e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com doi: 10.25258/ijpqa.16.10.54

International Journal of Pharmaceutical Quality Assurance 2025; 16(10); 339-346

Original Research Article

Comparative Evaluation of Dexmedetomidine versus Fentanyl Infusion on Intraoperative Hemodynamics and Postoperative Recovery in Elective Surgical Patients

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Received: 03-09-2025 / Revised: 11-10-2025 / Accepted: 28-10-2025

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Conflict of interest: Nil

Abstract:

Background: Maintaining intraoperative hemodynamic stability and ensuring smooth postoperative recovery are crucial in modern anesthesia. While fentanyl is a commonly used opioid for intraoperative analgesia, its side effects include respiratory depression, nausea, vomiting, and delayed recovery. Dexmedetomidine, an α2-adrenergic receptor agonist, offers sedative, analgesic, and sympatholytic effects with minimal respiratory depression.

Objective: To compare the effects of dexmedetomidine infusion versus fentanyl infusion on intraoperative hemodynamics and postoperative recovery in patients undergoing elective surgery under general anesthesia.

Methods: A prospective, randomized, double-blind study was conducted on 98 patients (ASA I–II) undergoing elective surgeries. Patients were allocated into Group D (dexmedetomidine, n=49) and Group F (fentanyl, n=49). Intraoperative heart rate (HR), mean arterial pressure (MAP), anesthetic requirements, emergence time, sedation level, and postoperative recovery were assessed. Statistical analysis was performed using SPSS v25.0, with $p<0.05$ considered significant.

Results: Baseline demographics and hemodynamics were comparable. Group D showed significantly lower HR and MAP fluctuations during induction, intubation, and intraoperative stimulation ($p<0.05$). Anesthetic and opioid requirements were reduced in Group D. Emergence and extubation times were shorter (7.6 ± 2.3 vs 10.9 ± 2.8 min, $p<0.001$), and Modified Aldrete Scores ≥9 were achieved earlier in Group D. Postoperative sedation was calm and cooperative, with lower pain scores at 30 and 60 minutes ($p<0.05$). Adverse events were minimal and manageable.

Conclusion: Dexmedetomidine infusion provides superior intraoperative hemodynamic stability, reduced anesthetic consumption, and faster, smoother postoperative recovery compared to fentanyl infusion, suggesting it as a safer and more effective alternative in balanced anesthesia.

Keywords: Dexmedetomidine, Fentanyl, Hemodynamic Stability, Postoperative Recovery, Anesthesia, Analgesia

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Introduction

Maintaining an adequate intraoperative hemodynamics and ensuring a smooth postoperative recovery are important, nonetheless, in the current anesthetic practice. Operative hemodynamic stability provides sufficient perfusion to tissues, lowers the likelihood of occurrence of perioperative complications, and leads to better patient outcomes. To accomplish these objectives, several pharmacological agents have been used, but most prominently, opioids, especially fentanyl had been used since the dawn of balanced anesthesia [1,2]. Nonetheless, the increasing knowledge in the harmful effects of opioid (respiratory depression, nausea, vomiting, delayed recovery and dependence) has prompted clinicians to seek other agents that have analogous analgesic properties but minimal adverse effects. Dexmedetomidine is an α2-adrenergic receptor agonist which is a promising adjuvant in anesthesia due to its sedative, analgesic and sympatholytic effects that have recently been discovered.

Dexmedetomidine is a dose-dependent sedative with analgesic effects along with minimal or no respiratory depression and acts on “2-receptors in the locus coeruleus and the spinal cord. Its sympatholytic effect buffers effects of stress to surgical stimuli leading to stable hemodynamics with lower heart rate and less variability of blood

pressure [3]. This renders dexmedetomidine especially helpful during surgery when cardiovascular fluctuations have the power to augment morbidity. Conversely, a strong μ-opioid receptor agonist, fentanyl, has excellent analgesic action, but may lead to respiratory depression, bradycardia, and postoperative nausea and vomiting. Although fentanyl remains a popular intraoperative analgesic, its side effects and the likelihood of delayed recovery have triggered research into the possibility of dexmedetomidine as a better or alternative analgesic [4,5].

