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Efficacy of 0.25% Bupivacaine Alone vs. with Dexmedetomidine for Ultrasound-Guided Supraclavicular Block in Upper Limb Surgery

Sara Sabir[1*], Rehan Hassan Khan Niazi[2], Shahzad Imran[1], Hafiz Faheem Asghar[3], Shumaila Ashfaq[1] and Aamna Muzaffar[4]

[1]Department of Anesthesia, Islam Medical and Dental College, Sialkot, Pakistan
[2]Department of Anesthesia, Ameer Ud Din Medical College, Lahore, Pakistan
[3]Department of Anesthesia, Islam Medical College, Gujranwala, Pakistan
[4]Department of Anesthesia, Indus Hospital, Lahore, Pakistan

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***Corresponding Author:**
Sara Sabir
Department of Anesthesia, Islam Medical and Dental College, Sialkot, Pakistan
sara.92816@gmail.com

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ABSTRACT

The pain after upper limb surgeries can be intense. The brachial plexus block is an effective and commonly used method to manage this pain, reduce opioid use, and facilitate smoother recovery. **Objective:** To see the effect of combining bupivacaine with dexmedetomidine in upper limb surgeries. **Methods:** Quasi-experimental research was carried out at Islam Medical College, Sialkot. 100 patients undergoing upper limb surgeries who were aged between 25 to 65 years. All the patients who were comprised allergies to study drugs, severe organ impairment, coagulopathy, neurological disorders affecting pain perception, and pregnancy were excluded and divided to receive either 0.25% bupivacaine alone or with dexmedetomidine.The outcome variables included pain, analgesia duration, sensory/motor block onset, and 24-hour analgesic consumption.Data were analyzed by SPSS version 23.0. The comparison of quantitative data was done by an independent sample t-test and chi-square test for insightful comparisons between qualitative variables, with the significance level at p-value<0.05. **Results:** The average age of patients was 40.1±11.5 and 39.8±10.5 years in Group I and Group II, respectively. Male were more in both groups. Group II showed significantly longer analgesia duration (12.7 vs. 5.3 hours), faster sensory/motor block onset, and lower analgesic consumption (p<0.001). There were no significant differences in adverse effects. **Conclusions:** It was concluded that combining dexmedetomidine with bupivacaine significantly extended analgesia, quickened sensory and motor block onset with a reduction in overall consumption of analgesia. Although sedation was more frequent, no major adverse events were observed.

INTRODUCTION

The pain after upper limb surgeries, particularly total shoulder arthroplasty, can be intense. The inter-scalene brachial plexus block is an effective and commonly used method to manage this pain, reduce opioid use, and facilitate smoother recovery [1]. However, the pain relief from a single injection of the anesthetic is usually short-term, even when additional medications are added. Continuous brachial plexus blocks can offer longer-lasting pain relief, but they need specialized expertise and more resources to perform [2]. Supraclavicular block has the potential to provide the optimal analgesia under regional anesthetic for upper limb treatment when this is the shoulder, arm, elbow, or hand region. This block provides clavicular brachial plexus obstruction and is a reliable and efficient upper extremity anesthesia [3]. Local anesthetics are drugs that are used in regional anesthesia; an example is the common local anesthetic bupivacaine and the supraclavicular block. Bupivacaine is a long-acting amide-type local anaesthetic and the most of the time is specifically used for upper limb regional anesthesia

