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Dexamethasone *versus* dexmedetomidine as adjuncts for parasternal block in cardiac surgery: a retrospective comparative study

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Abstract

Postoperative pain following cardiac surgery *via* sternotomy is typically severe, often impairing respiratory mechanics and delaying extubation. The use of parasternal blocks in combination with adjuvants, such as dexamethasone or dexmedetomidine, has shown potential in enhancing analgesia, facilitating earlier extubation, and reducing intensive care unit (ICU) length of stay. In this retrospective comparative study, medical records of patients were reviewed. At the conclusion of surgery, patients had received a bilateral superficial ultrasound-guided parasternal block (US-PSB) using a 30 mL dose (15 mL per side) of 0.375% levobupivacaine (112.5 mg total). The study cohort included 347 patients, categorized into two groups based on clinical administration: one group received 0.1 mg/kg dexamethasone (222) and the other group received 1 mcg/kg dexmedetomidine (125). The purpose of the study was to evaluate whether there is a difference between the two adjuvants administered in the block in terms of analgesia and extubation time. No statistically significant differences in weaning time from the ventilator or self-reported pain scores were observed between the two groups. Notably, 45.8% of patients reported no pain (Visual Analog Scale [VAS] score 0) at the 4-hour assessment following surgery, which increased to 97.1% at the 12-hour assessment. Both dexamethasone and dexmedetomidine showed comparable outcomes in terms of analgesia, with no significant differences observed between the groups up to 24 hours postoperatively, without significant differences in weaning time. There were no statistically significant differences in extubation time or pain levels between the dexamethasone and dexmedetomidine groups. Both agents showed comparable outcomes as adjuvants, but their absolute effectiveness cannot be concluded due to the absence of a control group for parasternal block in cardiac surgery.

Key words: cardiac surgery; regional anesthesia; dexamethasone; dexmedetomidine; parasternal block; opioid-sparing anesthesia.

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Introduction

Patients undergoing cardiac surgery frequently experience significant pain after median sternotomy or thoracotomy, leading to hypoventilation and associated hypoxemia.[1] Enhanced Recovery After Surgery programs emphasize multimodal, opioid-sparing analgesia to mitigate side effects such as sedation and respiratory complications, ultimately leading to improved recovery and shorter intensive care unit (ICU) stays. Neuraxial analgesia, while effective, carries risks such as epidural hematoma, particularly in patients receiving anticoagulants or antithrombotics.[2] Thus, effective management of postoperative pain is essential to avoid early morbidity and prevent chronic postoperative pain syndromes.[3]

Regional anesthesia, specifically ultrasound-guided parasternal block (US-PSB), is emerging as a valuable tool for postoperative pain management in cardiac surgery, providing analgesia of the anterior chest wall and reducing opioid consumption.[4,5] Recent literature, including the American Society of Regional Anesthesia and Pain Medicine/European Society of Regional Anesthesia and Pain Therapy Delphi consensus, has redefined the nomenclature for parasternal blocks, distinguishing between superficial and deep variants, also referred to as pectointercostal plane blocks.[6] Adjuvants, such as dexamethasone and dexmedetomidine, are employed to enhance the quality and duration of analgesia, thereby improving patient safety, satisfaction, and clinical outcomes.[7]

This study aimed to compare dexamethasone and dexmedetomidine as adjuvants to levobupivacaine for US-PSB in patients undergoing cardiac surgery, assessing primary outcomes of extubation time and secondary outcomes including analgesic requirements, morphine consumption, and postoperative analgesia duration.

