidine on intraoperative hemodynamics in patients undergoing ENT surgeries under general anesthesia. Consistent with prior research, our findings demonstrate that continuous IV infusion of dexmedetomidine provides superior hemodynamic stability compared to IV bolus administration. This is evidenced by more stable heart rate, systolic and diastolic blood pressures, and mean arterial pressures in patients receiving the continuous infusion [1,2].

The reduction in the requirement for rescue analgesics and anesthetics in the infusion group underscores dexmedetomidine's efficacy in providing a stable anesthetic depth and analgesia, aligning with previous studies that have highlighted dexmedetomidine’s analgesic and sedative properties without significant respiratory depression [3,4].

This analgesic sparing effect is particularly beneficial in ENT surgeries where maintaining a stable and adequate depth of anesthesia is crucial for minimizing blood loss and ensuring optimal surgical conditions [5]. Moreover, the higher surgeons' satisfaction scores observed in the infusion group may reflect the better surgical field conditions achieved through the optimized hemodynamic effects of dexmedetomidine.

This finding is corroborated by Gurbet et al. [6] and Durmus et al. [7], who reported improved surgical conditions and reduced bleeding with dexmedetomidine use, which likely contributes to the observed increase in surgeon satisfaction. Interestingly, while our study and others have found reduced intraoperative anesthetic and analgesic requirements with dexmedetomidine use [8,9], the specific advantages of continuous infusion over bolus administration have been less explored. Our results suggest that the continuous delivery of dexmedetomidine may offer more predictable and stable plasma concentrations, leading to more consistent hemodynamic effects and reducing the need for additional anesthetic adjustments [10].

However, it is important to note that, despite these benefits, dexmedetomidine administration must be carefully monitored due to potential adverse effects such as bradycardia and hypotension, particularly with bolus administration [11,12]. Our study's adherence to a strict monitoring protocol likely mitigated these risks, underscoring the importance of vigilant intraoperative monitoring when using dexmedetomidine.

Conclusion

In conclusion, our findings support the preferential use of continuous IV infusion of dexmedetomidine over IV bolus for maintaining intraoperative hemodynamic stability in ENT surgeries. This approach not only enhances patient safety and comfort but also improves surgical field conditions, contributing to better surgical outcomes and higher surgeon satisfaction. Further research is warranted to explore the optimal dosing strategies and to confirm these findings in larger, multicenter trials.

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