

The Effects of a Single Preanesthetic dose of Dexmedetomidine on Propofol Induction, Hemodynamics, and Cardiovascular Parameters

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Abstract

Objective: To find out the dose of propofol consumption for induction and also the variation in hemodynamics following single-dose dexmedetomidine premedication. **Methods:** A total of 60 American Society of Anesthesiologists Class 1 and 2 patients aged between 18 and 80 years, posted for elective surgeries were randomized into two groups: Group C – premedication with 2 mcg/kg fentanyl and Group D – premedication with 1 mcg/kg dexmedetomidine + 2 mcg/kg fentanyl. Both groups were preloaded with 10 ml/kg crystalloid solution. The parameters measured were propofol requirements, heart rate (HR), mean arterial pressure (MAP), cardiac index (CI), cardiac output (CO), and stroke volume variation (SVV). **Results:** Propofol requirements were 26.6% lesser in Group D ($P < 0.001$). In Group C, HR was significantly low at baseline ($P = 0.008$), induction ($P = 0.006$), and at intubation ($P = 0.001$) in Group D. Cardiovascular parameters such as MAP ($P = 0.007$), CI ($P = 0.038$), and CO ($P = 0.021$) were significantly lower in Group D compared to Group C only at baseline. There were no differences at any other point during the study. SVV was noted to be significantly lower ($P = 0.018$) in Group D only at intubation. **Conclusion:** Dexmedetomidine decreases the requirements of propofol for induction and also attenuates the hemodynamic response to intubation. Cardiovascular parameters such as MAP, CI, and CO were significantly lower in Group D only at baseline. Hemodynamic stability is mainly attributed to adequate preloading and less propofol requirement in the dexmedetomidine group.

Keywords: Cardiac index, cardiac output, stroke volume variability, α -2 adrenoceptor agonist

INTRODUCTION

Dexmedetomidine is a highly selective α -2 adrenoceptor agonist commonly used in anesthesia practice. Dexmedetomidine produces sedation, hypnosis, analgesia, anxiolysis, and sympatholysis with minimal respiratory depression.^[1]

The central effects are due to the activation of α -2A receptors in locus coeruleus, and cardiovascular effects are due to a dose-dependent decrease in the central sympathetic outflow. The transient hypertensive response is seen initially due to its effects on α -2B receptors present in the vascular smooth muscle until there is a decrease in the central sympathetic outflow.^[2]

Dexmedetomidine has been shown to reduce perioperative oxygen consumption and blunt the sympathetic response to laryngoscopy and surgical stimuli, resulting

in improved cardiac outcomes.^[3,4] Dexmedetomidine infusions postoperatively have been shown to reduce plasma catecholamine levels and lesser hemodynamic fluctuations.^[5] Dexmedetomidine has also been shown to reduce anesthetic and analgesic requirements.^[6,7] The above-stated properties make dexmedetomidine an ideal preanesthetic agent. A study demonstrated that single preanesthetic dose of dexmedetomidine decreased the thiopental dose requirement without any serious hemodynamic changes.^[7]

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The literature on the beneficial effects of dexmedetomidine in reducing perioperative sympathetic response is vast; fewer studies have been done on its direct cardiac effects. Although several studies have suggested a cardioprotective role of dexmedetomidine,^[8,9] there is conflicting evidence on this with adverse cardiovascular effects such as hypotension or hypertension, bradycardia, and even cardiac arrest having been reported.^[10-12]

We are routinely using dexmedetomidine as an adjuvant in general anesthesia. Propofol is used routinely for the induction of anesthesia. As most of the anesthetic drugs have a depressant effect on the cardiovascular system, it is important to know how the cardiovascular system (CVS) functions, when they are used together. The purpose of this study was to investigate the effects of single preanesthetic dose of dexmedetomidine on propofol requirements and cardiovascular parameters in the American Society of Anesthesiologists (ASA) Class 1 and 2 patients.

METHODS

The study design was a prospective randomized control trial. A total of 60 ASA Class 1 and 2 patients aged between 18 and 80 years, posted for elective surgeries in KMC Hospital, Ambedkar Circle, were included in the study. The study was conducted after the institutional Ethics Committee approval. Patients of either sex in the age group of 18–80, ASA Grade 1 and 2, undergoing elective surgeries were included in the study. Patients of either sex in the age group of 18–80 with ASA Grade 1 and 2 undergoing elective surgeries were included in the study. Those with preoperative heart rate (HR) <45, rhythm disturbances, and asthma were excluded.