Materials and Methods

This study was designed as a single-center retrospective comparative study. Data analyses were conducted following actual treatments received by the patients as documented in their clinical records, irrespective of clinical variations. Details regarding any exclusions and their impact on the analysis are reported to ensure transparency and methodological rigor. Following approval from the local ethics committee (CECN/1714), medical records of 347 consecutive patients who underwent elective cardiac surgery *via* median sternotomy at our tertiary care center between November 2020 and May 2022 were analyzed. Inclusion criteria included age >18 years, American Society of Anesthesiologists (ASA) physical status III-IV, and complete medical data availability (Table 1). Exclusion criteria encompassed known pregnancy, drug allergies, chronic pain medication use, opioid dependence, body weight <50 kg, hemorrhage, hemodynamic instability, mild hypothermia, and reintubation due to postoperative respiratory failure. This criterion specifically referred to patients requiring reintubation after surgery. According to institutional protocols, all patients received total intravenous general anesthesia, with induction and maintenance achieved using propofol and remifentanil through target-controlled infusion, targeting plasma concentrations between 1 and 3 mcg/mL.[8] Target-controlled infusion of propofol and remifentanil was administered using established pharmacokinetic models, with propofol delivered according to the Marsh model and remifentanil according to the Minto model, targeting effect-site concentrations in line with institutional practice. Intraoperative drug titration was guided by standard clinical parameters, including depth of anesthesia monitoring and hemodynamic responses. Muscle relaxation was induced with rocuronium (0.6 mg/kg bolus) and maintained with a continuous infusion (0.3-0.6 mg/kg/h). Mechanical ventilation was used to maintain end-tidal CO_2 levels at 35-45 mmHg.[9] At the conclusion of surgery, a bilateral superficial US-PSB was administered with a 30 mL bolus (15 mL per side) of 0.375% levobupivacaine. Based on retrospective cohort division, patients were grouped into 222 (64%) who received dexamethasone (0.1 mg/kg) and 125 (36%) who received dexmedetomidine (1 mcg/kg). The imbalance between groups (222 *vs.* 125) reflects the retrospective nature of the analysis and differential clinical choices, rather than an intentional uneven distribution. Blocks were performed using a 12 MHz linear ultrasound probe to visualize anatomical structures including the pectoralis major muscle, intercostal muscles, ribs, and pleura. The blocks were executed using an atraumatic 21-gauge 100-mm needle in the second and fourth intercostal spaces to achieve optimal distribution of local anesthetic within the fascial plane.[10] A standardized protocol for anesthetic discontinuation was historically applied, consisting of cessation of remifentanil followed by progressive reduction and discontinuation of propofol to facilitate emergence. Postoperatively, sedation management in the ICU followed a structured weaning approach aimed at early awakening and extubation, with sedation titrated to predefined clinical targets. These strategies were applied consistently across all patients to minimize variability in extubation timing related to anesthetic and sedation management. Patients were extubated when all the following were met: i) hemodynamics: mean arterial pressure 65-90 mmHg without escalation of vasoactive support in the prior 30 minutes, heart rate 50-110 bpm, no active myocardial ischemia/arrhythmia requiring intervention; ii) temperature: ≥36°C; iii) neurologic status: awake and cooperative (able to follow commands) with Richmond Agitation-Sedation Scale (RASS) −1 to +1 and adequate airway protective reflexes; iv) respiratory function: peripheral oxygen saturation (SpO_2) ≥94% on fraction of inspired oxygen (FiO_2) ≤0.40 with positive end-expiratory pressure (PEEP) ≤5 cmH_2O, respiratory rate 10-

Table 1. Baseline characteristics of the study population by treatment group.

