Section: Anaesthesiology

Original Research Article

POSTOPERATIVE ICU SEDATION WITH DEXMEDETOMIDINE: A PROSPECTIVE ANALYSIS OF HEMODYNAMIC MODULATION AND RECOVERY ACCELERATION

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Received *: 07/06/2025*
Received in revised form *: 03/08/2025*
Accepted *: 20/08/2025*

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DOI: 10.70034/ijmedph.2025.3.421

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (3); 2284-2287

ABSTRACT

Background: Optimal postoperative sedation in the ICU should ensure patient comfort, hemodynamic stability, and rapid recovery. Dexmedetomidine, a selective α2-adrenergic agonist, has emerged as a promising agent due to its sedative and analgesic properties without respiratory depression. This study evaluated the hemodynamic and recovery profile of dexmedetomidine compared to conventional sedatives in postoperative ICU patients.

Materials and Methods: This prospective observational study was conducted from July 2024 to June 2025 at the Department of Anaesthesia, Kamineni Institute of Medical Sciences, Narketpally. Sixty adult postoperative ICU patients requiring mechanical ventilation and sedation were enrolled and allocated into two groups (n=30 each): one received dexmedetomidine infusion (0.2–0.7 µg/kg/h), while the control group received midazolam or fentanyl-based sedation. Hemodynamic parameters, sedation scores, extubation time, ICU stay duration, and adverse events were recorded. Statistical analyses included Student's t-test, Chi-square test, and Mann–Whitney U test, with $p<0.05$ considered significant.

Results: Mean arterial pressure and heart rate were significantly lower in the dexmedetomidine group (78.6 ± 6.2 mmHg and 65.4 ± 5.7 bpm) compared to controls (86.2 ± 7.1 mmHg and 78.9 ± 6.4 bpm, $p<0.001$). Time to extubation and ICU stay were also shorter (12.3 ± 3.5 vs 20.8 ± 4.1 minutes; 36.5 ± 4.8 vs 48.2 ± 6.1 hours, both $p<0.001$). Sedation adequacy (93.3% vs 63.3%) and nursing satisfaction scores were significantly better in the dexmedetomidine group.

Conclusion: Dexmedetomidine infusion provided effective sedation with improved recovery outcomes and acceptable hemodynamic safety, making it a favorable option for postoperative ICU sedation.

Keywords: Dexmedetomidine, ICU sedation, postoperative recovery, hemodynamics, extubation, alpha-2 agonist.

INTRODUCTION

Postoperative sedation in the intensive care unit (ICU) plays a pivotal role in optimizing patient comfort, minimizing anxiety, facilitating mechanical ventilation, and improving overall outcomes in the critical care setting. The ideal sedative agent in the postoperative period should provide effective sedation, allow easy titration, maintain cardiovascular stability, and avoid respiratory depression. However, commonly used agents such as benzodiazepines, opioids, and propofol are often associated with significant drawbacks, including respiratory compromise, prolonged sedation, and delirium, particularly in vulnerable surgical populations.[1]

Dexmedetomidine, a highly selective alpha-2 adrenergic receptor agonist, has emerged as a promising sedative in ICU settings due to its unique pharmacological profile. Unlike traditional sedatives,

dexmedetomidine induces a state of arousable sedation, preserves respiratory drive, and exerts analgesic and sympatholytic effects.[2] These properties not only facilitate better patient-ventilator synchrony but also potentially reduce the incidence of postoperative delirium and the need for adjunctive analgesics or antipsychotics.[3] Furthermore, its relatively short elimination half-life enables rapid emergence from sedation, thus contributing to early extubation and shorter ICU stays.[4]

Despite these benefits, the hemodynamic profile of dexmedetomidine remains a subject of scrutiny. It is known to cause dose-dependent bradycardia and hypotension, particularly during loading phases or in volume-depleted patients.[5] This necessitates careful titration and individualized dosing strategies in the postoperative ICU population, where hemodynamic stability is critical for recovery. While previous studies have compared dexmedetomidine with conventional sedatives in general ICU cohorts, focused evaluation in postoperative ICU patients, especially with respect to both hemodynamic safety and recovery efficiency, remains underexplored.[6]

Clinical decisions regarding sedation often need to balance the depth and quality of sedation with the risk of cardiovascular compromise and delayed recovery. In this context, understanding the dual impact of dexmedetomidine on hemodynamics and recovery parameters such as time to extubation, ICU stay, and sedation adequacy is crucial for anesthesiologists and intensivists alike.[7] Additionally, sedation-related outcomes such as analgesic requirement, incidence of delirium, and nursing satisfaction merit attention, as they influence patient comfort, staff workload, and resource utilization.