The clinical interrogation of comparing dexmedetomidine and fentanyl during intraoperative period. Studies indicated that dexmedetomidine has the potential to alleviate anesthetic and opioid requirements, provide better control as compared to intraoperative hemodynamic responses to intubation and surgical stress, and improve faster and easier anesthesia [6]. Conversely, some studies also show that excessive bradycardia or hypotension may be achieved with dexmedetomidine, particularly with higher dosages, and that it is necessary to change the doses and manage them. Fentanyl on the other hand is rapid acting response and analgesic effect, yet most likely to cause post-Operative agitation, slow awakening and more frequent nausea [7,8]. Therefore, the controlled experiment of the two agents can make a great contribution to the streamlining of the anesthesia plans to enhance patient safety and comfort.

The purpose of the study is the comparison of the effect of dexmedetomidine infusion with fentanyl infusion on intraoperative hemodynamics and postoperative recovery in surgical patients with general anesthesia. The most important outcomes are the assessment of heart rate, mean arterial pressure, and the anesthetic requirements at the operating room, but the secondary ones are related to the emergence time, the level of sedation, and postoperative recovery profile. It will be the purpose of the study to provide evidence-based answers to the problems of anesthetic care, oriented on the decrease in hemodynamic imbalances and enhancement of the recovery of the postoperative period, by stating the comparative validity and safety of the two agents. Lastly, the outcomes of such comparative studies will assist in enhancing the work on the strategies of perioperative care and the overall quality of the anesthesia practice.

Material and Methods

The present study was conducted in the Department of Anaesthesiology, ESIC Medical College and Hospital, Bihta, Patna, India for one year.

98 adult patients were recruited into the study according to the calculated sample size, which was considered to be sufficient to have statistical power to identify any significant difference between the groups. The patients were randomly assigned to two equal groups by the computer-based randomization table: Group D (Dexmedetomidine group) and Group F (Fentanyl group), there were 49 patients in each group. The two groups were similar regarding their age, sex, weight, ASA (American Society of Anesthesiologists) physical status, and type of surgical operation. The study inclusion criteria were that patients were aged between 18 and 60 years of age, were of ASA physical status I or II, and were planned to undergo elective surgery procedures that mandated general anesthesia with endotracheal intubation. Patients who had known cardiovascular conditions, had a severe hepatic or renal dysfunction, were pregnant, were morbidly obese, or had a history of hypersensitivity to the study drugs were ignored as an exclusion criterion.

All patient was pre-assessed a day before they were operated upon and had listed out general examination, systemic examination, medical history and all pertinent investigations like complete blood count, ECG, renal and liver tests and chest X-ray where necessary. All the patients were required to starve at night and oral ranitidine and alprazolam were premeditated the night before the operation. A standard monitoring was assigned at the arrival in the operating room, i.e. electrocardiography (ECG), non-invasive blood pressure (NIBP), and pulse oxyphoemography (SpO 2). The hemodynamic parameters that were recorded were the baseline heart rate (HR), the systolic blood pressure (SBP), diastolic blood pressure (DBP), the mean arterial pressure (MAP), and oxygen saturation.

In Group D, patients were given an intravenous loading dose of dexmedetomidine 1 μg/kg of normal saline over 10 min prior to induction, then a constant rate of 0.5 μg/kg/hr was administered to them during the surgery. Group F patients were loaded with fentanyl 2 μg/kg intravenously over 10 minutes and then given a constant rate of 1 μg/kg/hr as a continuous infusion throughout the intraoperative period. The study drugs were made in the same syringes by an independent anesthesiologist with no interest in overseeing the patient and this ensured that both the anesthesiologist performing the anesthesia and the patient were blinded. All participants were subjected to the same anesthetic method. Propofol 2 mg/kg was used as intravenous induction and succinylcholine 2 mg/kg was used as endotracheal intubation aids. Nitrous oxide and oxygen (50:50) and isoflurane were used to maintain anesthesia at a MAC of 1.2 to 1.5 with periodic administration of vecuronium (0.1 mg/kg) to relax the muscle.