Sample size

The study was conducted in 60 patients who were randomized into two groups by block randomization:

Group C (control group) with 30 patients and Group D (dexmedetomidine group) with 30 patients. (consort flow chart 1)

The sample size was calculated using the formula:

$$n = \frac{2((Z\alpha + Z\beta)^2 \times \sigma^2)}{d^2}$$

where,

$Z\alpha = 1.96$ (95% confidence interval)

$Z\beta = 0.84$ (80% power)

$\sigma = 0.39$

$d = 0.29$

The observations and results were analyzed using the Student's unpaired *t*-test. $P < 0.05$ was considered statistically significant.

All patients underwent a detailed preanesthetic evaluation. The study protocol was explained to the patients, and written informed consent was obtained. A fasting period of 6 h before

surgery was advised. A large-bore intravenous catheter was initially secured for drug and fluid administration. Preloading with 10 ml/kg Ringer's lactate solution was done in all patients. A radial arterial catheter was secured for invasive blood pressure (BP) monitoring. Other monitors connected were electrocardiogram, pulse oximetry, temperature, and ETCO_2 .

The patients were randomized into two groups: (consort chart 1)

- Group C (control group) – premedication with 2 mcg/kg fentanyl
- Group D (dexmedetomidine group) – premedication with 1 mcg/kg dexmedetomidine + 2 mcg/kg fentanyl.

All patients were preloaded with 10 ml/kg crystalloids before dexmedetomidine administration and induction. Patients in Group D were premedicated with 1 mcg/kg of dexmedetomidine in 100 ml normal saline over 20 min before induction.

Mean arterial pressure (MAP), cardiac output (CO), cardiac index (CI), and stroke volume variation (SVV) were recorded by the Vigileo (Edwards, LLC) monitor. After noting baseline values (after dexmedetomidine administration and before induction), the above parameters were recorded at induction, intubation, and 5 min and 30 min after intubation.

Anesthesia was induced in both groups with propofol till the loss of response to verbal commands, and neuromuscular blockade was achieved with rocuronium. Anesthesia was maintained with isoflurane in $\text{N}_2\text{O} : \text{O}_2$ (50:50) mixture.

RESULTS AND OBSERVATIONS

The two groups were similar in demographic characteristics of patients, and they are comparable [Table 1].

There was a significant decrease in the dose of propofol for induction (69.50 ± 15.67 vs. 94.67 ± 27.88 $P = 0.001$) [Figure 1].

HR was significantly low at baseline (62.83 ± 8.76 vs. 72.43 ± 17.11 ; $P = 0.008$), induction (63.03 ± 9.76 vs. 71.93 ± 13.98 ; $P = 0.006$), and at intubation (71.33 ± 11.03 vs. 83.23 ± 13.89 ; $P = 0.001$) in Group D. There were no significant differences at any other point during the study [Figure 2].

In Group D, there was a significant decrease in MAP only at baseline ($P = 0.007$) compared with Group C. There were no significant changes noted at any other point during the study [Tables 2-4].

Table 1: Demography

parameters	Group D	Group C	P
Age (years)	47.87 ± 12.25	46.40 ± 12.03	0.153
Sex (male/female) (%)	33.3/66.7	53.3/46.7	0.118
Weight (kg)	62.7 ± 12.29	61.07 ± 13.90	0.632
Height (cm)	161.23 ± 8.81	162.17 ± 9.41	0.693

Cardiovascular Parameters: Group D

Cardiovascular parameters such as CI ($P = 0.038$) and CO ($P = 0.021$) were significantly lower in Group D compared to Group C only at baseline. There were no differences at any other point during the study. SVV was noted to be significantly lower ($P = 0.018$) in Group D only at intubation [Tables 2-4].

DISCUSSION

We found that the mean requirement of propofol for induction was reduced by 26.6% in the dexmedetomidine group compared to the control group. In a double-blinded study conducted by Le Guen *et al.*, dexmedetomidine reduced

propofol requirements by 23% for induction and by 29% for maintenance compared to the control group.^[13]

Park *et al.* studied the effects of low-dose dexmedetomidine in 30 adult patients undergoing laparoscopic cholecystectomies under bispectral index-guided intravenous anesthesia.^[14] They found that infusion of 0.3 µg/kg/h of dexmedetomidine reduced propofol and remifentanyl requirements (total intravenous anesthesia [TIVA]) by 16% and 23%, respectively.