	Total (n=347)	Dexamethasone 64% (n=222) % (CI 95%, n)	Dexmedetomidine 36% (n=125)	p-value
Age, years (mean±SD)	**65.8±8.2**	**65.1±8.5**	**66.9±7.5**	**0.049**
Sex, % male	72.1 (67.1-76.5, 250)	71.6 (65.3-77.1, 159)	72.8 (64.4-79.8, 91)	0.90
CAD	**73.8 (68.9-78.1, 256)**	**66.2 (59.7-72.1, 147)**	**87.2 (80.2-91.9, 125)**	**≤0.001**
PAD	**10.1 (7.3-13.7, 35)**	**7.7 (4.8-11.9, 17)**	**14.4 (9.3-21.6, 18)**	**0.038**
Hypertension	**86.5 (82.4-89.6, 300)**	**83.3 (77.8-87.6, 185)**	**92.0 (85.8-95.5, 115)**	**0.023**
COPD	41.8 (36.7-47.0, 145)	41.4 (35.1-48.0, 92)	42.4 (34.1-51.1, 53)	0.46
Stroke	2.3 (1.1-4.4, 8)	2.3 (0.9-5.1, 5)	2.4 (0.8-6.8, 3)	1
GFR <60 mL/mg	16.7 (13.2-21.0, 58)	14.0 (10.0-19.1, 31)	21.6 (15.3-29.6, 27)	0.07
Surgical time, min (mean±SD)	233.7±56.6	234.5±51.8	232.33±64.3	0.73
Weaning time, min (mean±SD)	214.8±75.8	215.1±77.9	214.2±72.2	0.91
AQT, min (mean±SD)	163.2±70.8	167.6±74.7	156±79	0.84
Surgery type				**≤0.001**
CABG	**70.9 (65.9-75.4, 246)**	**63.5 (57-69.5, 141)**	**84 (76.5, 89.3, 105)**	-
Aortic valve repair	**21.6 (17.6-26.2, 75)**	**27 (21.6-33-2, 60)**	**12 (7.4-18.8, 15)**	-
Mitral valve repair	**7.5 (5.1-10.7, 26)**	**9.5 (6.2-14, 21)**	**4 (1.7-9, 5)**	-

CI, confidence interval; SD, standard deviation; CAD, coronary artery disease; PAD, peripheral artery disease; COPD, chronic obstructive pulmonary disease; GFR, glomerular filtration rate; AQT, analgesia query time; CABG, coronary artery bypass graft; p-values refer to the univariate comparison between treatments (unpaired t-test for continuous factors, exact Fisher test for rates, and Wilcoxon rank sum test for Visual Analog Scale and Richmond Agitation-Sedation Scale score); boldface shows significant comparisons.

25/min, tidal volume ≥5 mL/kg predicted body weight, acceptable arterial blood gas values (pH ≥7.30, arterial partial pressure of carbon dioxide [$PaCO_2$] ≤50 mmHg, arterial partial pressure of oxygen [PaO_2] ≥80 mmHg or PaO_2/FiO_2 ≥200); v) spontaneous breathing trial: tolerated 30-60 minutes with pressure support 5-8 cmH_2O, PEEP 5 cmH_2O, FiO_2 ≤0.40 without distress; vi) airway/secretions: manageable with effective cough; vii) neuromuscular recovery: train-of-four ratio ≥0.9; viii) chest drains: no uncontrolled bleeding, drainage ≤100 mlLh in the preceding 2 hours; ix) analgesia/sedation: Visual Analog Scale (VAS) ≤4 with RASS −1 to 0. When criteria were satisfied, extubation was performed by ICU physicians following a standardized checklist. Post-extubation monitoring included continuous SpO_2 and capnography for at least 30 minutes. Pain intensity was assessed using VAS throughout the observation period. Patients received paracetamol (1,000 mg i.v. every 8 hours) for baseline analgesia, with additional morphine (0.1 mg/kg) administered intravenously by an ICU physician, following standardized rescue analgesia, if VAS scores exceeded 5. The primary outcome investigated was extubation time, defined as the time from surgery completion to meeting extubation criteria. Secondary outcomes included the first analgesic request and total morphine consumption postoperatively. Pain was assessed *via* VAS at various intervals (0, 1, 2, 4, 6, 8, 12, 24 hours) and sedation was evaluated using the RASS.[11] Although this was a retrospective study, the available sample size of 347 patients was determined to be sufficient to detect a moderate effect size (Cohen's d=0.5), with an alpha level of 0.05, and a power of 0.80 based on the pwr package in R.[12] Statistical analyses involved *t*-tests for unpaired continuous variables and Wilcoxon rank-sum tests for VAS and RASS scores. Chi-square and Fisher's exact tests were applied for categorical data comparisons. A multivariable regression model assessed associations between extubation time and potential confounders, including adjunct treatment, age, sex, surgery duration, and comorbidities (Table 2).