Given these considerations, there is a compelling need to generate evidence from real-world ICU settings that examine the utility of dexmedetomidine in postoperative sedation protocols. The current study was designed to assess the hemodynamic effects and recovery profile associated with dexmedetomidine infusion in postoperative ICU patients, using a comparative, prospective observational framework.

MATERIALS AND METHODS

This prospective observational study was conducted at the Department of Anaesthesia, Kamineni Institute of Medical Sciences, Narketpally, over a one-year period from July 2024 to June 2025. The primary aim was to assess the hemodynamic and recovery profiles of patients receiving dexmedetomidine infusion for postoperative sedation in the ICU. The study received institutional ethical committee approval, and written informed consent was obtained from all participants.

Study Design and Setting

Patients who underwent major elective surgeries requiring postoperative mechanical ventilation and ICU sedation were enrolled. The study was carried out in a multidisciplinary intensive care unit with uniform postoperative monitoring protocols. Based on the choice of sedative agent administered as per routine clinical practice, patients were divided into two groups:

- Dexmedetomidine Group (n = 30): Patients sedated with continuous infusion of dexmedetomidine at 0.2–0.7 µg/kg/h without a loading dose.
- Control Group (n = 30): Patients sedated using conventional agents (primarily midazolam or fentanyl infusion, titrated to similar sedation levels).

Inclusion and Exclusion Criteria

Inclusion Criteria

- Age 18–70 years
- ASA physical status I–III
- Undergoing major abdominal, orthopedic, or neurosurgical procedures
- Expected to require sedation in ICU postoperatively for at least 12 hours

Exclusion Criteria

- Pre-existing bradyarrhythmias or hemodynamic instability
- History of severe hepatic or renal impairment
- Use of clonidine or other alpha-2 agonists within 24 hours preoperatively
- Pregnancy or lactation
- Glasgow Coma Scale < 8 on ICU admission unrelated to anesthesia

Data Collection

Baseline demographic and perioperative data were recorded, including age, sex, ASA status, type of surgery, and intraoperative hemodynamics. In the ICU, sedation level was assessed using the Richmond Agitation Sedation Scale (RASS) every 2 hours. Hemodynamic parameters (mean arterial pressure [MAP] and heart rate) were recorded hourly for the first 12 hours postoperatively. Recovery outcomes included time to extubation, ICU stay duration, need for rescue analgesics (morphine equivalents), and nursing satisfaction scores. Complications such as bradycardia (HR < 50 bpm), hypotension (MAP < 60 mmHg), and incidence of delirium (evaluated using the Confusion Assessment Method for the ICU) were also documented.

Statistical Analysis

Sample size calculation was based on preliminary data indicating a difference in MAP of at least 7 mmHg between groups with a standard deviation of 8 mmHg, 80% power, and $\alpha = 0.05$. A sample of 30 patients per group was determined to be adequate. Data were analyzed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation or median with interquartile range and compared using Student's t-test or Mann–Whitney U test as appropriate. Categorical variables were analyzed using the Chi-square test or Fisher's exact test. A p-value < 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Characteristics of the Study Population

Variable	Dexmedetomidine Group (n=30)	Control Group (n=30)	p-value
Age (years, mean ± SD)	45.3 ± 12.4	46.1 ± 11.8	0.74
Gender (Male/Female)	18 / 12	17 / 13	0.79
ASA Physical Status (I/II/III)	8 / 14 / 8	7 / 15 / 8	0.92
Type of Surgery (Abdominal/Orthopedic/Neurosurgery)	12 / 10 / 8	11 / 11 / 8	0.95