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because of its potent and prolonged blockade of sensory and motor pathways [4]. Bupivacaine offers extended postoperative pain relief by obstructing voltage-gated sodium channels, effectively interrupting nerve signal transmission. Its considerable lipid solubility and strong protein affinity contribute to its long-lasting effects [5]. In the regional anesthesia procedures, like supraclavicular brachial plexus blocks, bupivacaine can uniquely target at lower doses while preserving motor function and the pain fibers. Its gradual dissociation offers prolonged pain relief, reduces the need for opioids, and enhances patient comfort, thus ideal during long surgeries and continuous nerve blocks [6]. To enhance postoperative and regional analgesic potential related to anesthesia there has been research done on various potential adjuvants such as opioids, clonidine and dexmedetomidine [7]. Dexmedetomidine is an α2-adrenoceptor agonist and has potential for use as an adjuvant in regional analgesia. The mechanism is that it prevents norepinephrine from being released, thus reducing sympathetic nervous system activity and increasing analgesia [8]. It is also associated with additional benefits as sedation and anxiolysis without significant respiratory depression, which comes very handy in the immediate postoperative era. Dexmedetomidine with bupivacaine has been applied in several techniques of regional anesthesia, and studies have shown mixed results in terms of better block quality, post-operative analgesia and decreased opioid consumption [9, 10]. Unprecedented revolution in the practice of delivering regional blocks with better precision and safety in locating the nerve by Ultrasound-guided (USG) technique [11]. Since it remains in front of the intended target tissue and the anatomical structures, the chances of complications such as nerve damage or accidental vascular puncture are reduced when positioning a needle under ultrasound guidance. Rather, postoperative analgesia is based on an element of reliability and reproducibility that may be improved with the precision of the USG technique [12, 13].

Although supraclavicular brachial plexus block with bupivacaine provides effective postoperative analgesia for upper limb surgeries, its duration remains limited, prompting the use of adjuvants like dexmedetomidine; however, existing evidence on their combined efficacy shows inconsistent results. This uncertainty limits optimal analgesic strategies for enhancing block duration and reducing opioid requirements. This study aims to compare the effect of combining bupivacaine with dexmedetomidine on the analgesia effect after post-operative recovery time in upper limb surgeries.

METHODS

A quasi-experimental research was conducted at Islam Medical College, Sialkot, from July to November 2024, after ethical approval (Ref: 900/IMCS/ERC/000103. Participants were recruited using a convenience sampling method. Eligibility criteria of participants include patients undergoing upper limb surgeries who were aged between 25 to 65 years and who fall in ASA criteria I and II. All the patients who were comprised allergies to study drugs, severe organ impairment, coagulopathy, neurological disorders affecting pain perception, and pregnancy were excluded. The Open Epi software is used for sample size calculation by using duration of analgesia in the bupivacaine with dexmedetomidine Group was 722 ± 88.45 min and 210 ± 35.88 in Bupivacaine Alone Group, by taking 80% power of test, 5% margin of Error and 10% drop out rate is 100 (50 in each group) [14]. A written informed consent was taken. A total of 100 participants were enrolled to effectively assess the duration of analgesia and were equally divided into two groups of 50 each. Group I received 20 ml of 0.25% bupivacaine, while Group II received 20 ml of 0.25% bupivacaine combined with 50 ug of dexmedetomidine for enhanced analgesic effect. Upon arrival in the preoperative area, baseline vital signs and pain scores were assessed by the Visual Analogue Scale (VAS). The total score of VAS was 10, where 0 indicates no pain and 10 shows the worst pain. An 18-gauge intravenous line was secured in each participant, ensuring proper preparation for the procedure. This structured approach reflects our commitment to delivering effective and high-quality pain management. VAS is a widely used tool for pain assessment, demonstrating a reliability of 0.95 [15]. Patients were monitored and pre-medicated with IV midazolam (1 mg). Using a high-frequency linear ultrasound probe, the brachial plexus was visualized, and a 22-gauge needle was used to administer the anesthetic solution according to the randomized group, ensuring safety with incremental injections. The study measured the duration of postoperative analgesia. It also examined the onset of sensory and motor blocks, along with total analgesic consumption within the first 24 hours. In response to pain complaints, rescue analgesia was administered as nalbuphine (0.1 mg/kg). Adverse events, including hypotension, bradycardia, nausea, vomiting, and sedation, were monitored closely. Data analysis was conducted using SPSS version 23.0. Normality of the data using the Shapiro-Wilk test before executing the t-tests. The quantitative variables, including age, VAS score, post op analgesia effect (duration in minutes), and the onset times for sensory and motor blockade through independent sample t-tests. For categorical variables, we utilized the chi-square test for insightful comparisons with the significance level at p-value<0.050.

