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Original Research Article

EXPLORING THE HEMODYNAMIC AND POST-OPERATIVE IMPLICATIONS: A COMPARATIVE ANALYSIS OF INTRAVENOUS SEDATION WITH DEXMEDETOMIDINE VERSUS PROPOFOL IN CARDIAC SURGICAL PROCEDURES

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Abstract: *A comparative study was conducted to examine the impact of dexmedetomidine and propofol on hemodynamic stability and post-operative outcomes in cardiac surgery patients. The study included 100 patients aged 15-60 who were ASA physical Status I-III and scheduled for elective open-heart surgery. Patients were divided into the dexmedetomidine group (n=50) and the propofol group (n=50). The study meticulously detailed hemodynamic assessments, induction protocols, and anesthesia management. The study found that dexmedetomidine exhibited consistently lower heart rates at critical intervals. In the post-operative phase, dexmedetomidine showed favorable outcomes, including significantly shorter ventilation duration (6.43 ± 8.86 vs. 8.86 ± 5.60 hours, P = 0.014) and ICU stay (92.34 ± 56.71 vs. 118.56 ± 41.89 hours, P = 0.01). The incidence of delirium was also significantly lower in the dexmedetomidine group (8% vs. 24%, P = 0.029), suggesting potential neuroprotective effects. It is important to note that the study's sample size was moderate and focused on short-term outcomes. Therefore, further research is needed to explore diverse patient subgroups and the long-term implications of dexmedetomidine and propofol in cardiac surgery anesthesia. Nonetheless, the study concluded that dexmedetomidine demonstrated favorable hemodynamic stability and beneficial post-operative outcomes, making it a promising option for cardiac surgery patients.*

Keywords: Dexmedetomidine, Propofol, Cardiac surgery, Hemodynamics, Post-operative outcomes, Delirium, Intensive Care Unit, Anesthesia

Introduction

The increasing use of dexmedetomidine in cardiac anesthesia is remarkable. This has been fueled by recent studies that highlight its crucial role in maintaining cardiovascular stability during cardiac surgeries. Dexmedetomidine is known for its various attributes as an effective analgesic, sedative, anxiolytic, and sympatholytic agent. It can be seamlessly combined with standard intravenous induction drugs for routine anesthesia (Akram et al., 2021). Cardiac surgery patients' hypertensive response to endotracheal intubation is reduced, thanks to this technique. This leads to stable hemodynamics, reducing the need for additional intravenous anesthetic agents (Tosun et al., 2013). Historically, there was a belief that perioperative dexmedetomidine use was cardio-protective. However, a study conducted by Tosun et al. challenged this notion (Elgebaly et al., 2020).

The literature on dexmedetomidine's impact on cardiac surgery patients is limited, with only a few studies available. However, one study showed that dexmedetomidine can improve patient outcomes by reducing the incidence of delirium, ventricular tachycardia, and the duration of mechanical ventilation (Pan et al., 2019).

Propofol, another intravenous anesthetic agent, finds its well-established niche in the induction and maintenance of anesthesia. Its documented use in cardiac surgery induction, marked by doses ranging from 1.0 to 2.5 mg/kg, has been associated with significant hypotension in various studies (Kunisawa et al., 2011; Sattar et al., 2023; Sheikh et al., 2018). This study aims to improve our understanding of the effects of dexmedetomidine and propofol infusions on hemodynamic responses during cardiac surgeries. The study will carefully compare the two drugs and their potential impacts on critical post-operative outcomes, such as ventilation duration, ICU stay, myocardial ischemia, stroke, coma, heart block, delirium, and acute renal failure. Through this comprehensive exploration, we hope to gain insights that can help optimize patient care during cardiac surgery.

