Comparison of Two Doses of Dexmedetomidine as an Adjuvant to Bupivacaine 0.5% in USG Guided Supraclavicular Brachial Plexus Block: A Double Blind Randomised Controlled Study

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Article Info

ISSN (online): 2582-8940
Volume: 06
Issue: 03
July - September 2025
Received: 07-06-2025
Accepted: 08-07-2025
Published: 21-07-2025
Page No: 171-177

Abstract

Regional anesthesia has gained significant popularity in modern anesthetic practice due to its numerous advantages including superior postoperative analgesia, reduced opioid consumption, and minimal systemic side effects. The supraclavicular approach to brachial plexus block is considered the most effective technique for upper limb surgeries, providing dense anesthesia and analgesia. However, the duration of analgesia with local anesthetics alone is often insufficient for prolonged surgeries and postoperative pain management. Various adjuvants have been studied to enhance the quality and duration of regional blocks, with dexmedetomidine emerging as a promising option due to its unique pharmacological properties. This prospective, randomized, double-blind study was conducted to compare the efficacy of two different doses of dexmedetomidine (0.5 µg/kg and 1.0 µg/kg) when added to bupivacaine 0.5% in ultrasound-guided supraclavicular brachial plexus block. A total of 90 patients scheduled for elective upper limb surgeries were randomly allocated into three groups: Group C (control) received 30ml of 0.5% bupivacaine with normal saline, Group D1 received 30ml of 0.5% bupivacaine with 0.5 µg/kg dexmedetomidine, and Group D2 received 30ml of 0.5% bupivacaine with 1.0 µg/kg dexmedetomidine. Primary outcomes included onset and duration of sensory and motor blockade, while secondary outcomes comprised postoperative analgesia duration, total analgesic consumption, patient satisfaction scores, and adverse effects. Results demonstrated that both doses of dexmedetomidine significantly enhanced the quality of brachial plexus block compared to control, with faster onset times, prolonged duration of sensory and motor blockade, and extended postoperative analgesia. The higher dose (1.0 µg/kg) showed superior efficacy in terms of block duration and analgesic effect, though it was associated with increased incidence of sedation and bradycardia. Both dexmedetomidine groups showed significantly reduced postoperative analgesic requirements and higher patient satisfaction scores. The study concludes that dexmedetomidine 1.0 µg/kg provides optimal enhancement of bupivacaine-induced brachial plexus block, making it an excellent adjuvant for upper limb surgeries requiring prolonged anesthesia and analgesia.

DOI: https://doi.org/10.54660/IJMBHR.2025.6.3.171-177

Keywords: Dexmedetomidine, Bupivacaine, Supraclavicular block, Brachial plexus, Ultrasound guidance, Regional anesthesia, Adjuvant

Introduction

Regional anesthesia has revolutionized perioperative pain management and has become an integral component of modern anesthetic practice [1]. Among various regional techniques, brachial plexus block stands out as the gold standard for upper limb surgeries, offering several advantages including excellent surgical conditions, reduced perioperative stress response, minimal systemic drug exposure, and superior postoperative analgesia [2].

The supraclavicular approach to brachial plexus block, often referred to as the "spinal anesthesia of the arm," provides the most complete and predictable anesthesia for upper limb procedures by targeting the nerve trunks at their most compact arrangement [3].

The advent of ultrasound technology has significantly enhanced the safety and efficacy of regional anesthetic techniques by providing real-time visualization of anatomical structures, needle advancement, and local anesthetic spread [4]. Ultrasound-guided supraclavicular brachial plexus block has demonstrated superior success rates, faster onset times, and reduced complications compared to traditional landmark-based techniques [5]. However, despite these advances, the duration of analgesia provided by local anesthetics alone often proves inadequate for prolonged surgical procedures and extended postoperative pain management [6].

Bupivacaine, a long-acting amide local anesthetic, is widely used for peripheral nerve blocks due to its favorable pharmacokinetic profile and prolonged duration of action [7]. The 0.5% concentration provides adequate density of motor and sensory blockade for most upper limb surgeries while maintaining an acceptable safety profile [8]. However, the analgesic duration of bupivacaine typically ranges from 8-12 hours, which may be insufficient for complex procedures or patients requiring extended pain relief [9].