The parameters of the intraoperative monitoring were ECG continuous recordings, NIBP, SpO_2, and end-tidal CO_2 continuous recordings. Data on hemodynamic parameters was measured at the

following time points: baseline (pre-induction), after loading dose, post-induction, immediately after intubation, 5, 10, 15, 30, and 45 minutes after intubation, and then at 15-minute intervals up to the conclusion of surgery: HR, SBP, DBP, and MAP. Any dramatic change in hemodynamics (increase or decrease of HR or MAP by more than 20) was dealt with in such cases. Atropine 0.6 mg IV was used to treat bradycardia (HR <50 beats/min) and IV fluids and mephentermine 6 mg bolus were used to treat hypotension (MAP <65 mmHg).

When surgery was over, the neuromuscular blockade was reversed by neostigmine (0.05 mg/kg) and glycopyrrolate (0.01 mg/kg), and the study drug infusions were stopped. The extubation was done after the sufficient spontaneous respiration and muscle tone had been re-established. Emergence time was measured using the calculation of time taken between cessation of anesthetics to eye opening on the response to verbal command and removal of the respiratory device (extubation). In the recovery room, postoperative recovery was determined by the Modified Aldrete Scoring System whereby parameters like activity, respiration, circulation, consciousness and saturation of oxygen were measured after every 10 minutes until the recovery attained a score of 9 or more which would mean satisfactory recovery. The level of sedation was measured with the help of Ramsay Sedation Scale (RSS), and postoperative pain was rated with the help of Visual Analog Scale (VAS) at the set time intervals. Any side effects like nausea, vomiting, bradycardia or hypotension were reported and dealt with accordingly.

Data were collected systematically with the help of a pre-designed proforma. The two main outcomes that were used were intraoperative hemodynamic stability (HR and MAP changes) and the need to administer further anesthetic or vasoactive medications. The outcome measures that were considered secondary were emergence time, level of sedation, postoperative level of pain, and recovery profile. The statistical analysis was performed on the SPSS software (version 25.0). The quantitative variables were depicted as the mean with standard deviation (SD) and compared across the groups with the help of the Student t-test whereas qualitative variables were assessed with the help of the Chi-square test or Fisher's exact test respectively. A p-value less than 0.05 was taken to be statistically significant.

Through standardization of protocols and constant monitoring by trained personnel, reliability and validity of collecting data was guaranteed. Randomization and double-blindedness minimised selection and observer bias, which increased internal validity of the study. The sample size of 98 was selected due to previous researches as well as power analysis with a confidence level of 95% and power of 80% to identify clinically significant differences in the hemodynamic variables among the groups.

Results

The present prospective, randomized, and double-blind comparative study was conducted on 98 patients who underwent elective surgical procedures under general anesthesia. Patients were divided equally into two groups of 49 each: Group D (Dexmedetomidine infusion) and Group F (Fentanyl infusion). Both groups were comparable in terms of demographic profile, baseline hemodynamic parameters, duration of surgery, and type of surgical procedure, ensuring that any observed differences in intraoperative or postoperative outcomes could be attributed to the study drugs rather than to confounding variables. Both groups were comparable with respect to age, gender distribution, body weight, and ASA physical status. The mean age of patients in Group D was 37.6 ± 10.4 years, while in Group F it was 36.9 ± 9.8 years. The male-to-female ratio was similar across both groups (1.2:1 in Group D and 1.3:1 in Group F). Mean body weight was 63.8 ± 8.2 kg in Group D and 64.1 ± 7.9 kg in Group F. All patients belonged to ASA physical status I or II. The mean duration of surgery was 92.3 ± 18.4 minutes in Group D and 94.6 ± 20.1 minutes in Group F, with no statistically significant difference ($p > 0.05$).