RESULTS

The patients' mean age was 40.1 ± 11.5 and 39.8 ± 10.5 years in Group I and Group II, respectively, with no significant difference (p=0.820). Gender distribution was similar, with males comprising 62% in Group I and 52% in Group II, while

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females made up 38% and 48%, respectively (p=0.680). ASA physical status classification was also comparable, with 44% of patients in Group I and 48% in Group II categorized as ASA I, and 56% and 52% as ASA II (p=0.650). The mean VAS score at baselines was 6.5 ± 1.2 and 6.7 ± 1.1 in Group I and Group II (p=0.580) (Table 1).

Table 1: Clinical Parameters of Patients (n=100)

Characteristics		Group I	Group II	p-value
Age		40.1 ± 11.5	39.8 ± 10.5	0.890
Gender	Male	31 (62%)	26 (52%)	0.680
	Female	19 (38%)	24 (48%)	
ASA Physical Status	I	22 (44%)	24 (48%)	0.540
	II	28 (56%)	26 (52%)	
Baseline Pain Score (VAS)		6.5 ± 1.2	6.7 ± 1.1	0.380

As compared to bupivacaine alone (5.3 ± 1.4 hours), there was a statistically significant prolonged duration of analgesia with (12.7 ± 2.1 hours) addition of dexmedetomidine to bupivacaine (p<0.001). Times of sensory and motor blockade onset were faster in Group II (Bupivacaine + Dexmedetomidine) than in Group I (Bupivacaine alone) at 8.3 ± 1.8 minutes and 12.3 ± 2.6 minutes (p=0.002 and 0.003, respectively) and total analgesic (40.7 ± 15.8 mg vs 75.4 ± 20.2 mg, p<0.001) requirement was significantly lower among them (Table 2).

Table 2: Comparison of Analgesia Duration and Onset Time, and Total Analgesic Consumption among Study Groups

Characteristics	Group I	Group II	p-value	Test Used
Analgesia Duration				
Analgesia Duration in Hours,	5.3 ± 1.4	12.7 ± 2.1	<0.001	Independent t-test
Onset Time and Total Analgesic Consumption				
Onset of Sensory Block (min)	10.4 ± 2.3	8.3 ± 1.8	<0.001*	Independent t-test
Onset of Motor Block (min)	15.2 ± 3.0	12.3 ± 2.6	<0.001*	Independent t-test
Total Analgesic Consumption (mg)	75.4 ± 20.2	40.7 ± 15.8	<0.001*	Independent t-test

The dextromethorphan and bupivacaine combination produced a significantly greater degree of sedation (16% vs. 0%, p=0.010) without increasing the rate of any other adverse effects, including bradycardia (8% vs. 2%, p=0.36), hypotension (10% vs. 4%, p=0.240), and nausea (4% vs. 6%, p=0.650). While Group II experienced significantly more sedation, the other adverse events were similar (Figure 1).