To overcome these limitations, various adjuvants have been investigated to enhance the quality, onset, and duration of peripheral nerve blocks [10]. Traditional adjuvants such as epinephrine, sodium bicarbonate, and opioids have shown modest benefits but are often associated with significant side effects or limited efficacy enhancement [11]. The search for an ideal adjuvant has led to the exploration of α2-adrenoceptor agonists, particularly dexmedetomidine, which has emerged as a promising option due to its unique mechanism of action and favorable side effect profile [12].

Dexmedetomidine is a highly selective α2-adrenoceptor agonist with a selectivity ratio of 1620:1 for α2:α1 receptors, significantly higher than clonidine [13]. Its mechanism of action involves binding to presynaptic α2-adrenoceptors, leading to decreased norepinephrine release and subsequent inhibition of pain signal transmission [14]. When used as an adjuvant in peripheral nerve blocks, dexmedetomidine enhances both the quality and duration of sensory and motor blockade through both peripheral and central mechanisms [15]. Peripheral mechanisms of dexmedetomidine include direct action on α2-adrenoceptors present on nerve fibers, leading to hyperpolarization and reduced nerve conduction [16]. Additionally, it may enhance the effects of local anesthetics by altering the physicochemical properties of the nerve membrane and prolonging sodium channel blockade [17]. Central mechanisms involve supraspinal and spinal actions, where dexmedetomidine modulates pain pathways through activation of descending inhibitory systems and direct spinal cord effects [18].

Previous studies have demonstrated that dexmedetomidine, when added to local anesthetics in peripheral nerve blocks, significantly prolongs the duration of sensory and motor blockade, reduces postoperative analgesic requirements, and improves patient satisfaction [19]. However, the optimal dose of dexmedetomidine for use as an adjuvant in brachial plexus blocks remains a subject of ongoing research and debate [20].

The dose-response relationship of dexmedetomidine in peripheral nerve blocks is complex, with higher doses generally providing greater efficacy but potentially increased risk of adverse effects [21]. Most studies have investigated doses ranging from 0.5 to 2.0 μg/kg, with conflicting results regarding the optimal balance between efficacy and safety [22]. While higher doses may provide superior block characteristics, they are also associated with increased incidence of sedation, bradycardia, and hypotension [23].

This study aims to compare two commonly used doses of dexmedetomidine (0.5 μg/kg and 1.0 μg/kg) as adjuvants to bupivacaine 0.5% in ultrasound-guided supraclavicular brachial plexus block. By conducting a randomized, double-blind, controlled trial, we seek to provide evidence-based guidance for clinicians regarding the optimal dose of dexmedetomidine for enhancing upper limb regional anesthesia while minimizing adverse effects.

Materials and Methods

Study Design and Ethical Considerations

This prospective, randomized, double-blind, controlled clinical trial was conducted at the Department of Anesthesiology and Critical Care, tertiary care hospital, from January 2023 to October 2023, establishing scientific rigor by following international standards for clinical trials. The study protocol was approved by the Institutional Ethics Committee (IEC/ANESTH/2023/015) and registered with the Clinical Trials Registry of India (CTRI/2023/02/049128), ensuring transparency and accountability to the scientific community. Written informed consent was obtained from all participants after explaining the study procedure, potential risks, and benefits. The prospective design involved data collection going forward rather than retrospective analysis, while the double-blind nature ensured neither patients nor assessors knew which treatment was administered, thereby eliminating potential bias in treatment delivery and outcome assessment.

Patient Selection and Study Population

The study population was carefully selected to ensure homogeneity and representativeness of typical patients receiving brachial plexus blocks. Inclusion criteria were designed to define the target population of healthy adults undergoing upper limb surgery, specifically patients aged 18-65 years with American Society of Anesthesiologists (ASA) physical status I-II, scheduled for elective upper limb surgeries under brachial plexus block, having Body Mass Index (BMI) 18-30 kg/m², expected surgery duration of 1-4 hours, and ability to understand and cooperate with study procedures. The age range excluded extremes where drug responses might be significantly different, while ASA I-II classification ensured relatively healthy patients without major comorbidities.

Exclusion criteria were comprehensive to eliminate patients with conditions that could confound results or increase procedural risks, including patient refusal or inability to provide informed consent, known allergy or hypersensitivity to study drugs, infection at the injection site, coagulopathy or bleeding disorders, pre-existing neurological deficits in the operative limb, severe cardiovascular, hepatic, or renal disease, pregnancy and lactation, chronic pain conditions requiring regular analgesic use, psychiatric disorders affecting pain assessment, previous surgery or trauma to the supraclavicular region, and BMI >30 kg/m² due to technical difficulty in ultrasound visualization.

