RESEARCH PAPER

Comparative Evaluation of Hemodynamic Effects Between Dexmedetomidine and Propofol-Fentanyl on Patients Undergoing Day-Care Procedures

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Received: 12th Mar, 2026 | **Revised:** 24th Mar, 2026 | **Accepted:** 14th Apr, 2026 | **Available Online:** 30th Apr, 2026

ABSTRACT

Background:

Maintaining intraoperative hemodynamic stability is crucial in day-care surgeries to ensure patient safety and rapid recovery. Propofol–fentanyl combinations are commonly used but may lead to hypotension and respiratory depression. Dexmedetomidine, a selective α2-adrenergic agonist, provides sedation and analgesia with minimal respiratory compromise and improved cardiovascular stability.

Aim:

To compare dexmedetomidine and propofol–fentanyl in terms of hemodynamic parameters, oxygen saturation, and adverse effects in day-care surgical patients.

Methods:

This prospective randomized comparative study included 60 ASA I–II patients undergoing elective day-care procedures. Patients were divided into Group A (dexmedetomidine) and Group B (propofol–fentanyl), with 30 patients each. Hemodynamic parameters (HR, SBP, DBP, MAP, SpO_2) were recorded at baseline and intraoperative intervals. Statistical analysis was performed using SPSS 27 with unpaired t-test, ANOVA, and chi-square test.

Results:

Dexmedetomidine group demonstrated significantly better hemodynamic stability with controlled heart rate and blood pressure compared to the propofol–fentanyl group ($p < 0.05$). The incidence of hypotension (36.7%), respiratory depression (16.7%), and nausea/vomiting (26.7%) was significantly higher in Group B. Oxygen saturation remained more stable in the dexmedetomidine group. Bradycardia was observed in Group A but was clinically manageable.

Conclusion:

Dexmedetomidine provides superior hemodynamic stability and safety profile compared to propofol–fentanyl, making it a preferred anesthetic agent for day-care surgeries.

Keywords: Dexmedetomidine; Propofol; Fentanyl; Hemodynamic stability; Day-care surgery; Randomized controlled trial.

How to cite this article: Nizamuddin S, Ladla A, Singh K, Gupta A, Ramzan I, Rahman BSR, Singh MV, Serawat S, Anwar M. Comparative Evaluation of Hemodynamic Effects Between

Dexmedetomidine and Propofol-Fentanyl on Patients Undergoing Day-Care Procedures. Int J Drug Deliv Technol. 2026;16(39s): 374-380. DOI: 10.25258/ijddt.16.39s.47
Source of support: Nil.
Conflict of interest: None

INTRODUCTION

Day-care surgery has emerged as a key component of modern healthcare due to reduced hospital stay, cost-effectiveness, and improved patient turnover. The success of ambulatory surgical procedures largely depends on the anesthetic technique, which should ensure rapid onset, adequate analgesia, hemodynamic stability, and early recovery without complications.

Hemodynamic fluctuations during anesthesia are common and can lead to significant perioperative morbidity. Induction of anesthesia and surgical stimulation may cause alterations in heart rate and blood pressure due to sympathetic activation or drug-induced cardiovascular depression. Such changes may be detrimental, especially in patients with limited cardiovascular reserve, increasing the risk of myocardial ischemia and delayed recovery [1,2].

Propofol, a widely used intravenous anesthetic agent, provides rapid induction and smooth recovery but is associated with dose-dependent hypotension due to systemic vasodilation and myocardial depression [3]. Fentanyl, an opioid analgesic, enhances anesthetic depth but may cause respiratory depression and bradycardia [4]. The combination of propofol and fentanyl, though effective, may exaggerate cardiovascular instability and respiratory compromise [5].

Dexmedetomidine, a highly selective α2-adrenergic agonist, has gained popularity due to its sedative, analgesic, and sympatholytic properties. It reduces catecholamine release, thereby maintaining stable hemodynamics without significant respiratory depression [6]. Additionally, dexmedetomidine provides cooperative sedation and reduces the requirement for other anesthetic agents, supporting opioid-sparing anesthesia protocols [7].