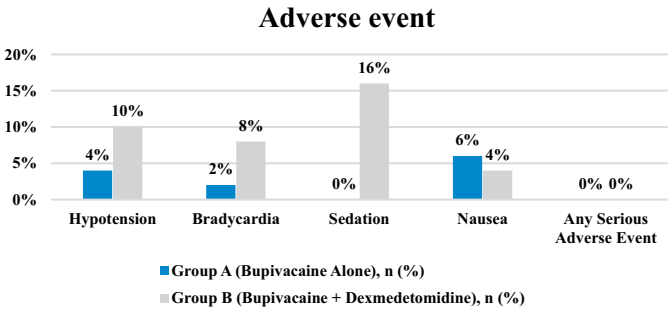

Figure 1: Comparison of Adverse Events in Both Drugs

DISCUSSION

This study evaluates the efficacy of dexmedetomidine as an adjuvant to 0.5% bupivacaine versus bupivacaine alone in spinal anesthesia, aiming to enhance analgesic onset, duration, and quality across upper limb surgery. Literature found that adding dexmedetomidine to bupivacaine enhances postoperative analgesia, reduces rescue analgesic use, and improves patient satisfaction without increasing severe side effects. It prolongs the duration of sensory evaluation, remains hemodynamically safe, and lowers the postoperative shivering incidence [16]. These findings align with results reported in similar studies, which show that additional trials have further enhanced the benefits of dexmedetomidine supplementation to local anesthetics, thereby improving regional anesthesia, as discussed in the current study. The block provided by bupivacaine combined with dexmedetomidine lasted appreciably longer than bupivacaine alone, reducing postoperative pain and the need for additional analgesics. Furthermore, patients receiving the combined technique reported superior fulfilment with their postoperative pain management [17]. Moreover, another study indicated that incorporating dexmedetomidine with bupivacaine in spinal anesthesia enhances pain relief without raising the risk of adverse effects. The findings indicated that combining dexmedetomidine with bupivacaine enhances postoperative analgesia and accelerates the onset of both motor and sensory nerve block, as observed in the current study [18]. It is suggested that Dexmedetomidine's contribution to the prolonged instances of analgesia is towards blocking nerve conduction, thus reducing pain signals. Previously conducted studies of brachial plexus blockade revealed that incorporation of Dexmedetomidine with Bupivacaine significantly extended analgesic effects. That our results support these previous findings has been attested, as the combination of Dexmedetomidine and Bupivacaine exhibits significantly longer duration and stronger analgesic effect than Bupivacaine on its own [19]. Dexmedetomidine significantly increased the effects of bupivacaine. There was an earlier onset of time to sensory and time to motor nerve block for Bupivacaine + Dexmedetomidine than Bupivacaine alone. In a like manner, another trial documented a much faster appearance of the sensory and motor blockade and longer analgesia duration when Bupivacaine was combined with Dexmedetomidine [14]. The current study revealed no adverse effects in both study groups, corroborating the safety of both treatments. Although differences in individual side effects were observed, hypotension and bradycardia were more common in bupivacaine plus dexmedetomidine, but were not significant. These findings correspond with previous reports showing that administering dexamethasone shortens the onset time and duration of sensory and motor blockade. There was a faster onset of sensory and motor

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blocks significantly compared to the control group, with minimal side effects, which confirms the role of dexmedetomidine as a safe and useful adjunct for bupivacaine in regional anesthesia.[20].Current results showed that bupivacaine when used with dexmedetomidine provided effective analgesia without the need to increase the rate of adverse effects such as bradycardia (8% vs. 2%, p=0.36), hypotension (10% vs. 4%, p=0.24) and nausea (There were no major events of high-grade toxicity in neither group, and safety profiles were similar, but not different (p>0.05), without significant adverse events being reported.These findings were confirmed by Sane *et al.*, Intriguingly, no serious complications were reported in either group, which implies that adding dexamethasone did not increase the risk of complications[21].

The relatively small sample size and single-center design may limit the generalizability of the findings. Additionally, short-term follow-up restricts assessment of long-term analgesic outcomes and potential delayed adverse effects. Future large-scale, multicenter studies with extended follow-up are recommended to further evaluate the long-term safety and efficacy of dexmedetomidine as an adjuvant in spinal anesthesia.

CONCLUSIONS

The combination of dexmedetomidine to bupivacaine significantly enhanced its efficacy. Bupivacaine combined with Dexmedetomidine exhibited a faster onset of both sensory and motor block as compared to Bupivacaine alone. Furthermore, our findings demonstrated that the combination provided effective analgesia with no reported side effects.

Authors' Contribution

Conceptualization: SS
Methodology: SS, RHKN, SI, HFA
Formal analysis: RHKN, AM
Writing and Drafting: SI, SA
Review and Editing: SS, RHKN, SI, HFA, SA, AM

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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