Table 1: Demographic and Baseline Characteristics

Parameter	Group D (Dexmedetomidine)	Group F (Fentanyl)	p-value
Sample size (n)	49	49	–
Age (years)	37.6 ± 10.4	36.9 ± 9.8	0.72
Gender (M/F)	27/22	28/21	0.84
Weight (kg)	63.8 ± 8.2	64.1 ± 7.9	0.88
ASA Grade (I/II)	32/17	30/19	0.67
Duration of Surgery (min)	92.3 ± 18.4	94.6 ± 20.1	0.59

No significant difference in baseline parameters between the two groups.

Results of this study was the intraoperative hemodynamic stability. The baselines of heart rate (HR) and mean arterial pressure (MAP) were not significantly different in the two groups prior to the

administration of any drug ($p > 0.05$). After administration of the loading dose, Group D exhibited significant decrease on HR and MAP in comparison with Group F, which indicated the improved hemodynamic control. Group D displayed attenuated responses during induction and intubation with little increase in HR and BP, but Group F experienced a short-term increase because of the sympathetic stimulation. This was statistically significant ($p < 0.05$). During the intraoperative, Group D showed stabilization of HR and MAP within the 10% variation range of the baseline and Group F had a wider variation in their measurements especially when the surgery was stimulated. Group F (12.2) had more episodes of tachycardia and hypertension than Group D (4.1%). On the other hand, a trivial bradycardia was noted in 3 patients (6.1) in Group D and successfully treated with atropine. Group D and Group F had 2 and 1 patients, respectively, who had hypotension that needed to be addressed ($p > 0.05$).

Table 2: Comparison of Mean Heart Rate (beats/min) and Mean Arterial Pressure (mmHg)

Time Interval	HR (Group D)	HR (Group F)	p-value	MAP (Group D)	MAP (Group F)	p-value
Baseline	84.2 ± 9.1	83.7 ± 8.6	0.78	94.8 ± 7.2	95.1 ± 6.8	0.82
After Loading Dose	76.3 ± 8.5	82.6 ± 7.9	0.001*	89.2 ± 6.5	94.7 ± 7.4	0.002*
Post-Intubation	82.1 ± 8.9	95.4 ± 9.1	0.0001*	90.4 ± 7.6	101.2 ± 8.1	0.0001*
30 min After Incision	78.2 ± 8.3	88.5 ± 9.0	0.0002*	88.6 ± 6.4	97.3 ± 7.0	0.0001*
End of Surgery	77.5 ± 8.8	86.9 ± 8.7	0.001*	87.1 ± 6.2	94.8 ± 6.8	0.001*

Significant difference at $p < 0.05$

These findings are a clear indication that dexmedetomidine was better in controlling intraoperative hemodynamics than fentanyl, and tachycardic and hypertensive reactions achieved statistically significant attenuation. Group D had a lower total propofol requirement during induction, as well as, isoflurane during maintenance, than Group F. The average concentration of isoflurane needed to sustain a satisfactory depth of anesthesia was 0.9 / 0.2 percent in Group D and 1.2 / 0.3 percent in Group F (p less than 0.05). There was no significant difference between the number of additional boluses of vecuronium needed in each of the two groups ($p > 0.05$). There was no patient who needed further opioid supplement in the dexmedetomidine arm, but 6 patients (12.2) in the fentanyl arm had to receive rescue doses of fentanyl during surgery.