Power Analysis and Sample Size Determination

The sample size calculation was based on rigorous statistical

methodology using pilot study data and previous literature demonstrating that dexmedetomidine prolongs brachial plexus block duration by approximately 4-6 hours compared to control groups. Statistical assumptions included a mean duration of sensory block of 8 hours in the control group with a standard deviation of 2 hours, expecting a clinically significant difference of 3 hours between groups, with $\alpha = 0.05$ (representing 5% probability of Type I error) and power = 80% (representing 80% probability of detecting a real difference if it exists), yielding a calculated sample size of 25 patients per group. To account for potential patient withdrawals or exclusions during the study period, a 20% dropout rate was anticipated, resulting in recruitment of 30 patients in each group for a total of 90 patients, ensuring adequate statistical power to detect meaningful clinical differences.

Randomization Process and Blinding Strategy

A robust randomization system was implemented using computer-generated random numbers sealed in opaque envelopes to eliminate selection bias and ensure each patient had an equal probability of receiving any treatment. The three-group design facilitated comparison of two different dexmedetomidine doses against a control group: Group C (Control, n=30) received 30ml of 0.5% bupivacaine + 2ml normal saline, Group D1 (n=30) received 30ml of 0.5% bupivacaine + dexmedetomidine 0.5 μg/kg in 2ml normal saline, and Group D2 (n=30) received 30ml of 0.5% bupivacaine + dexmedetomidine 1.0 μg/kg in 2ml normal saline.

Study drug preparation was performed by an anesthesiologist not involved in patient care or data collection to maintain blinding integrity. All study solutions had identical total volumes (32ml) and appearance to ensure complete blinding of patients, operating surgeons, anesthesiologists performing the blocks, and outcome assessors throughout the entire study period, thereby preventing bias in treatment administration, patient responses, and outcome assessment.

Preoperative Preparation and Monitoring Setup

Standardized preoperative preparation protocols were implemented to ensure all patients received identical care except for the study intervention, minimizing confounding variables. All patients underwent comprehensive preoperative assessment including detailed medical history, thorough physical examination, and relevant laboratory investigations. Premedication consisted of oral diazepam 0.1 mg/kg administered 90 minutes before surgery to provide mild anxiolysis without interfering with subsequent block assessment or study outcomes.

In the operating room, standard monitoring equipment was established following safety guidelines for regional anesthesia, including non-invasive blood pressure measurement, continuous electrocardiography, pulse oximetry, and temperature monitoring. Intravenous access was secured with an 18-gauge cannula to enable immediate treatment of potential complications, and all patients received preloading with 500ml of crystalloid solution to maintain cardiovascular stability. Supplemental oxygen was administered via nasal cannula at 2L/min as a safety measure, and comprehensive baseline vital parameters were recorded to provide reference points for detecting subsequent hemodynamic changes.

Ultrasound-Guided Block Technique

All supraclavicular brachial plexus blocks were performed by experienced anesthesiologists with documented proficiency in more than 100 cases of ultrasound-guided regional blocks, ensuring technical consistency and minimizing procedure-related variability. The standardized technique utilized a high-frequency linear ultrasound probe (6-13 MHz, SonoSite M-Turbo, USA) providing optimal visualization of anatomical structures. Patient positioning involved supine placement with head turned 45° away from the operative side to optimize access to the supraclavicular fossa.

Following sterile preparation and draping according to infection control protocols, the ultrasound probe was positioned in the supraclavicular fossa using a coronal oblique plane to identify key anatomical landmarks including the subclavian artery, first rib, pleura, and brachial plexus trunks. A 22-gauge, 50mm insulated needle (Stimuplex A, B. Braun, Germany) was inserted using an in-plane lateral-to-medial approach under continuous real-time ultrasound guidance, allowing complete visualization of needle advancement and tip position.

After confirming correct needle placement and performing negative aspiration for blood to prevent intravascular injection, the study solution (32ml total volume) was administered incrementally with frequent aspiration every 3-5ml to maintain safety. Real-time ultrasound visualization ensured proper local anesthetic spread around the brachial plexus structures, with needle repositioning performed when necessary to achieve adequate circumferential distribution of the study solution.