Previous studies have demonstrated that dexmedetomidine provides better hemodynamic stability compared to conventional anesthetic agents. Gulabani et al. reported that dexmedetomidine was more effective than lignocaine in attenuating hemodynamic responses during laryngoscopy [8]. Similarly, other studies have shown reduced perioperative stress response and improved cardiovascular stability with dexmedetomidine use [9,10].

Despite these advantages, limited comparative data exist evaluating dexmedetomidine against propofol–fentanyl specifically in day-care surgical settings. Therefore, this study was designed to compare the effects of dexmedetomidine and propofol–fentanyl on hemodynamic parameters, oxygen saturation, and adverse effects in patients undergoing elective day-care procedures.

MATERIAL AND METHODS

This prospective, randomized comparative study was conducted in the Department of Anaesthesiology at NIMS Hospital, Jaipur, a tertiary care hospital, after obtaining informed consent from all participants.

A total of 60 patients aged 18–65 years belonging to ASA physical status I and II undergoing elective day-care surgical procedures were included. Patients with cardiovascular disease, respiratory disorders, hepatic or renal dysfunction, pregnancy, or known drug allergies were excluded from the study.

Patients were randomly divided into two groups of 30 each using a simple random sampling technique:

- **Group A (Dexmedetomidine group):** Received dexmedetomidine 1 µg/kg as a loading dose over 10 minutes followed by infusion of 0.2–0.7 µg/kg/hr.
- **Group B (Propofol–Fentanyl group):** Received fentanyl 2 µg/kg followed by propofol 1–1.5 mg/kg infusion.

Baseline parameters including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO_2) were recorded prior to drug administration. Monitoring was continued at regular intraoperative intervals (5, 10, 15 minutes) and postoperatively.

The primary outcome measure was hemodynamic stability assessed by HR, SBP, DBP, and MAP. Secondary outcomes included oxygen saturation and incidence of adverse effects such as hypotension, bradycardia, respiratory depression, and nausea/vomiting.

Hypotension was defined as a decrease in SBP >20% from baseline, and bradycardia was defined as HR <60 beats per minute. Respiratory depression was assessed clinically and via oxygen saturation monitoring.

Statistical analysis was performed using SPSS version 27. Continuous variables were expressed as mean ± standard deviation and compared using unpaired t-test and ANOVA. Categorical variables were analyzed using chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 60 patients completed the study without any dropouts. Baseline demographic characteristics including age, gender, and weight were comparable between the two groups (p > 0.05).

Table 1: Demographic Profile

Variable	Group A (n=30)	Group B (n=30)	p-value
Age (years)	44.2 ± 9.1	43.6 ± 8.7	0.78
Weight (kg)	69.5 ± 8.2	70.1 ± 7.9	0.71
Gender (M/F)	16/14	17/13	0.80

Table 2 shows the comparison of heart rate between Group A and Group B at different time intervals. At baseline, the mean heart rate in Group A (82.4 ± 4.5 beats/min) and Group B (83.1 ± 4.8 beats/min) was comparable, with no statistically significant difference (p = 0.52). Similarly, at 5 minutes, the difference between Group A (78.2 ± 4.2) and Group B (79.6 ± 5.1) remained statistically non-significant (p = 0.28). However, from 10 minutes onwards, a statistically significant difference was observed between the two groups. At 10 minutes, 15 minutes, and in the postoperative period, Group A showed significantly lower heart rate values compared to Group B (p < 0.05).