Table 2: Primary Outcome Measures

Parameter	Dexmedetomidine Group	Control Group	p-value
Mean Arterial Pressure (mmHg, mean ± SD)	78.6 ± 6.2	86.2 ± 7.1	<0.001
Heart Rate (bpm, mean ± SD)	65.4 ± 5.7	78.9 ± 6.4	<0.001
Sedation Score (RASS, median [IQR])	-2 [-3 to -1]	0 [-1 to +1]	<0.001

Table 3: Secondary Outcomes

Outcome	Dexmedetomidine Group	Control Group	p-value
Time to Extubation (minutes, mean ± SD)	12.3 ± 3.5	20.8 ± 4.1	<0.001
ICU Stay Duration (hours, mean ± SD)	36.5 ± 4.8	48.2 ± 6.1	<0.001
Incidence of Bradycardia (%)	5 (16.7%)	2 (6.7%)	0.23
Incidence of Hypotension (%)	4 (13.3%)	1 (3.3%)	0.17

Table 4: Comparative Analysis of Sedation Quality and Recovery Parameters

Parameter	Dexmedetomidine Group	Control Group	p-value
Sedation Adequacy (%)	28 (93.3%)	19 (63.3%)	0.004
Analgesic Requirement (mg morphine equivalent, mean ± SD)	4.2 ± 1.3	8.6 ± 2.4	<0.001
Delirium Incidence (%)	1 (3.3%)	5 (16.7%)	0.19
Nursing Satisfaction Score (1–10, mean ± SD)	8.9 ± 0.7	6.2 ± 1.1	<0.001

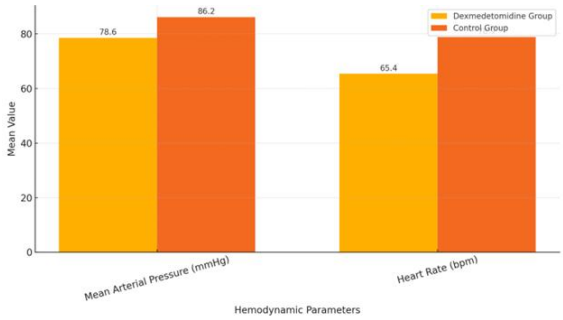

Figure 1: Comparison of hemodynamic parameters

A total of 60 patients were included in the study, with 30 in the dexmedetomidine group and 30 in the control group. Baseline characteristics such as age (45.3 ± 12.4 vs 46.1 ± 11.8 years, p = 0.74), gender distribution (18/12 vs 17/13, p = 0.79), ASA physical status, and type of surgery were comparable between groups (all p > 0.9), indicating well-matched cohorts.

Hemodynamic parameters differed significantly. The mean arterial pressure (MAP) was lower in the dexmedetomidine group (78.6 ± 6.2 mmHg) compared to the control group (86.2 ± 7.1 mmHg), with a statistically significant difference (p < 0.001). Similarly, heart rate was reduced in the dexmedetomidine group (65.4 ± 5.7 bpm) relative to control (78.9 ± 6.4 bpm), also statistically significant (p < 0.001). The accompanying bar chart visually reinforces these intergroup differences in MAP and heart rate.

Sedation quality, assessed via RASS scores, was significantly deeper in the dexmedetomidine group [-2 (IQR -3 to -1)] versus [0 (IQR -1 to +1)] in controls (p < 0.001), suggesting more consistent target-level sedation.

Recovery outcomes showed superior performance in the dexmedetomidine group. Time to extubation was shorter (12.3 ± 3.5 vs 20.8 ± 4.1 minutes, p < 0.001), and ICU stay was reduced (36.5 ± 4.8 vs 48.2 ± 6.1 hours, p < 0.001). Although bradycardia (16.7% vs 6.7%) and hypotension (13.3% vs 3.3%) were more frequent in the dexmedetomidine group, these did not reach statistical significance (p = 0.23 and 0.17 respectively).