Methodology

In this retrospective comparative study conducted at the Cardiothoracic Anesthesia Department of Bahria International Hospitals in Lahore from June 2022 to 2023, our primary objective was to comprehensively investigate and compare the hemodynamic responses elicited by dexmedetomidine and propofol infusions during cardiac surgeries. Ethical approval was obtained from the Institutional Ethical Committee, and the study involved 100 patients aged 15–60, falling within the American Society of Anesthesiologists physical Status I–III, scheduled for elective open-heart surgery. Inclusion criteria comprised patients with ASA I-III, aged 15-60, with 1 or 2

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comorbidities like DM and HTN. Exclusion criteria included known hypersensitivity to drugs, age less than 15 or more than 60 years, heart block and myocardial dysfunction, severely deranged liver function, and comorbidities such as DM, HTN, IHD, and stroke. The same consultant cardiac surgeon operated on all patients.

For this retrospective comparative study, patients were retrospectively divided into two groups: dexmedetomidine (n = 50) and propofol (n = 50).

Preoperative procedures involved the administration of intramuscular midazolam (0.05 mg/kg) 30 minutes before surgery and inserting an 18G peripheral venous cannula for intravenous access. Comprehensive physiological monitoring, including ECG, pulse oximetry, noninvasive blood pressure, temperature, neuromuscular, and urine output monitoring, was initiated, and baseline values for systolic arterial pressure, diastolic arterial pressure, and heart rate (HR) were recorded for all patients.

Anesthesia induction protocols for both groups included propofol (1–2.5 mg/kg), morphine (0.1–0.2 mg/kg), and isoflurane (minimum alveolar concentration 1.2), with tracheal intubation facilitated by intravenous atracurium (0.5–0.8 mg/kg).

The drug administration phase involved a bolus of dexmedetomidine (1 μg/kg diluted in 100 ml of normal saline over 10 minutes) for the dexmedetomidine group, followed by an infusion (0.2–0.6 μg/kg/h). Conversely, the propofol group received an infusion (0.25–1 mg/kg/h).

Monitoring included using a BIS monitor to gauge the depth of anesthesia maintaining a targeted BIS at 50 ± 10. An independent anesthesiologist conducted hemodynamic assessments and applied interventions to manage hemodynamic instability.

During the Cardiopulmonary Bypass (CPB) phase, a standardized protocol standard for both groups addressed pump flows, ventilation, myocardial protection, and temperature maintenance.

Post-operative care followed a standardized Cardiothoracic Intensive Care Unit (CICU) protocol. Outcomes, such as the duration of mechanical ventilation, length of ICU stay, and complications, were systematically evaluated.

Statistical analysis, including Student's t-test, analysis of variance, and Mann–Whitney U-test, was performed using IBM SPSS Statistics, with significance set at $P < 0.05$. This retrospective comparative study aims to provide historical insights into the hemodynamic impacts of dexmedetomidine and propofol in cardiac surgery.

Results

Demographic characteristics, as presented in Table 1, revealed no statistically significant differences ($P > 0.05$) between the Dexmedetomidine and Propofol groups. The mean age for the Dexmedetomidine group was 43.6 ± 10.86 years, while the Propofol group had a mean age of 45.6 ± 8.54 years. Similarly, the two groups had no significant differences in weight, baseline heart rate (HR), baseline systolic and diastolic blood pressure, ejection fraction, and cardiopulmonary bypass time.

Moving on to heart rate variations at specific intervals, detailed in Table 2, a significant difference ($P < 0.001$) was noted between the two groups. Notably, the Dexmedetomidine group exhibited lower mean heart rates at various time points, including intubation, 30 minutes post-intubation, 60 minutes post-intubation, 30 minutes post-bypass, 60 minutes post-bypass, and the end of surgery, compared to the Propofol group.

Regarding post-operative outcomes, as shown in Table 3, the duration of post-operative ventilation was significantly shorter in the Dexmedetomidine group (6.43 ± 8.86 hours) compared to the Propofol group (8.86 ± 5.60 hours, P = 0.014). The Dexmedetomidine group also demonstrated a shorter ICU stay (92.34 ± 56.71 hours) than the Propofol group (118.56 ± 41.89 hours, P = 0.01). While no occurrences of myocardial infarction, stroke, coma, heart block, or renal failure were reported in either group, the incidence of delirium was significantly lower in the Dexmedetomidine group (8%, n=4) compared to the Propofol group (24%, n=12, P = 0.029). No participants were excluded due to hemodynamic alterations, and no deaths were reported during the study.