Table 2: Comparison of Heart Rate (beats/min)

Time	Group A (Mean ± SD)	Group B (Mean ± S
Baseline	**82.4 ± 4.5**	**83.1 ± 4.8**
5 min	**78.2 ± 4.2**	**79.6 ± 5.1**
10 min	**76.9 ± 4.0**	**80.2 ± 5.3**
15 min	**75.8 ± 3.8**	**79.8 ± 5.0**
Post-op	**77.1 ± 4.1**	**80.5 ± 5.2**

Table 3 presents the comparison of systolic blood pressure (SBP) between Group A and Group B at different time intervals. At baseline, the mean SBP in Group A (124.8 ± 5.2 mmHg) and Group B (125.6 ± 5.6 mmHg) was comparable, with no statistically significant difference (p = 0.80).

However, from 5 minutes onwards, a statistically significant difference was observed between the two groups. At 5 minutes, 10 minutes, 15 minutes, and in the postoperative period, Group B showed significantly lower SBP values compared to Group A (p < 0.05 at all time points).

Table 3: Comparison of Systolic Blood Pressure (mmHg)

Time	Group A (Mean ± SD)	Group B (Mean ± SD)
Baseline	**124.8 ± 5.2**	**125.6 ± 5.6**
5 min	**118.2 ± 4.8**	**111.4 ± 6.2**
10 min	**116.5 ± 4.6**	**108.9 ± 6.0**
15 min	**115.4 ± 4.4**	**106.7 ± 5.8**
Post-op	**117.2 ± 4.7**	**109.5 ± 6.1**

Table 4 presents the comparison of diastolic blood pressure (DBP) between Group A and Group B at different time intervals. At baseline, the mean DBP in Group A (79.8 ± 3.8 mmHg) and Group B (80.5 ± 4.2 mmHg) was comparable, with no statistically significant difference (p = 0.55).

However, at 5 minutes and 10 minutes, a statistically significant difference was observed between the two groups. Group B showed

significantly lower DBP values at both 5 minutes (71.2 ± 4.8 mmHg) and 10 minutes (69.0 ± 4.5 mmHg) compared to Group A ($p < 0.05$).

Table 4: Comparison of Diastolic Blood Pressure (mmHg)

Time	Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
Baseline	79.8 ± 3.8	80.5 ± 4.2	0.55
5 min	75.6 ± 3.6	71.2 ± 4.8	<0.05
10 min	74.1 ± 3.4	69.0 ± 4.5	<0.05
15 min	73.2 ± 3.3	67.5 ± 4.3	<0.05
Post-op	75.0 ± 3.5	70.1 ± 4.6	<0.05

Table 5 shows the comparison of mean arterial pressure (MAP) between Group A and Group B at different time intervals. At baseline, the mean MAP in Group A (94.8 ± 3.9 mmHg) and Group B (95.5 ± 4.1 mmHg) was comparable, with no statistically significant difference ($p = 0.50$).

However, from 5 minutes onwards, a statistically significant difference was observed between the two groups. At 5 minutes, 10 minutes, 15 minutes, and in the postoperative period, Group B demonstrated significantly lower MAP values compared to Group A ($p < 0.05$ at all time points).

Table 5: Comparison of Mean Arterial Pressure (mmHg)

Time	Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
Baseline	94.8 ± 3.9	95.5 ± 4.1	0.50
5 min	89.8 ± 3.7	84.6 ± 4.9	<0.05
10 min	88.2 ± 3.5	82.3 ± 4.7	<0.05
15 min	87.3 ± 3.4	80.5 ± 4.5	<0.05
Post-op	89.1 ± 3.6	83.2 ± 4.8	<0.05

Table 6 presents the comparison of oxygen saturation (SpO_2) between Group A and Group B at different time intervals. At baseline, the mean SpO_2 in Group A (99.1 ± 0.6%) and Group B (99.0 ± 0.7%) was comparable, with no statistically significant difference ($p = 0.60$).

However, from 5 minutes onwards, a statistically significant difference was observed between the two groups. At 5 minutes, 10 minutes, 15 minutes, and in the postoperative period, Group B showed significantly lower SpO_2 values compared to Group A ($p < 0.05$ at all time points).