Sedation adequacy was higher (93.3% vs 63.3%, p = 0.004), opioid requirement lower (4.2 ± 1.3 vs 8.6 ± 2.4 mg, p < 0.001), and nursing satisfaction scores greater (8.9 ± 0.7 vs 6.2 ± 1.1, p < 0.001) in the dexmedetomidine group. Delirium incidence was lower (3.3% vs 16.7%), though not statistically significant (p = 0.19).

These findings support the favorable hemodynamic control and enhanced recovery profile with dexmedetomidine, without significant compromise in safety.

DISCUSSION

Postoperative sedation in the ICU requires a balance between achieving adequate anxiolysis and ensuring hemodynamic and respiratory stability. Dexmedetomidine has gained prominence for its sedative, analgesic, and sympatholytic effects without causing significant respiratory depression. This study evaluated its impact on hemodynamic parameters and recovery outcomes in comparison with conventional sedative agents.

In our study, patients receiving dexmedetomidine exhibited significantly lower mean arterial pressure (78.6 ± 6.2 mmHg) and heart rate (65.4 ± 5.7 bpm) compared to controls (86.2 ± 7.1 mmHg and 78.9 ± 6.4 bpm, respectively). These findings are supported by Jakob et al., who in a randomized controlled trial involving 500 ICU patients demonstrated a higher incidence of bradycardia and hypotension in the dexmedetomidine group, attributed to its central sympatholytic action.[9] Riker et al. also reported bradycardia in 14% of patients receiving dexmedetomidine in their multicenter PRODEX study of 244 mechanically ventilated ICU patients.[10] Our study found better sedation quality in the dexmedetomidine group, with 93.3% of patients achieving adequate sedation levels, compared to 63.3% in the control group. Similar outcomes were observed by Pandharipande et al., who compared dexmedetomidine with lorazepam in a randomized trial of 103 ICU patients and found a 42% reduction in sedation failure with dexmedetomidine.[11]

Recovery outcomes were significantly improved. The dexmedetomidine group had a shorter time to extubation (12.3 ± 3.5 minutes vs 20.8 ± 4.1 minutes), echoing the findings of Maldonado et al., who studied 90 post-cardiac surgery patients and observed earlier extubation by an average of 9 hours with dexmedetomidine compared to propofol.[12] ICU stay was also reduced in our cohort (36.5 ± 4.8 hours vs 48.2 ± 6.1 hours), consistent with a meta-analysis by Chen et al. which included 18 randomized trials and demonstrated a 10–14 hour reduction in ICU duration with dexmedetomidine.[13]

Opioid requirement in our study was lower in the dexmedetomidine group (4.2 ± 1.3 mg vs 8.6 ± 2.4 mg), confirming its analgesic-sparing effect. Bhana et al. described similar reductions in opioid use, attributing it to the α2-mediated inhibition of nociceptive transmission.[14] Although delirium was less frequent in our dexmedetomidine group (3.3% vs 16.7%), the difference was not statistically significant. This trend aligns with findings by Maldonado et al., who noted a lower delirium incidence among patients sedated with dexmedetomidine versus midazolam.[15]

This study's limitations include its non-randomized, single-center design and relatively small sample size. Nevertheless, the findings add valuable real-world evidence supporting the clinical utility of dexmedetomidine in postoperative ICU sedation. Future research should focus on large-scale, multicenter trials evaluating cost-effectiveness and long-term cognitive outcomes.

CONCLUSION

Dexmedetomidine infusion for postoperative ICU sedation was associated with significantly improved hemodynamic control, effective sedation, reduced time to extubation, and shorter ICU stay compared to conventional sedatives. Despite a trend toward increased bradycardia and hypotension, these effects were not statistically significant and remained clinically manageable. Additionally, dexmedetomidine reduced opioid requirements and enhanced nursing satisfaction without compromising safety. These findings suggest that dexmedetomidine offers a favorable recovery profile and sedation quality in the postoperative critical care setting. When used judiciously with appropriate monitoring, it can serve as a valuable alternative to traditional sedatives, potentially improving patient comfort and ICU efficiency. Further large-scale, randomized studies are recommended to confirm these results and evaluate long-term outcomes.

Acknowledgements: The authors would like to express their gratitude towards the staff of the institution for their support during conducting this study.

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