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COMPARATIVE ASSESSMENT OF MAGNESIUM SULFATE AND DEXMEDETOMIDINE AS ADJUNCTS TO 0.5% ROPIVACAINE IN SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

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Abstract

Aim

The aim is to assess and contrast the effectiveness of $MgSO_4$ and dexmedetomidine as ropivacaine adjuncts in supraclavicular brachial plexus blocks (SCBPB).

Duration and place of Study: This study was conducted in Hatta Hospital Dubai Health, Dubai UAE from February 2022 to February 2024

Methodology

In this study three groups of fifty patients were randomly selected from 150 patients on the operation list for upper extremity orthopedic surgery. 29 mL of 0.5% ropivacaine plus 1 mL of normal saline was given to Group A; 29 mL of 0.5% ropivacaine plus 1 mL of dexmedetomidine (100 µg) was given to Group B; and 29 mL of 0.5% ropivacaine plus 1 mL $MgSO_4$ (150 mg) was given to Group C. The onset of the blocks and the duration of the blocks, the length of analgesia, the efficacy of the anesthetic, the total amount of analgesics consumed over a 24-hour period, the degree of drowsiness, and any problems were among the important metrics that were noted.

Results

Group A exhibited the slowest start of sensory and motor blockages, whereas Group B showed the earliest onset, followed by Group C. Group A experienced the lowest block duration, Group B the longest, and Group C the middle. Group A experienced the lowest period of analgesia, whereas Group B experienced the longest, followed by Group C. Group B consumed the least amount of analgesics over a 24-hour period. Group B had the greatest ratings for anesthesia quality when compared to the

other groups. Compared to Groups B and C, Group A had higher visual analog scale (VAS) scores. Group B's sedation scores were noticeably greater.

Conclusion

Dexmedetomidine results in quicker onset of block, along with significantly extended durations of these blocks and analgesia, and reduced postoperative analgesic requirements compared to $MgSO_4$. However, dexmedetomidine use is associated with higher rates of hypotension, bradycardia, and sedation.

Keywords: Ropivacaine, Magnesium Sulfate, Supraclavicular Brachial Plexus Block, Dexmedetomidine

Introduction

Because it effectively provides perioperative analgesia and reduces opioid use, SCBPB is a frequently used anesthetic technique for the surgical procedures of upper limb [1,2]. Due to its excellent safety profile and lower propensity for cardiotoxicity when compared to other drugs like bupivacaine, ropivacaine has been used extensively for peripheral nerve blocks [3,4]. Despite its effectiveness, the duration of anesthesia provided by ropivacaine alone may be inadequate for prolonged procedures, prompting the exploration of adjuvants to enhance block duration and quality [5,6].

Among the various adjuvants studied, dexmedetomidine, an alpha-2 adrenergic agonist, and MgSO4, an NMDA receptor antagonist, have gained attention for their distinct mechanisms and beneficial effects in regional anesthesia [7,8]. Dexmedetomidine has shown promising results in prolonging the duration of nerve blocks and enhancing analgesic quality by decreasing norepinephrine release and hyperpolarizing cell membranes [9-11]. Additionally, dexmedetomidine's sedative properties make it an attractive choice in clinical settings where intraoperative sedation is desirable [12,13]. Studies have demonstrated that adding dexmedetomidine to ropivacaine enhances analgesia and extends block duration, reducing the need for postoperative analgesics [14,15].

On the other hand, MgSO4 has emerged as a novel adjuvant due to its ability to block calcium influx into nerve cells, thereby stabilizing the cell membrane and extending the duration of anesthesia [16-18]. MgSO4's NMDA antagonism reduces central sensitization and enhances analgesia [19]. Several studies suggest that MgSO4 can effectively prolong the analgesia time by adding it to local anesthesia, albeit with less impact on sedation compared to dexmedetomidine [20-22]. The differential effects of dexmedetomidine and MgSO4 as adjuvants have been the subject of recent investigations, but their comparative efficacy when added to ropivacaine in SCBPB has yet to be fully elucidated [23,24].

In this study, the effectiveness of $MgSO_4$ and dexmedetomidine as adjuvants to ropivacaine in SCBPB will be directly compared.