The types of postoperative emergence and recovery were evaluated by the use of the Modified Aldrete Score and Ramsay Sedation Scale (RSS). The information regarding the mean emergence time (time to eye opening on verbal command) was significantly lower in Group D (7.6 + 2.3 minutes) that in Group F (10.9 + 2.8 minutes, $p < 0.001$). On the same note, the extubation time in Group D (8.4 ± 2.1 minutes) was lower than in Group F (11.5 ± 2.5 minutes, $p < 0.001$). Group D patients had an easier emergence and less agitation and improved orientation during the initial postoperative period. Group D had higher postoperative sedation score right after the extubation which indicated calm and cooperative sedation instead of drowsiness. The majority of Group D patients recorded an Aldrete score 9 or higher, at a 15-20 minute period but in Group F, the time was 25-30 minutes to achieve the same level of recovery. Group D scored significantly lower than Group C at 30 and 60 minutes post-extubation on the Visual Analog Scale (VAS) on postoperative pain, which suggests a more extended analgesic effect of dexmedetomidine.

Table 3: Postoperative Recovery and Analgesia

Parameter	Group D (Dexmedetomidine)	Group F (Fentanyl)	p-value
Emergence time (min)	7.6 ± 2.3	10.9 ± 2.8	0.0001*
Extubation time (min)	8.4 ± 2.1	11.5 ± 2.5	0.0001*
Aldrete score ≥9 (min)	17.2 ± 4.1	26.8 ± 5.6	0.0001*
RSS (immediate post-extubation)	3.8 ± 0.6	2.9 ± 0.5	0.0001*
VAS score (30 min)	2.3 ± 0.8	3.9 ± 1.0	0.0001*
VAS score (60 min)	2.9 ± 0.9	4.4 ± 1.1	0.0001*

Significant difference at $p < 0.05$

The negative events were low in both groups. Group D had three (6.1) patients with mild bradycardia, two patients (4.1) with hypotension, both of which were easily controlled with atropine and fluid boluses, respectively. Five patients were observed to have postoperative nausea and vomiting (10.2%) and three (6.1) exhibiting restlessness or agitation during emergence in Group F. All the patients did not develop respiratory depression, desaturation or severe cardiovascular events. The intravenous

administration of dexmedetomidine was more effective in blocking intraoperative hemodynamic variability, decreasing anesthetic and analgesic demands, and was also more effective in achieving smooth and quicker postoperative recovery than fentanyl infusion. Patients that were treated with dexmedetomidine experienced lower HR and MAP during critical surgical events, reduced eye opening and extubation time and a reduced postoperative pain and agitation score. Mild cases of bradycardia and hypotension were sometimes noted though they were brief and the patients responded quickly to treatment. Although it is effective as a painkiller, Fentanyl was linked to an increase in hemodynamic changes and a prolonged recovery period after the anesthetic.

Discussion

The present study compared intraoperative hemodynamic stability and postoperative recovery between a dexmedetomidine-infusion group and a fentanyl-infusion group in patients undergoing surgery under general anaesthesia. Our findings demonstrate that the dexmedetomidine group achieved significantly better control of heart rate (HR) and mean arterial pressure (MAP) during key intraoperative periods, a reduced requirement of anaesthetic and analgesic drugs, and a smoother, faster recovery profile compared with the fentanyl group. These results are consistent with, and extend, the existing literature on the use of dexmedetomidine as an anaesthetic adjunct.

Firstly, in terms of intraoperative haemodynamic responses, our data show that dexmedetomidine effectively attenuated the sympathetic responses associated with laryngoscopy, intubation, surgical incision and intra-operative stimulation, maintaining HR and MAP closer to baseline. This observation aligns with previous investigations. For example, in hypertensive patients undergoing major surgery, administration of dexmedetomidine (1 μg/kg loading, 0.5 μg/kg/h infusion) led to significantly less increase in HR and MAP at intubation versus fentanyl ($P = 0.004$ for MAP and $P = 0.01$ for HR) [9]. That study concluded that dexmedetomidine better mitigates the sympathetic stress response compared to fentanyl. Moreover, in kyphoscoliosis correction surgery under propofol-based TIVA, a study found that dexmedetomidine group exhibited more stable SBP, DBP and HR ($p < 0.05$) than fentanyl group [10]. These findings reinforce the observation that dexmedetomidine has a stronger capacity for maintaining haemodynamic stability than fentanyl.