Results

Table 1 summarizes patient characteristics based on treatment group allocation. Patients receiving dexmedetomidine were slightly older and exhibited higher rates of peripheral arterial disease (PAD), hypertension, and coronary artery disease (CAD). A significant baseline imbalance was noted in CAD prevalence (dexmedetomidine 87.2% *vs.* dexamethasone 66.2%, p=0.049, d=0.5, n=347), which may have influenced the results. This imbalance was considered in the analysis and is acknowledged as a limitation of the study. Surgical interventions included aortic valve replacement (21.6%), mitral valve repair (7.5%), and coronary artery bypass graft (CABG; 70.9%) (Table 1). There were no statistically significant differences in extubation time or VAS scores between the two groups at any time point (Figures 1 and 2). By 4 hours post-surgery, 45.8% of patients reported no pain (VAS score 0), which increased to 97.1% by 12 hours, with similar trends observed across both groups (Figure 1). Table 2 summarizes postoperative pain data.

Safety reporting was systematically addressed in the present study. No adverse events related to the use of perineural dexmedetomidine or dexamethasone were observed. No clinically significant episodes of bradycardia, hypotension, excessive sedation, or signs of local anesthetic systemic toxicity were recorded. These findings support the favorable safety profile of both adjuvants within the context of this multimodal analgesic regimen; however, the sample size may limit the detection of rare adverse events, and larger studies are warranted to further confirm these observations.

Only eight patients required additional analgesia (2.3%), with six from the dexamethasone group (2.7%) and two from the dexmedetomidine group (1.6%). Morphine requirements were similar between the groups (0.1 mg/kg), with patients in the dexamethasone group needing additional analgesia at an average of 12 hours

Table 2. Postoperative pain data.

	Total (n=347)	Dexamethasone 64% (n=222) Mean±SD, median (IQR)	Dexmedetomidine 36% (n=125)	p-value
VAS score				
Baseline	1.07±1.16, 1 (0-2)	1.09±1.13, 1 (0-2)	1.03±1.21, 0 (0-2)	0.45
6 h	0.62±0.93, 0 (0-1)	0.63±0.89, 0 (0-1)	0.6±0.99, 0 (0-1)	0.41
8 h	0.17±0.57, 0 (0-0)	0.16±0.53, 0 (0-0)	0.18±0.62, 0 (0-0)	0.86
12 h	0.05±0.31, 0 (0-0)	0.02±0.23, 0 (0-0)	0.09±0.42, 0 (0-0)	0.052
24 h	0.05±0.31, 0 (0-0)	0.03±0.26, 0 (0-0)	0.08±0.39, 0 (0-0)	0.19
12 h delta	1.02±1.2, 1 (0-2)	1.06±1.15, 1 (0-2)	0.93±1.28, 0 (0-2)	0.23
24 h delta	1.02±1.2, 1 (0-2)	1.05±1.17, 1 (0-2)	0.95±1.26, 0 (0-2)	0.26
RASS score				
Baseline	−0.02±0.31, 0 (0-0)	−0.02±0.23, 0 (0-0)	−0.02±0.43, 0 (0-0)	0.42
1 h	0.01±0.15, 0 (0-0)	0.004±0.11, 0 (0-0)	0.24±0.19, 0 (0-0)	0.45
2 h	0.008±0.11, 0 (0-0)	0±0, 0 (0-0)	0.024±0.19, 0 (0-0)	0.25
4 h	0.008±0.11, 0 (0-0)	0±0, 0 (0-0)	0.024±0.19, 0 (0-0)	0.25
6 h	0.008±0.11, 0 (0-0)	0±0, 0 (0-0)	0.024±0.19, 0 (0-0)	0.25
8 h	0.002±0.53, 0 (0-0)	0±0, 0 (0-0)	0.008±0.89, 0 (0-0)	0.72
12 h	0.002±0.53, 0 (0-0)	0±0, 0 (0-0)	0.008±0.89, 0 (0-0)	0.72
24 h	0.002±0.53, 0 (0-0)	0±0, 0 (0-0)	0.008±0.89, 0 (0-0)	0.72