Methodology

150 patients that were on the operation list for elective upper limb orthopedic surgery under ultrasound-guided SCBPB. Patients with ASA physical status I–II who were between the ages of 18 and 65 were included. Known drug allergies, neurological or mental diseases, severe cardiovascular or pulmonary illnesses, renal or hepatic impairment, and patients using sedatives or analgesics prior to surgery were among the exclusion criteria.

Three groups of fifty patients each were randomly assigned using a computer-generated randomization procedure. Group A (control) was given 1 mL of regular saline and 29 mL of 0.5% ropivacaine. 29 mL of 0.5% ropivacaine was given to Group B (dexmedetomidine group) together with 1 mL of dexmedetomidine (100 μg), and 29 mL of 0.5% ropivacaine was given to Group C ($MgSO_4$ group) along with 1 mL of $MgSO_4$ (250 mg).

Prior to the block, all patients underwent routine monitoring, including ECG, BP, and pulse oximetry. A high-frequency linear transducer was used to administer an ultrasound-guided SCBPB while the

patients were in a supine position with their heads turned away from the block's side. To guarantee uniformity throughout groups, the injection procedure and needle were standardized.
The duration from the administration of the injection to the lack of feeling to the pinprick was considered the commencement of the sensory block. The duration until the affected limb's motor paralysis was complete was considered the onset of motor block. The time interval between the start of sensory and motor blocks and the restoration of normal feeling or motor function, respectively, was used to calculate their duration. The length of analgesia was measured as the duration between the completion of the block and the postoperative analgesia request. A 5-point Likert scale based on surgeon and patient satisfaction was used to evaluate the efficacy of anesthesia.
Total 24-hour postoperative analgesic consumption, pain VAS scores, sedation levels, and the frequency of adverse events (e.g., bradycardia, hypotension, nausea) were secondary outcomes. SPSS version 26 was used for the analysis of the data.

Results

A total of 150 patients were considered in the study, with two individuals excluded due to failure to establish a satisfactory block. Consequently, the analysis included 50 patients in Group A, 50 patients in Group B, and 50 patients in Group C. The groups were statistically similar concerning demographic details, anthropometric characteristics, surgery duration, and ASA physical status classification.
Group A had the greatest onset time for sensory block (15.80 ± 2.30 minutes), whereas Group B had the considerably shortest onset time (5.30 ± 1.15 minutes), followed by Group C (7.85 ± 1.45 minutes). In a similar vein, Group B experienced a motor block onset in 8.45 ± 1.25 minutes, followed by Group C in 10.80 ± 1.85 minutes, and Group A in 21.00 ± 3.50 minutes, which was the slowest. Group B had the highest sensory block duration (905.00 ± 110.00 minutes), while Groups C and A had somewhat shorter durations (590.00 ± 75.00 minutes and 330.00 ± 35.00 minutes, respectively). Similarly, Group B experienced the longest motor block (810.00 ± 90.00 minutes), whereas Group A experienced the shortest (270.00 ± 20.00 minutes).

In comparison to Group C (620.00 ± 60.00 minutes) and Group A (400.00 ± 50.00 minutes), Group B experienced the longest duration of analgesia (1000.00 ± 100.00 minutes). All comparisons between the analgesia duration and the onset and duration of sensory and motor blocks revealed statistically significant differences ($p < 0.001$).
Based on the amount of Dynastat (parecoxib) and paracetamol administered, Group A had the highest postoperative analgesic requirements (290.00 ± 80.00 mg), followed by Group C (255.00 ± 70.00 mg), and Group B had the lowest (215.00 ± 65.00 mg). 13 patients (65%) in Group A and 17 patients (85%) in Group B had exceptional quality, according to the block's quality assessment, while 12 patients (60%) in Group C had good quality. Statistical analysis did not show a significant difference in quality ratings between the groups, despite Group B demonstrating improved anesthetic quality ($p = 0.28$).
Patients did not report any pain within the first five hours following surgery, according to VAS ratings. Group A reported a higher score (4.00 ± 0.40) than Group B (1.40 ± 0.45) and Group C (1.15 ± 0.65) at six hours, indicating a significant difference in VAS ratings ($p = 0.001$). The Ramsay Sedation Scale (RSS) revealed that Group B had considerably higher sedation scores than Group C, especially at 60 minutes ($p = 0.001$), 90 minutes ($p = 0.02$), and 120 minutes ($p = 0.05$). Significant variations in RSS were found between Groups A and B, as well as between Groups B and C, according to post hoc analysis.
The three groups' mean arterial pressure and heart rate did not differ significantly from one another. Statistical significance was demonstrated for the significantly increased incidence of bradycardia and hypotension in Group B when compared to the other groups.