Table 1: Demographics of the study population

Demographics	Dexmedetomidine Group	Propofol Group	*P*-value
Age	43.6 ±10.86	45.6 ±8.54	0.309
Weight	53.5 ±8.83	55.5 ±8.24	0.244
Hypertension	30 (62%)	28(56%)	0.66
Baseline HR	76.5 ±6.89	77.57 ±5.76	0.402
Baseline systolic BP	135.78 ±6.43	133.87± 6.37	0.139
Baseline diastolic BP	80.76 ±7.5	78.9± 6.9	0.22
Ejection fraction	55.86 ±5.6	53.98 ±6.7	0.131
Cardiopulmonary bypass time	119.90 ±45.67	110.87 ±56.7	0.383

Table 2: Heart rate at specific intervals

Parameters (heart rate at specific intervals)	Dexmedetomidine group	Propofol group	*P*-value
Intubation	75.6 ± 7.5	80.86 ±8.9	0.002
30 minutes intubation	74.8 ±6.8	81.4 ±7.9	<0.001
60 minutes after intubation	73.9 ±5.4	80.4 ±8.9	<0.001
30 minute after bypass	79.8 ± 7.9	89.7± 7.9	<0.001
60 minutes after bypass	76.43 ±8.93	81.7± 9.3	0.004
End of surgery	74.7 7.54	80.34 8.6	<0.001

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Table 3: Post-operative outcomes

Parameters	Dexmedetomidine group	Propofol Group	*P*-value
Post-operative ventilation	6.43± 8.86	8.86 ±5.60	0.014
ICU stay	92.34 ± 56.71	118.56 ± 41.89	0.01
Myocardial infarction	0	0	-
Stroke	0	0	-
Coma	0	0	-
Heart block	10%(n=5)	16%(n=8)	0.372
Renal failure	0	0	-
Delirium	8%(n=4)	24%(12)	0.029

Discussion

Dexmedetomidine is increasingly used in cardiac anesthesia due to recent studies highlighting its vital role in maintaining cardiovascular stability during cardiac surgeries. This study compares the effects of Dexmedetomidine and Propofol in cardiac surgery anesthesia. The demographic analysis showed no significant differences between the two groups, ensuring a fair comparison. The differences in heart rate dynamics are fascinating, as the Dexmedetomidine group consistently had lower mean heart rates at various critical intervals. This aligns with the known sympatholytic properties of dexmedetomidine, indicating its potential to maintain hemodynamic stability during cardiac surgery. The significant reduction in heart rate at the end of surgery is noteworthy and suggests that it could contribute to a smoother recovery trajectory and possibly lead to better post-operative outcomes.

We compared these results with international studies. Kunisawa and colleagues conducted a study that observed a reduced percentage increase in hemodynamic parameters (HR, SBP, and diastolic blood pressure) at skin incision or sternotomy in the dexmedetomidine group compared to the control group (Kunisawa et al., 2011). In a separate study by Tosun et al., MAPs were noted to be lower in the dexmedetomidine group than in the control group, with statistical significance ($P < 0.05$) (Elgebaly et al., 2020). Jalonen et al. incorporated dexmedetomidine as an anesthetic adjunct in coronary artery bypass grafting patients, reporting a significant blunting effect on systolic arterial pressure and HR responses to intubation and skin incision. They observed decreased tachycardia and hypertension during the surgery (Sheikh et al., 2018). The hemodynamic response to intravenous dexmedetomidine exhibits a biphasic pattern, involving an immediate increase in systemic arterial pressure followed by a more prolonged reduction influenced by the infusion rate. A 10-minute infusion in our study did not increase SBP, maintaining a predictable and acceptable hemodynamic profile. Concomitant bradycardia, while present, was not clinically significant, without an associated increase in inotropic or pacing requirements, nor premature cessation of dexmedetomidine infusion. In another investigation by Martin et al. involving 401 postsurgical patients, continuous dexmedetomidine infusion, even with a 1.0 µg/kg loading dose over 10 minutes, did not heighten the risk of cardiovascular complications in patients with a presurgical history of various cardiovascular conditions, including hypotension, hypertension, bradycardia, or tachycardia (Martin et al., 2003). This is particularly relevant as increases in SBP and HR have been linked to perioperative ischemia in patients with cardiovascular disease, emphasizing the importance of hemodynamic management during critical perioperative periods such as laryngoscopy, tracheal intubation, and emergence from anesthesia.