Despite this statistical difference, the SpO_2 value in both groups remained within clinically acceptable limits throughout the study period.

Table 6: Comparison of Oxygen Saturation (%)

Time	Group A (Mean ± SD)	p-value	Group B (Mean ± SD)
Baseline	99.1 ± 0.6	<0.05	99.0 ± 0.7
5 min	98.9 ± 0.7		97.8 ± 1.0
10 min	98.8 ± 0.8		97.5 ± 1.1
15 min	98.9 ± 0.7		97.3 ± 1.2
Post-op	99.0 ± 0.6		97.8 ± 1.0

Table 7 shows the intra-group comparison of hemodynamic parameters in Group A (Dexmedetomidine) across different time intervals using ANOVA test.

A statistically significant reduction was observed in heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) from baseline to subsequent time intervals ($p < 0.05$). The values showed a gradual decline from baseline up to 15 minutes, followed by a slight increase in the postoperative period, but still remained lower than baseline levels. This indicates that dexmedetomidine produces a consistent and controlled reduction in hemodynamic parameters.

In contrast, oxygen saturation (SpO_2) did not show any statistically significant change over time ($p = 0.08$), and remained within normal physiological limits throughout the study period.

Table 7: Intra-group Comparison of Hemodynamic Parameters in Group A (Dexmedetomidine)

Parameter	Baseline (Mean ± SD)	5 min (Mean ± SD)	10 min (Mean ± SD)	15 min (Mean ± SD)	Post-op (Mean ± SD)	p-value
HR (beats/min)	82.4 ± 4.5	78.2 ± 4.2	76.9 ± 4.0	75.8 ± 3.8	77.1 ± 4.1	<0.05
SBP (mm Hg)	124.8 ± 5.2	118.2 ± 4.8	116.5 ± 4.6	115.4 ± 4.4	117.2 ± 4.7	<0.05
DBP (mm Hg)	79.8 ± 3.8	75.6 ± 3.6	74.1 ± 3.4	73.2 ± 3.3	75.0 ± 3.5	<0.05
MAP (mm Hg)	94.8 ± 3.9	89.8 ± 3.7	88.2 ± 3.5	87.3 ± 3.4	89.1 ± 3.6	<0.05
SpO_2 (%)	99.1 ± 0.6	98.9 ± 0.7	98.8 ± 0.8	98.9 ± 0.7	99.0 ± 0.6	0.08

Table 8 presents the intra-group comparison of hemodynamic parameters in Group B (Propofol–Fentanyl) across different time intervals using ANOVA test.

A statistically significant reduction was observed in heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) from baseline to subsequent time intervals ($p < 0.05$). The values showed a marked decline from baseline to 15 minutes, followed by a slight increase in the postoperative period; however, they remained lower than baseline values.

Additionally, oxygen saturation (SpO_2) also showed a statistically significant decrease over time ($p < 0.05$). Although the values declined, they remained within clinically acceptable limits throughout the study period.

Table 8: Intra-group Comparison of Hemodynamic Parameters in Group B (Propofol-Fentanyl)

Parameter	Baseline (Mean ± SD)	5 min (Mean ± SD)	10 min (Mean ± SD)	15 min (Mean ± SD)	Post-op (Mean ± SD)	p-value
HR (beats/min)	83.1 ± 4.8	79.6 ± 5.1	80.2 ± 5.3	79.8 ± 5.0	80.5 ± 5.2	<0.05
SBP (mm Hg)	125.6 ± 5.6	111.4 ± 6.2	108.9 ± 6.0	106.7 ± 5.8	109.5 ± 6.1	<0.05
DBP (mm Hg)	80.5 ± 4.2	71.2 ± 4.8	69.0 ± 4.5	67.5 ± 4.3	70.1 ± 4.6	<0.05
MAP (mm Hg)	95.5 ± 4.1	84.6 ± 4.9	82.3 ± 4.7	80.5 ± 4.5	83.2 ± 4.8	<0.05
SpO_2 (%)	99.0 ± 0.7	97.8 ± 1.0	97.5 ± 1.1	97.3 ± 1.2	97.8 ± 1.0	<0.05

Table 10 presents the comparison of adverse effects between Group A and Group B. The incidence of bradycardia was higher in Group B (20%) compared to Group A (13.3%), however, the difference was not statistically significant ($p > 0.05$).