This difference has a solid pharmacological explaining rationale. The dexmedetomidine is an extremely **selective alpha-2 adrenergic receptor agonist**, decreasing sympathetic tone and catecholamine effundation, leading to bradycardia and moderate hypotension and enhanced haemodynamic stability On the other hand, Fentanyl is a strong μ-opioid receptor agonist and it can suppress nociceptive responses but is not as effective at suppression of the sympathetic response related to noxious stimulation; in addition, opioid-related adverse effects (such as respiratory depression, nausea, vomiting, and delayed recovery, etc.) can also complicate the peri-operative management. The results of our study, as well as those of previous ones, are, therefore, indicative of the mechanistic benefit of dexmedetomidine in the management of the peri-operative sympathetic uproars.

In addition to regulation of haemodynamic variability, our research proved that the dexmedetomidine group needed lower inhalational anaesthetic concentrations and less rescue boluses of opioids and muscle relaxants. As an example, the average concentration of isoflurane in our dexmedetomidine group was much less than in the fentanyl group. Such anesthetics-sparing effect of dexmedetomidine is reported in the literature. Tufanogullari et al. (2008) [11] hypertensive-surgery study indicated a decreased dose of thiopentone induction and a decreased dose of isoflurane. Correspondingly, the consumption of propofol was considerably reduced in dexmedetomidine group compared to the spinal surgery monitoring study [12] ($p = 0.03$). These decreases indicate the analgesic and sedative augmentative effects of dexmedetomidine that allow the reduction of the main agents of anaesthetics. The clinical implication would be low cost of drugs, decreased side-effects of high-dose anaesthetics, and possibly quicker healing.

In terms of recovery parameters, we discovered that patients receiving dexmedetomidine had less time to eye opening (time to extubation) and a higher Modified Aldrete Score (at least 9) and lower time to eye opening. The pain level of postoperative, measured using VAS, was also lower at 30 and 60 minutes in the dexmedetomidine group. These results show that early postoperative recovery is enhanced as well as intraoperative stability. These are justified by literature: Shetty et al. (2017) reported that dexmedetomidine infusion in pediatric cochlear-implantation led to a reduced recovery rate after anesthesia and decreased postoperative analgesics than fentanyl infusion [13]. However, there are also certain contradictory results that should be mentioned. A randomized analysis of laparoscopic cholecystectomy using dexmedetomidine vs fentanyl in TIVA showed that fentanyl group recovered faster and was much better prepared with hemodynamic stability whereas the dexmedetomidine group had slower recovery and higher rescue analgesia (77% vs 22). It indicates that dexmedetomidine may not be beneficial in all

surgical settings and anaesthetic plans and that fentanyl may continue to be helpful in some of the shortest procedures and minimal-stimulus procedures.

The variance between our findings and the cholecystectomy study could be as a result of variance in dose of infusion, patient selection, infusion stimulation and depth of anaesthesia. The loading and maintenance doses of dexmedetomidine were selected in our trial to achieve the ideal haemodynamic control without undue sedation. The relative advantage of dexmedetomidine might not be as noticeable or even counterbalanced by the delayed emergence in shorter or outpatient-type procedures [14]. Therefore, in interpreting our results, one must take into account the surgery, drug regime, and recovery standards.

One of the interesting results of the study that we made was the low number of adverse effects. Mild bradycardia (6.1%), and hypotension (4.1%) were seen in the dexmedetomidine group, but all were easily treated with no consequences; postoperative nausea and vomiting (10.2%) and agitation (6.1) were more common in the fentanyl group. The safety observations are reiterative of prior research: Shetty et al. have discovered that an incidence of PONV was less in the group using dexmedetomidine than in the group using fentanyl [13]. Similar results were also observed in other studies which had fewer nausea/vomiting episodes and lower adverse events linked to opioids with dexmedetomidine use [14,15]. Nonetheless, this bradycardic and hypotensive effect of dexmedetomidine requires a close observation and proper titration especially in patients with underlying bradycardia or conduction defects.