Yoo *et al.* found that premedication of 1 mcg/kg of dexmedetomidine reduced the median effective dose of propofol for successful laryngeal mask airway insertion without the use of muscle relaxants by 38%.^[15]

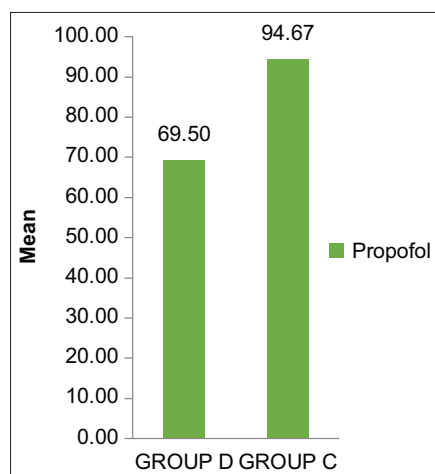


Figure 1: Propofol consumption during induction

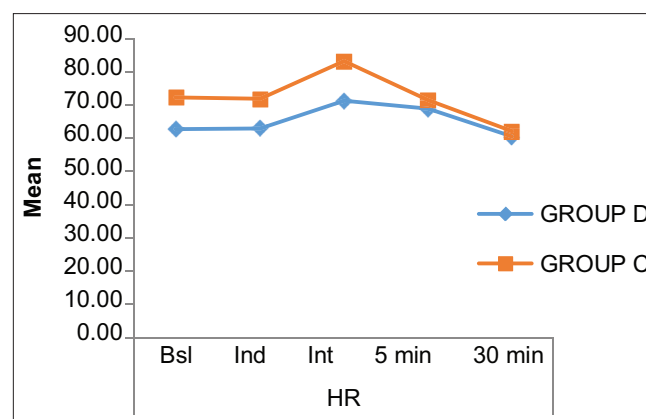


Figure 2: Heart rate variation

Table 2: Group D hemodynamic and cardiovascular parameters

Group D	Baseline	Induction	Intubation	5 min	30 min
MAP	100.67±18.51	98±18.76	103.17±20.76	80.83±14.83	79±14.04
CI	3.32±0.77	4.03±3.57	3.63±0.92	3.19±0.72	2.64±0.64
CO	5.46±1.23	5.53±1.42	5.91±1.53	5.23±1.20	4.33±0.94
SVV	12.97±6.64	10.23±4.99	6.80±3.13	11.93±4.23	10.73±4.35

MAP=Mean arterial pressure, CI=Cardiac index, CO=Cardiac output, SVV=Stroke volume variation

Table 3: Group C hemodynamic and cardiovascular parameters

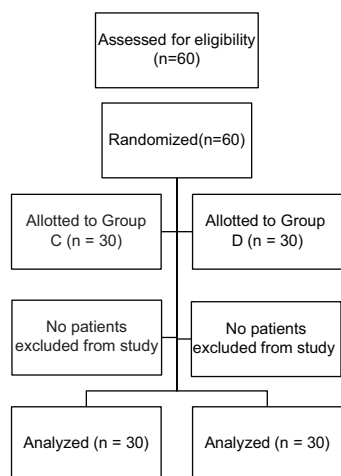
Group C	Baseline	Induction	Intubation	5 min	30 min
MAP	114.50±19.71	102±19.18	104.43±21.42	83.90±12.77	83.67±14.36
CI	3.88±1.22	3.67±1.07	3.67±0.90	2.93±0.56	2.83±0.69
CO	6.37±1.71	6±1.70	5.88±1.56	4.83±1.07	4.62±1.04
SVV	11.27±5.48	9.03±4.07	8.83±3.34	11.03±3.64	11.07±5.44

MAP=Mean arterial pressure, CI=Cardiac index, CO=Cardiac output, SVV=Stroke volume variation

Table 4: Hemodynamic and cardiovascular parameters, *t/P* values

Group C and D	Baseline	Induction	Intubation	5 min	30 min
MAP	2.80*	0.82	0.23	0.86	1.27
CI	2.13*	0.52	0.17	1.60	1.09
CO	2.38*	1.17	0.08	1.39	1.13
SVV	1.08	1.023	2.43*	0.88	0.26

* $P < 0.05$ considered statistically significant.. MAP=Mean arterial pressure, CI=Cardiac index, CO=Cardiac output, SVV=Stroke volume variation