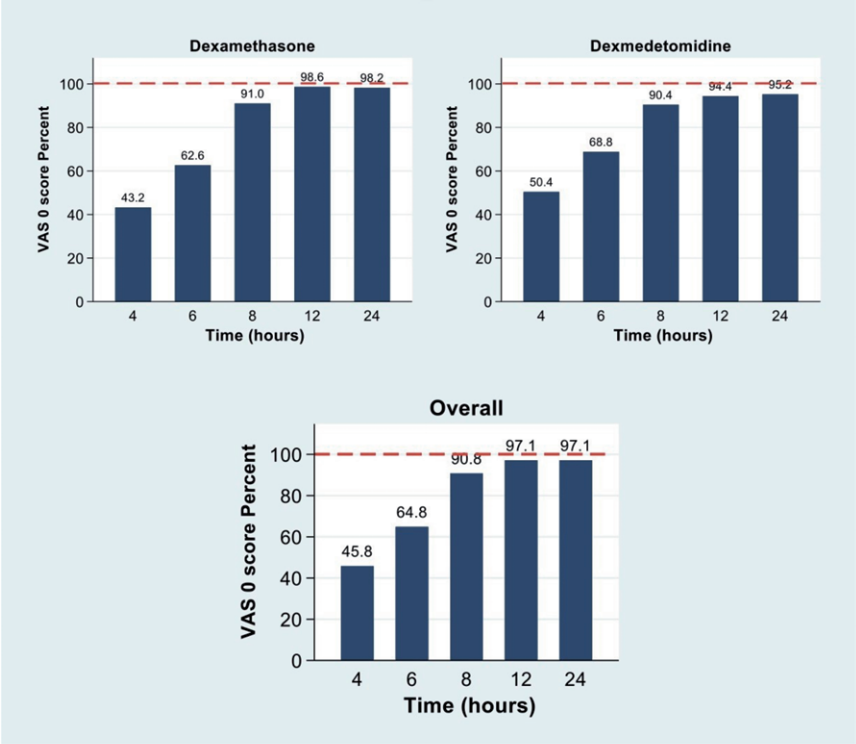
SD, standard deviation; IQR, interquartile range; VAS, Visual Analog Scale; RASS, Richmond Agitation-Sedation Scale.

post-block, compared to 20 hours for those in the dexmedetomidine group. Multivariate analysis indicated that adjunct treatment type was not significantly associated with weaning time (Table 3), whereas age, sex, and type of surgery were significant factors. No patients in the study developed postoperative respiratory failure necessitating reintubation. No block-related complications were observed during the study period. Specifically, no cases of local anesthetic systemic toxicity, vascular puncture, pneumothorax, infection, or clinically significant hematoma were reported, supporting the safety of the technique.

Table 3. Weaning time multiple regression.