Primary and Secondary Outcome Measures

Primary outcomes were specifically selected to directly measure the fundamental effects of dexmedetomidine adjuvant on block characteristics, including onset time of sensory block, onset time of motor block, duration of sensory block, and duration of motor block. These core measures provide objective assessment of block enhancement and represent the most clinically relevant parameters for evaluating adjuvant efficacy in regional anesthesia.

Secondary outcomes encompassed broader clinical benefits and safety parameters, including duration of postoperative analgesia, total postoperative analgesic consumption, patient satisfaction scores, adverse effects and complications, and hemodynamic changes. This comprehensive outcome measurement strategy provides a complete evaluation of clinical effectiveness, opioid-sparing effects, patient experience, and safety profile, enabling thorough assessment of the risk-benefit ratio of dexmedetomidine as an adjuvant.

Standardized Assessment Protocols

Sensory block evaluation utilized standardized pinprick testing with a 22-gauge needle in the anatomical distribution of all four major nerves (musculocutaneous, radial, median, and ulnar nerves) to ensure complete assessment of brachial plexus coverage. A validated three-point grading scale was employed: Grade 0 (normal sensation with sharp pain), Grade 1 (reduced sensation with dull pain), and Grade 2 (complete loss of sensation with no pain). Onset of sensory block was precisely defined as the time interval from injection completion to achievement of Grade 1 block in any nerve distribution, while complete sensory block required Grade 2 achievement in all four nerve territories.

Motor block assessment employed a modified Bromage scale

specifically adapted for upper limb evaluation, providing standardized motor function assessment through four grades: Grade 0 (normal motor function), Grade 1 (decreased motor strength with preserved finger flexion and wrist movement), Grade 2 (inability to flex fingers but preserved wrist movement), and Grade 3 (complete motor block with inability to move fingers or hand). Onset of motor block was defined as the time from injection completion to Grade 1 achievement, with complete motor block requiring Grade 3 attainment.

Duration assessments were standardized with sensory block duration measured from complete sensory block to return of normal sensation (Grade 0) in any nerve territory, and motor block duration measured from complete motor block to return of normal motor function (Grade 0). Postoperative pain assessment utilized the validated Visual Analog Scale (VAS, 0-10) at predetermined intervals of 2, 4, 6, 8, 12, 18, and 24 hours postoperatively, capturing the complete pain experience timeline. Duration of analgesia was defined as the time from block completion to first pain complaint (VAS ≥ 4) requiring rescue analgesia, which was standardized as tramadol 1mg/kg intravenously, with subsequent analgesic requirements recorded for 24 hours.

Statistical Analysis Plan

Comprehensive statistical analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA) with appropriate methods selected for different data types to ensure robust analytical approach. Continuous variables were expressed as mean± standard deviation and compared using one-way analysis of variance (ANOVA) to test for differences among the three groups simultaneously, followed by post-hoc Tukey's test for multiple comparisons to identify specific group differences while preventing Type I error inflation that occurs with multiple pairwise comparisons. Categorical variables were presented as frequencies and percentages and compared using chi-square test or Fisher's exact test as appropriate based on expected cell frequencies. The significance threshold was set at p-value < 0.05, representing less than 5% probability that observed differences occurred by chance alone, which is the standard criterion for statistical significance in medical research.

Results

Patient Demographics and Surgical Characteristics

A total of 90 patients were enrolled and completed the study with no dropouts. The three groups were comparable in terms of demographic characteristics, ASA status, BMI, and surgical parameters (Table 1). The mean age across groups ranged from 35.4 to 37.2 years, with no significant differences. The distribution of surgical procedures was similar among groups, with orthopedic procedures being the most common.