**Chart 1:** Consort chart

In our study, there was a significant decrease in HR at baseline and intubation between the groups. The mean HR was 62.83 ± 8.76 versus 72.43 ± 17.11 , 63.03 ± 9.76 versus 71.93 ± 13.98 , and 71.33 ± 11.03 versus 83.23 ± 13.89 at baseline, induction, and intubation, respectively. There was no significant difference in HR between the two groups, 5 min and 30 min after intubation. Gu *et al.* studied the impact of dexmedetomidine on cardiac function in children undergoing laparoscopic surgery and observed a fall in HR.^[16] Basar *et al.* noticed a fall in HR following the infusion of a single dose of dexmedetomidine.^[7]

In our study, a significant decrease in systolic BP (SBP) (144.8 ± 32.36 vs. 169.27 ± 31.8), diastolic BP (74.6 ± 11.9 vs. 84.27 ± 14.82), and MAP (100.67 ± 18.5 vs. 114.5 ± 19.71) was noted only at baseline. There was no significant difference between the two groups at induction, intubation, and 5 min and 30 min after intubation. Studies done using dexmedetomidine by authors like Kunisawa *et al.*^[17] and Lee *et al.*^[18] have a contradicting outcome compared to El-Gohary and Arafa *et al.*^[19]

Kunisawa *et al.* studied the effect of dexmedetomidine and found that following induction, SBP was higher in the dexmedetomidine group compared to the fentanyl group, and there was no significant change in SBP after intubation.^[17] They concluded dexmedetomidine combination with fentanyl during induction suppressed the fall in BP.

Lee *et al.* investigated the effects of dexmedetomidine as an adjuvant to TIVA.^[18] In his study patients who received dexmedetomidine compared with saline after 20 min had a lower mean HR (56.7 ± 5.2 vs. 67.1 ± 7.1 beats/min) and higher mean systolic BP (125.7 ± 18.9 vs. 109 ± 7.9 mmHg). El-Gohary and Arafa evaluated the efficacy of dexmedetomidine as a hypotensive agent in comparison with sodium nitroprusside in scoliosis surgery in 40 patients aged 12–16 years.^[19] HR and MAP were significantly lower in both the groups compared from induction until 5 min after stopping hypotensive drugs.

In our study, there was a significant decrease in CI (3.32 ± 0.77 vs. 3.88 ± 1.22) and CO reduced by 14.28%

in patients who were administered dexmedetomidine at baseline compared to the control group. There was no difference between the two groups at any other point in the study. In our study, there was a significant difference in SVV between the two groups only at intubation (6.8 ± 3.13 in the dexmedetomidine group vs. 8.83 ± 3.34 in the control group).

Basar *et al.* evaluated the effects of a preanesthetic dose of dexmedetomidine (0.5 mcg/kg over 10 min) on cardiovascular parameters recorded by noninvasive thoracic bioimpedance electrodes.^[7] There was a significant decrease in CI at baseline (2.9 ± 0.8 vs. 3.24 ± 0.7). CI decreased throughout the surgery in both the groups, but no significant difference was noted between the groups. Gu *et al.* used dexmedetomidine bolus 1 μ g/kg followed by infusion 0.01 μ g/kg/min in children for laparoscopic surgeries, and cardiac function was recorded by noninvasive continuous CO monitoring.^[16] The study found no significant changes in CI and CO following the use of dexmedetomidine. El-Gohary and Arafa evaluated the effects of dexmedetomidine as a hypotensive agent in scoliosis surgery.^[19] They recorded CI using noninvasive impedance cardiography and found that CI was significantly lower in the dexmedetomidine group compared to baseline values throughout the duration and until 5 min after stopping the infusion.

Ebert *et al.* investigated the effects of increasing plasma concentration of dexmedetomidine in healthy men.^[20] Higher plasma concentrations of dexmedetomidine resulted in decreases in CO due to decreases in both HR and SVV. He also observed a biphasic (first low then high) dose–response relation for MAP. In a double-blinded study by Lee *et al.*, where dexmedetomidine was given after induction once the patient was hemodynamically stable, there was a significant decrease in CO compared with baseline values.^[18]

CONCLUSION

Dexmedetomidine decreases the requirements of propofol for induction and also attenuates the hemodynamic response to intubation. There were no significant changes in hemodynamics and cardiovascular parameters at any other point during the study. Hemodynamic stability is mainly attributed to adequate preloading of patients and lesser propofol requirements. Adverse effects of dexmedetomidine such as bradycardia and hypotension were not observed during the study. A larger study is required to assess the effects of dexmedetomidine in the presence of other anesthetic agents.

Limitations

We did not measure the invasive parameters before giving premedication/preloading. Our baseline values are recorded following premedication. Larger study is desirable in this direction for ASA Grade 3 patients with associated cardiac diseases.

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Conflicts of interest

There are no conflicts of interest.

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