The dexmedetomidine profile in terms of sedation is worth mentioning in terms of recovery. Dexmedetomidine causes so-called **conscious sedation** (i.e. patients are not very active but can still be awakened), which could be the basis of the easier appearance and the enhanced postoperative orientation that we experienced. Conversely, opioids can also cause sedation but also respiratory depression and delayed mobilisation [16,17]. Therefore, this enhanced recovery profile observed in our paper could be the combination of a quicker emergence and enhanced quality of this emergence, less agitation, improved pain management, and reduced side-effects.

Our findings are applicable in clinical anaesthetic practice with implications on high-risk patients. In the case of surgeries where cardiovascular stability is paramount (such as in hypertensive, coronary or cerebrovascular disease patients) dexmedetomidine as the intraoperative infusion can be used to address haemodynamic fluctuations and eliminate the necessity of using rescue vasoactive drugs [18]. Also, the anaesthetic-sparing effect could allow reduced volatile or intravenous anaesthetic levels, which may minimise after-effect of sedation and post-surgical sedative effects. Higher recovery room perspective, decreased pain level and nausea/vomiting can cause earlier discharge out of PACU, better patient satisfaction, and less resource use.

However, limitations and considerations are to be made. To begin with, the bradycardic and hypotensive effects of dexmedetomidine do not make it risk-free particularly in patients with conduction defects, deep hypovolemia or high vagal tonicity. Such incidences were low in our research; however, close surveillance is important. Secondly, the effectiveness of dexmedetomidine relative to fentanyl could vary according to the type of surgery, duration, type of anaesthetic procedure (TIVA vs inhalational) and postoperative recovery measure. The cholecystectomy research [9] recommends the possibility of fentanyl still being beneficial in fast recovery and hemodynamics stability in shorter or least invasive operations. Thirdly, the assumptions of cost and drug availability can affect the choice of the agent in some settings. The other limitation is generalisability. We undertook our research in the Department of Anaesthesiology, ESIC Medical College and Hospital, Bihta, Patna, India, among patients who had an age of 18-60 years, ASA I- II and underwent elective surgeries. The results might not be generalized to the elderly patient population, ASA III/IV, emergency surgery, and patients with a complicated predisposition. Future research needs to look at dexmedetomidine versus fentanyl in these populations of higher risk and in other surgical procedures (e.g., cardiac surgery, neurosurgery, major vascular surgery). Moreover, although our main results were the HR, MAP and recovery times, such long-term outcomes as analgesic consumption 24 to 48 hrs after the operation, delirium incidence, length of hospital stay and cost-effectiveness were not studied and should be further researched.

Our results support that dexmedetomidine infusion offers meaningful advantages over fentanyl infusion in terms of intraoperative haemodynamic stability, reduced anaesthetic/ analgesic consumption, and improved postoperative recovery profile in elective surgical patients. These findings are consistent with multiple prior studies, especially in moderate to major surgeries, and suggest that dexmedetomidine may be preferred in contexts where sympathetic stress suppression and smooth recovery are priorities. However, anaesthetic planning must consider individual patient characteristics, surgical duration and context, dosing regimens and monitoring requirements.

Conclusion

The present study demonstrates that dexmedetomidine infusion provides superior intraoperative hemodynamic stability and a smoother postoperative recovery compared to fentanyl infusion in patients undergoing general anesthesia. Dexmedetomidine effectively attenuated fluctuations in heart rate and blood pressure, reduced anesthetic and analgesic requirements, and promoted faster emergence with minimal adverse effects. In contrast, fentanyl was associated with greater variability in hemodynamic parameters and delayed recovery. Hence, dexmedetomidine may be considered a safer and more effective alternative to fentanyl for achieving balanced anesthesia and optimizing perioperative patient outcomes.

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