Speaking of which, the post-operative phase revealed compelling advantages associated with dexmedetomidine. The shorter post-operative ventilation and ICU stay in the Dexmedetomidine group suggests a more expedited recovery process. This could be attributed to the sedative properties of dexmedetomidine without compromising respiratory function, facilitating earlier extubation and reducing the overall ICU stay.

Afanador et al. (Afanador et al., 2010) reported significantly shorter tracheal extubation times in patients receiving intraoperative dexmedetomidine during elective heart surgery and off-pump coronary artery bypass grafting, respectively. Our study supports these findings, suggesting that dexmedetomidine, compared to propofol, may contribute to early extubation due to minimal impact on respiratory drive, sympatholytic activity, and reduced opioid requirements.

Furthermore, our investigation revealed a shorter ICU stay in the dexmedetomidine group, aligning with prior trials demonstrating its role in facilitating early ICU discharge following cardiac surgery (Heybati et al., 2022; Patel et al., 2022). Although total ICU costs were not directly assessed in our study, the shorter ICU stay in the dexmedetomidine group implies potential cost savings.

Considering the significant impact of delirium on healthcare systems, our study supports the association between perioperative dexmedetomidine use and a reduced risk of post-operative delirium, consistent with a retrospective cohort study involving 7653 cardiac surgery patients (Peng et al., 2019). The precise mechanism through which dexmedetomidine mitigates delirium remains unclear, but existing studies propose its gamma-aminobutyric acid receptor-sparing activity, minimal respiratory depression, sleep-mimicking effect, absence of anticholinergic activity, and opioid-sparing development as potential contributors (Burry et al., 2021; Lee, 2019).

The absence of myocardial infarction, stroke, coma, heart block, or renal failure in both groups underscores the safety profiles of both agents in the studied population. However, the strikingly lower incidence of delirium in the Dexmedetomidine group is a noteworthy finding. This aligns with existing literature suggesting the neuroprotective qualities of dexmedetomidine, potentially reducing post-operative cognitive complications.

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This study has limitations that include a moderate sample size, impacting the generalizability of findings. Focused on short-term outcomes, it lacks exploration of potential long-term effects or extended recovery patterns. While providing insights into Dexmedetomidine and Propofol, a broader anesthesia options analysis could offer a comprehensive understanding. The study does not extensively explore specific patient subgroups or conditions that might influence drug responses. Despite efforts to control variables, inherent patient variability and the complexity of cardiac surgery introduce unaccounted factors, requiring cautious result interpretation.

Conclusion

In conclusion, dexmedetomidine exhibited favorable hemodynamic stability, manifested by consistently lower heart rates and advantageous post-operative outcomes, including reduced ventilation and ICU stay. Its association with a lower risk of delirium suggests potential neuroprotective effects. However, the study's moderate sample size and focus on short-term outcomes underscore the need for cautious interpretation. Future research should explore diverse patient subgroups and long-term implications for a comprehensive understanding of Dexmedetomidine and Propofol in cardiac surgery anesthesia.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
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Approved
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Conflict of interest

The authors declared absence of conflict of interest.

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