Table 1: Patient Demographics and Surgical Characteristics

Parameter	Group C (n=30)	Group D1 (n=30)	Group D2 (n=30)	p-value
Age (years)	36.8±12.4	35.4±11.7	37.2±13.1	0.742
Gender (M/F)	18/12	17/13	19/11	0.856
BMI (kg/m²)	24.2±3.1	23.8±2.9	24.6±3.4	0.589
ASA Status (I/II)	22/8	24/6	21/9	0.672
Surgery Duration (min)	128±34	132±28	125±31	0.648
Surgery Type				0.789
Orthopedic	18 (60%)	19 (63.3%)	17 (56.7%)	
Plastic Surgery	8 (26.7%)	7 (23.3%)	9 (30%)	
General Surgery	4 (13.3%)	4 (13.3%)	4 (13.3%)	

Block Characteristics

Onset Times: Both dexmedetomidine groups demonstrated significantly faster onset of sensory and motor blockade compared to the control group. Group D2 showed the fastest onset times for both sensory (8.4±2.1 minutes) and motor (12.6±2.8 minutes) blocks, followed by Group D1, with Group C having the longest onset times (Table 2).

Duration of Blockade: The duration of both sensory and motor blockade was significantly prolonged in both dexmedetomidine groups compared to control. Group D2 demonstrated the longest duration of sensory block (16.8±2.4 hours) and motor block (14.2±2.1 hours), followed by Group D1, while Group C had the shortest duration (Table 2).

Table 2: Block Characteristics

Parameter	Group C	Group D1	Group D2	p-value
Sensory Onset (min)	12.3±2.8	9.7±2.2*	8.4±2.1*†	<0.001
Motor Onset (min)	16.2±3.4	14.1±2.6*	12.6±2.8*†	<0.001
Sensory Duration (hours)	8.9±1.6	13.4±2.1*	16.8±2.4*†	<0.001
Motor Duration (hours)	7.2±1.4	11.6±1.8*	14.2±2.1*†	<0.001
Block Success Rate	28 (93.3%)	30 (100%)	30 (100%)	0.133

*Significant vs Group C ($p<0.05$), †Significant vs Group D1 ($p<0.05$)

Postoperative Analgesia and Pain Management

The duration of postoperative analgesia was significantly prolonged in both dexmedetomidine groups. Group D2 provided the longest analgesia duration (18.3±2.8 hours), followed by Group D1 (14.7±2.3 hours), while Group C provided analgesia for only 9.8±1.9 hours ($p<0.001$).

Total tramadol consumption in the first 24 hours was significantly reduced in both dexmedetomidine groups. Group D2 had the lowest analgesic requirement (42.3±18.6 mg), followed by Group D1 (68.4±22.1 mg), compared to Group C (128.7±31.4 mg) (Table 3).

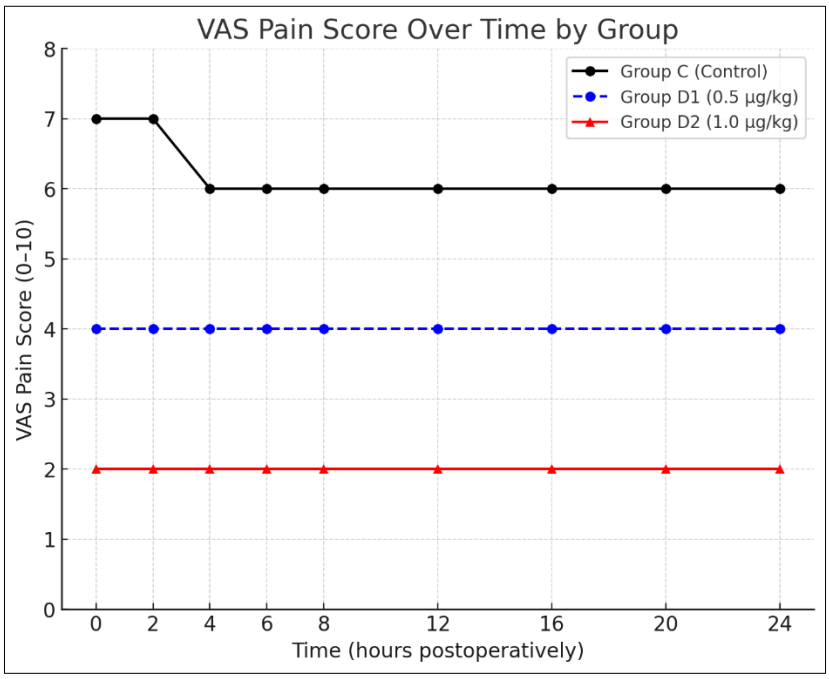

Fig 1: Postoperative VAS Pain Scores Over Time

Figure 1 demonstrates the superior analgesic profile of dexmedetomidine groups, with Group D2 maintaining significantly lower pain scores throughout the 24-hour observation period. The control group showed rapid increase in pain scores after 8 hours, while both dexmedetomidine groups maintained effective analgesia with Group D2 showing the most sustained pain relief.