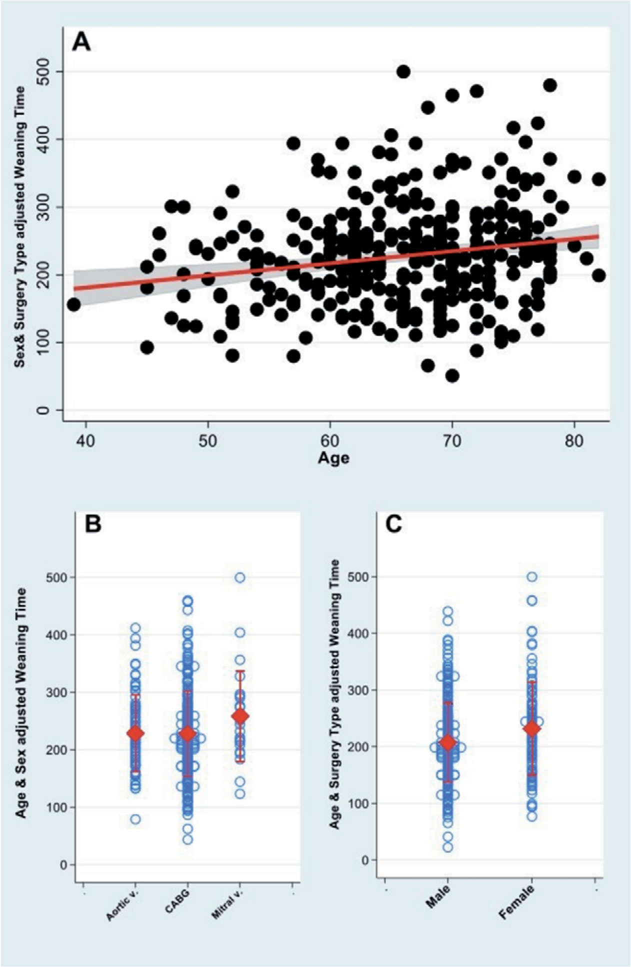
	Global R2=0.08			
	Coeff.	**p-value**	**Percent fraction of global R2 (%)**	**Linearity/ non-linearity**
Age (10 years)	17.9	≤0.0001	53.0	Linearity
Sex, male	−21.1	0.025	25.9	NA
Surgery type (CABG as reference)				
Aortic valve	1	0.92	21.1	NA
Mitral valve	30.9	0.048		
Surgical time	0.04	0.61	NA	NA
Dexmedetomidine treatment	−2.2	0.8	NA	NA
CAD	18.6	0.48	NA	NA
PAD	−2.2	0.83	NA	NA
Hypertension	−5.2	0.66	NA	NA
COPD	−0.76	0.93	NA	NA
Stroke	12.4	0.64	NA	NA
GFR <60 mL/mg	−5.2	0.63	NA	NA

CABG, coronary artery bypass graft; CAD, coronary artery disease; PAD, peripheral artery disease; COPD, chronic obstructive pulmonary disease; GFR, glomerular filtration rate; NA, not applicable. Dexamethasone was used as the reference treatment group.



VAS, Visual Analog Scale.

Figure 1. VAS score distribution: percentage of patients with no pain (VAS 0) over time. Time is represented on the x-axis and the percentage of patients with VAS 0 on the y-axis.



CABG, coronary artery bypass graft.

Figure 2. Covariate-adjusted weaning time: associations with age, surgery type, and sex. A) Age is represented on the x-axis and sex, surgery type, and adjusted weaning time on the y-axis. B) The type of surgery performed is represented on the x-axis and age, sex, and adjusted weaning time on the y-axis. C) Gender is represented on the x-axis and age, surgery type and adjusted weaning time on the y-axis.

Discussion

Head-to-head data on perineural dexamethasone *vs.* dexmedetomidine are heterogeneous across block types and surgical models but overall do not demonstrate a consistent superiority of one agent over the other. Systematic evidence suggests broadly similar analgesic duration, with dexmedetomidine more prone to sedation and hemodynamic effects in some trials.[13,14] Randomized comparisons have yielded mixed results: in thoracic surgery with erector spinae plane block, dexmedetomidine (≈1 µg/kg) sometimes prolonged sensory block and lowered early pain scores *vs.* dexamethasone (≈8-10 mg),[15] whereas in lower-limb surgery with popliteal/saphenous blocks, 10 mg dexamethasone extended analgesia longer than ≈0.75 µg/kg dexmedetomidine and was associated with fewer bradycardia/hypotension events.[16] In supraclavicular brachial plexus blocks, several studies found the two adjuvants comparable for duration and analgesic consumption.[17] For chest-wall fascial plane/parasternal blocks in cardiac surgery specifically, direct dexamethasone-dexmedetomidine head-to-head data remain scarce; available reports primarily compare a single adjuvant to control or evaluate block *vs.* no block.[18] These external data, together with our fast-track extubation target, are congruent with the absence of a measurable between-group difference and caution against assuming a class-favoring agent in this context.