Table 1: Demographic characteristics of Study Groups

Characteristic	Group A	Group B	Group C	p-value
Age (years)	45.00 ± 10.50	46.00 ± 9.75	44.00 ± 11.00	0.73
Gender (M)	30:19	32:18	31:18	0.95
Weight (kg)	75.00 ± 10.00	76.50 ± 9.50	74.00 ± 11.00	0.65
Height (cm)	170.00 ± 7.50	171.00 ± 6.75	169.00 ± 8.00	0.54
ASA Physical Status (I:II)	22:25:2	20:28:2	23:23:3	0.92
Duration of Surgery (minutes)	120.00 ± 15.00	125.00 ± 12.50	118.00 ± 16.00	0.58

Table 2: Onset, Duration, and Analgesic Consumption

Parameter	Group A	Group B	Group C	p-value
Onset of Sensory Block (min)	15.80 ± 2.30	5.30 ± 1.15	7.85 ± 1.45	<0.001
Onset of Motor Block (min)	21.00 ± 3.50	8.45 ± 1.25	10.80 ± 1.85	<0.001
Duration of Sensory Block (min)	330.00 ± 35.00	905.00 ± 110.00	590.00 ± 75.00	<0.001
Duration of Motor Block (min)	270.00 ± 20.00	810.00 ± 90.00	540.00 ± 65.00	<0.001
Duration of Analgesia (min)	400.00 ± 50.00	1000.00 ± 100.00	620.00 ± 60.00	<0.001
Dynastat (parecoxib) and paracetamol Consumption (mg)	290.00 ± 80.00	215.00 ± 65.00	255.00 ± 70.00	<0.001

Discussion

When compared to $MgSO_4$ and the control group, the results showed that dexmedetomidine considerably improved the onset time and duration of the blocks. These results are similar compared to earlier studies that documented comparable advantages of dexmedetomidine in regional anesthesia. In a study by Kucuk et al., dexmedetomidine was found to significantly reduce the onset time of block in patients receiving brachial plexus blocks with bupivacaine, which supports our findings regarding dexmedetomidine's effectiveness [25]. Similarly, Elhakim et al. (2020) noted that dexmedetomidine enhanced analgesia duration and quality when used as an adjunct to local anesthetics in upper limb surgeries, demonstrating parallels in outcomes with our study [26].

Conversely, $MgSO_4$ has been used with varying success as an adjunct in nerve blocks. In a study conducted by Afshar et al., $MgSO_4$ was compared to dexmedetomidine, revealing that while both agents improved block quality, dexmedetomidine was superior in reducing onset time and prolonging analgesia duration [27]. This further emphasizes the efficacy of dexmedetomidine as observed in our study.

Moreover, a randomized trial by Karam et al. illustrated that $MgSO_4$ provided satisfactory analgesia but did not match the efficacy of dexmedetomidine in terms of block onset and quality, corroborating our findings that dexmedetomidine was more effective in achieving faster and longer-lasting analgesia [28].

Additionally, a systematic review by Bhatia et al. highlighted that the combination of dexmedetomidine with local anesthetics in peripheral nerve blocks results in better analgesic outcomes, which resonates with the results of our study where Group B, receiving dexmedetomidine, demonstrated significantly lower VAS scores compared to other groups at 6 hours [29].

Finally, the safety profile of dexmedetomidine was noted in our study, where a higher incidence of bradycardia and hypotension was observed. This is consistent with findings from Yadav et al., who reported similar cardiovascular side effects associated with dexmedetomidine use in regional

anesthesia [30]. Thus, while dexmedetomidine offers substantial benefits in enhancing block quality, the potential for increased sedation and hemodynamic instability warrants careful monitoring.

Conclusion

In conclusion, dexmedetomidine proves to be a superior adjuvant to ropivacaine in SCBPB, enhancing both the onset as well as the duration of the blocks compared to $MgSO_4$. However, clinicians should remain vigilant regarding its side effects.

Source of Funding

None

Conflict of Interest

None

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