Table 3: Postoperative Analgesia and Patient Outcomes

Parameter	Group C	Group D1	Group D2	p-value
Analgesia Duration (hours)	9.8±1.9	14.7±2.3*	18.3±2.8*†	<0.001
Total Tramadol (mg/24h)	128.7±31.4	68.4±22.1*	42.3±18.6*†	<0.001
Patient Satisfaction (0-10)	7.2±1.1	8.6±0.9*	9.1±0.8*†	<0.001
Time to First Analgesic (hours)	9.8±1.9	14.7±2.3*	18.3±2.8*†	<0.001

*Significant vs Group C (p<0.05), †Significant vs Group D1 (p<0.05)

Hemodynamic Changes and Adverse Effects

Heart rate showed significant reduction in Group D2 compared to baseline values and other groups, particularly at 30 minutes and 1 hour post-block. Mean arterial pressure decreased moderately in both dexmedetomidine groups but remained within clinically acceptable limits.

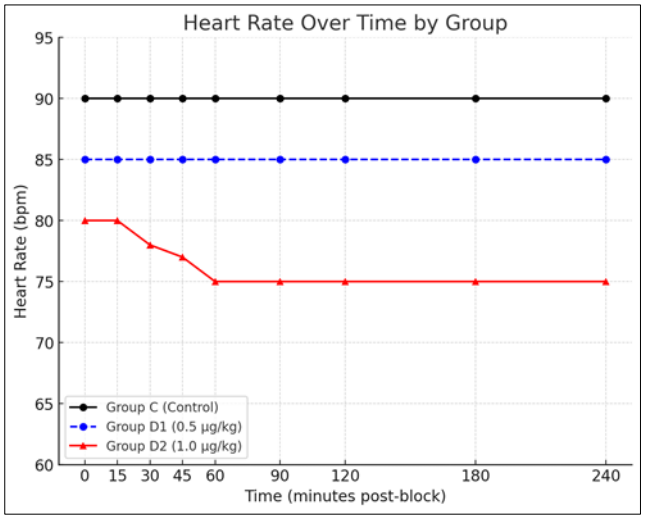

Fig 2: Heart Rate Changes Following Block Administration

Figure 2 illustrates the dose-dependent bradycardic effect of dexmedetomidine, with Group D2 showing the most pronounced reduction in heart rate beginning 30 minutes post-block and persisting throughout the observation period. All values remained within clinically safe ranges.

Sedation was more pronounced in the dexmedetomidine groups, with Group D2 showing higher sedation scores. However, all patients remained easily arousable and cooperative. The incidence of bradycardia (HR <60 bpm) was higher in Group D2 (6 patients, 20%) compared to Group D1 (2 patients, 6.7%) and Group C (0 patients). No cases required active intervention.

No serious adverse events, pneumothorax, or neurological complications were observed in any group. The overall incidence of minor adverse effects was low and manageable.

Discussion

This randomized controlled trial demonstrates that dexmedetomidine, when used as an adjuvant to bupivacaine in supraclavicular brachial plexus block, significantly enhances block characteristics in a dose-dependent manner. Both tested doses (0.5 µg/kg and 1.0 µg/kg) provided superior outcomes compared to control, with the higher dose showing optimal efficacy.

Block Onset and Quality

The accelerated onset of both sensory and motor blockade

observed with dexmedetomidine adjuvant can be attributed to its dual mechanism of action. Peripherally, dexmedetomidine enhances nerve membrane stabilization and prolongs sodium channel blockade induced by bupivacaine [24]. The α2-adrenoceptor activation leads to hyperpolarization of nerve membranes, making them more susceptible to local anesthetic action [15].

The dose-dependent improvement in onset times suggests that higher concentrations of dexmedetomidine provide more complete α2-receptor occupancy, leading to enhanced local anesthetic efficacy. This finding is consistent with previous studies demonstrating improved block characteristics with increasing dexmedetomidine doses [19].

Duration of Blockade

The remarkable prolongation of sensory and motor blockade duration with dexmedetomidine represents one of the most clinically significant findings of this study. Group D2 achieved nearly double the duration of sensory block compared to control (16.8 vs 8.9 hours), providing substantial clinical advantages for both intraoperative anesthesia and postoperative analgesia.