This retrospective study found that dexamethasone and dexmedetomidine showed no significant differences between the groups as adjuvants for US-PSB in cardiac surgery, with no significant differences in extubation times or pain relief outcomes between the two groups. These results align with previous studies, such as Chapman *et al.* (2021), which demonstrated comparable efficacy for both adjuvants in colorectal surgery.[19]

The absence of statistically significant differences between dexamethasone and dexmedetomidine may be due to several factors. The robust baseline analgesia provided by the parasternal block with levobupivacaine, combined with multimodal analgesia, likely produced a ceiling effect that limited further detectable benefits. The selection of extubation time as the primary endpoint warrants careful consideration. Although early extubation represents a clinically relevant outcome within enhanced recovery pathways, it is inherently influenced by multiple perioperative factors beyond analgesic efficacy, including patient characteristics (*e.g.*, age and comorbidities), surgical complexity, intraoperative hemodynamic stability, sedation strategies, and institutional ICU practices. In the present study, postoperative pain scores were consistently low and opioid requirements were minimal, with only a small proportion of patients requiring rescue analgesia. This finding suggests the presence of a potential ceiling effect related to the combined use of parasternal block and multimodal analgesia, which may have attenuated the ability to detect incremental benefits between the two adjuvant strategies. Consequently, the lack of significant differences in extubation time should be interpreted with caution, as it may reflect the limited discriminative capacity of the chosen endpoint in a context of highly effective baseline analgesia rather than a true equivalence between interventions. Extubation time, influenced by multiple variables including age, sex, procedure type, and sedation strategy, may have masked small effects, particularly as dexmedetomidine's sedative and hemodynamic effects counterbalanced any analgesic advantage. Baseline imbalances, such as the higher prevalence of CAD and slightly older age in the dexmedetomidine group, could also have influenced outcomes. Furthermore, the standardized rescue analgesia protocol minimized differences in pain scores, and the study was powered for a moderate effect size (d≈0.5), leaving it underpowered to detect smaller true differences.

Limitations

This study has several limitations that should be acknowledged. First, the absence of a control group without adjuvant precludes assessment of the absolute effectiveness of the intervention and limits conclusions to comparative effects between the study groups. Second, the single-center design may reduce the generalizability of the findings to other clinical settings with different patient populations and perioperative practices. In addition, potential baseline imbalances between groups, although not statistically significant, may have influenced the observed outcomes. The consistently low postoperative pain scores and minimal opioid requirements also suggest a possible ceiling effect related to the combined use of parasternal block and multimodal analgesia, which may have limited the ability to detect clinically meaningful differences between the two adjuvant strategies.

The present findings should also be interpreted within the context of the rapidly evolving literature on cardiothoracic regional anesthesia and the use of perineural adjuvants. Recent evidence highlights the growing role of regional techniques in enhancing recovery after cardiac surgery, with contemporary analyses emphasizing the clinical utility of parasternal and intercostal plane blocks in patients undergoing median sternotomy. Recent contributions by Chen T. *et al.* and Chen M. Y. *et al.* underscore the expanding adoption and favorable safety profile of these approaches in modern practice.[18,20]

For instance, comparative studies evaluating dexamethasone *vs.* dexmedetomidine in other regional anesthesia techniques, such as those reported by Coviello *et al.*,[21] provide valuable evidence on differences in block duration and analgesic quality, offering mechanistic insights that may be cautiously extrapolated to optimize the efficacy and duration of parasternal blocks.

Further research should consider multicenter randomized controlled trials to validate these findings in more diverse populations and to explore whether specific clinical settings may favor one adjuvant over the other. The observed associations between age, sex, and type of surgery with extubation time underscore the complexity of postoperative recovery and highlight areas for individualized patient care.

Conclusions

This single-center retrospective comparative study found no statistically significant differences in pain score or extubation times between dexamethasone and dexmedetomidine as adjuvants for US-PSB in cardiac surgery. Both agents showed comparable outcomes for postoperative pain control over a 24-hour period, though absolute effectiveness cannot be determined without a control group.

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Conflict of interest: the authors declare no competing interests.

Ethics approval and consent to participate: the study adhered to the Declaration of Helsinki and received approval from the local health authority Ethics Committee of Campania North (CECN/1714). All patients provided written informed consent to participate.

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