A statistically significant higher incidence of hypotension was observed in Group B (36.7%) compared to Group A (10%) ($p < 0.05$). Similarly, respiratory depression was significantly more frequent in Group B (16.7%) than in Group A (3.3%) ($p < 0.05$).

Nausea and vomiting were also significantly higher in Group B (26.7%) compared to Group A (10%) ($p < 0.05$). Other minor adverse effects were slightly more in Group B (6.7%) than Group A (3.3%), but this difference was not statistically significant ($p > 0.05$).

Adverse Effects

The incidence of adverse effects was significantly higher in Group B:

- Hypotension: 36.7% vs 10%
- Respiratory depression: 16.7% vs 3.3%
- Nausea/vomiting: 26.7% vs 10%

Bradycardia was more common in Group A but was mild and managed effectively without complications.

DISCUSSION

The present study compared dexmedetomidine-based anesthesia with propofol–fentanyl in patients undergoing surgical procedures,

focusing on hemodynamic stability, oxygenation, and adverse effects. Both techniques were effective; however, dexmedetomidine demonstrated superior hemodynamic control, better preservation of oxygen saturation, and fewer complications.

Heart rate remained more stable in the dexmedetomidine group due to its central sympatholytic action, which reduces catecholamine release and provides controlled bradycardia. Similar findings have been reported by Bajwa SJ et al. and Reddy SV et al., who observed improved cardiovascular stability with dexmedetomidine. In contrast, the propofol–fentanyl group showed greater variability, likely due to myocardial depression and vagal effects, consistent with findings by Tripathi M et al.

Blood pressure parameters (SBP, DBP, MAP) showed a greater reduction in the propofol–fentanyl group, indicating a higher incidence of hypotension. This is clinically significant, as excessive hypotension may compromise organ perfusion. Studies **by Yaddanapudi LN** et al. and **Verma R et** al. have similarly highlighted increased hemodynamic fluctuations with opioid-based anesthesia. Propofol-induced vasodilation and reduced cardiac output, as described by Sahinovic MM et al., further explain these findings. In contrast, dexmedetomidine maintained more stable mean arterial pressure, supporting better tissue perfusion.

Oxygen saturation remained within normal limits in both groups, but a slight decline was observed in the propofol–fentanyl group, suggesting mild respiratory depression. This aligns with studies **by Saxena KN et al. and Agarwal A** et al., which report increased respiratory compromise with opioid-based sedation. Dexmedetomidine, however, preserves respiratory function, as supported by Tan JA and Ho KM.

The adverse effect profile favored dexmedetomidine, with lower incidences of hypotension, respiratory depression, and nausea/vomiting. Although bradycardia was more frequent, it was mild and manageable. Similar safety profiles have been reported by Tomar GS et al. and Bajwa SJ et al., while Weerink MA et al. highlighted the predictable and controllable effects of dexmedetomidine.

Clinically, these findings support the use of dexmedetomidine in day-care surgeries, where stable hemodynamics, minimal respiratory depression, and rapid recovery are essential. Its opioid-sparing effect also aligns with Enhanced Recovery After Surgery (ERAS) protocols. Indian studies, including those by Singh R et al. and Bajwa SJ et al., further support its superiority in terms of analgesia, stability, and recovery outcomes.

CONCLUSION

Dexmedetomidine offers markedly superior hemodynamic stability, enhanced oxygenation, and a reduction in adverse effects when compared to propofol–fentanyl in outpatient surgical procedures. It is a safer and more effective alternative, which supports its use in modern anesthesia practice and protocols for faster recovery.

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