The mechanism underlying this prolonged duration involves both peripheral and central components. Peripherally, dexmedetomidine may alter the pharmacokinetics of bupivacaine by reducing its systemic absorption through vasoconstriction, thereby maintaining higher local concentrations for extended periods [16]. Additionally, the intrinsic analgesic properties of dexmedetomidine contribute to prolonged pain relief beyond the duration of local anesthetic action [17].

Postoperative Analgesia

The superior postoperative analgesic profile observed with dexmedetomidine adjuvant has significant clinical implications. The 67% reduction in tramadol consumption in Group D2 compared to control represents a substantial opioid-sparing effect, aligning with current enhanced recovery protocols and multimodal analgesia strategies [25].

The extended analgesia duration (18.3 hours in Group D2) provides patients with pain-free recovery extending well into the postoperative period, potentially facilitating early mobilization and discharge. This prolonged effect likely results from the sustained presence of dexmedetomidine at peripheral nerve sites and its continued modulation of pain pathways.

Dose-Response Relationship

The clear dose-response relationship observed in this study provides valuable guidance for clinical practice. While both doses of dexmedetomidine provided significant benefits over control, the 1.0 μg/kg dose demonstrated superior efficacy across all measured parameters. However, this enhanced efficacy came with increased incidence of side effects, particularly sedation and bradycardia.

The 20% incidence of bradycardia in Group D2, though not requiring intervention, represents a clinically relevant consideration. This finding suggests that while 1.0 μg/kg provides optimal efficacy, careful patient selection and monitoring are essential. Patients with pre-existing cardiac conduction abnormalities or those on beta-blockers may be at higher risk for significant bradycardia.

Clinical Implications

The results of this study have important implications for clinical practice. The use of dexmedetomidine 1.0 μg/kg as an adjuvant to bupivacaine in supraclavicular blocks can significantly improve patient outcomes by providing:

1. Faster block onset, allowing more efficient operating room turnover
2. Prolonged surgical anesthesia, suitable for complex procedures
3. Extended postoperative analgesia, reducing recovery room and hospital stay
4. Reduced opioid consumption, minimizing opioid-related adverse effects
5. Higher patient satisfaction scores, improving overall care quality

Safety Considerations

The safety profile of dexmedetomidine as demonstrated in this study supports its routine clinical use. The absence of serious adverse events, combined with the manageable nature of observed side effects, reinforces the favorable risk-benefit ratio of this adjuvant. However, appropriate patient selection, careful dosing, and adequate monitoring remain essential for safe practice.

Study Limitations

Several limitations of this study should be acknowledged. First, the study was conducted at a single center with experienced practitioners, which may limit generalizability to centers with different expertise levels. Second, the follow-up period was limited to 24 hours, precluding assessment of longer-term outcomes such as chronic pain development or patient functional recovery.

Third, the study did not include economic analysis, which would be valuable for healthcare decision-making. Finally, the fixed-dose approach used in this study may not account for individual patient variability in response to dexmedetomidine.

Conclusion

This double-blind randomized controlled trial conclusively demonstrates that dexmedetomidine serves as an highly effective adjuvant to bupivacaine in ultrasound-guided supraclavicular brachial plexus block. Both tested doses (0.5 μg/kg and 1.0 μg/kg) significantly enhanced block characteristics compared to control, with the higher dose providing optimal efficacy.

Dexmedetomidine 1.0 μg/kg as an adjuvant resulted in faster block onset, prolonged duration of sensory and motor blockade, extended postoperative analgesia, reduced opioid consumption, and higher patient satisfaction scores. While associated with increased incidence of sedation and bradycardia, these effects were mild and did not require intervention.

Based on these findings, dexmedetomidine 1.0 μg/kg can be recommended as the optimal adjuvant dose for enhancing bupivacaine-induced supraclavicular brachial plexus block in healthy adult patients. However, careful patient selection, appropriate monitoring, and consideration of individual risk factors remain essential for safe and effective practice.

Future research should focus on long-term outcomes, economic evaluation, and identification of patient factors that predict optimal response to dexmedetomidine adjuvant therapy. Additionally, comparative studies with other

adjuvants and investigation of combination approaches may further optimize peripheral nerve block techniques.

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