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Comparison between Magnesium Sulfate and Dexmedetomidine as Adjuvants in Supraclavicular Brachial Plexus Block for Upper Limb Surgeries below Mid-Shaft Humerus

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Abstract

Introduction: Supraclavicular brachial plexus block is a commonly used regional anesthetic technique for upper limb surgeries below the shoulder joint. It provides dense Intraoperative anesthesia, good muscle relaxation and effective postoperative analgesia. However, the limited duration of single-shot local anesthetic blocks often necessitates the use of Adjuvants to hasten onset, prolong sensory and motor blockade, reduce postoperative pain and decrease rescue analgesic requirement. Magnesium sulphate and dexmedetomidine are commonly used Adjuvants with different mechanisms of action.

Aim: To compare the efficacy of magnesium sulphate and dexmedetomidine as Adjuvants to Bupivacaine in Supraclavicular brachial plexus block.

Methodology: This prospective, randomized, double-blind comparative study was conducted in the Department of Anaesthesiology, Swaroopa Rani Nehru Hospital, Motilal Nehru Medical College, Prayagraj, from March 2024 to March 2025. Forty adult patients aged 20–60 years, ASA physical status I and II, scheduled for elective upper limb surgeries below the mid-shaft Humerus were randomly allocated into two groups of 20 each. Group M received 30 ml of 0.5% Bupivacaine with 150 mg magnesium sulphate diluted to 1 ml. Group D received 30 ml of 0.5% Bupivacaine with

dexmedetomidine 1 µg/kg diluted to 1 ml. Ultrasound-guided Supraclavicular brachial plexus block was performed. Onset and duration of sensory and motor block, duration of analgesia, rescue analgesic requirement, hemodynamic parameters, VAS score, sedation, adverse effects and patient satisfaction were recorded.

Results: Baseline characteristics were comparable between the groups. Sensory block onset was significantly faster in Group D than Group M (10.1 ± 2.4 vs 15.8 ± 3.2 minutes; p<0.001). Motor block onset was also faster in Group D (12.3 ± 2.9 vs 18.5 ± 4.1 minutes; p<0.001). Duration of sensory block was longer in Group D (562.3 ± 61.8 vs 386.5 ± 45.7 minutes; p<0.001), motor block duration (498.6 ± 54.2 vs 341.2 ± 38.4 minutes; p<0.001). Duration of analgesia was significantly prolonged in Group D (598.4 ± 67.5 vs 412.7 ± 52.3 minutes; p<0.001), while diclofenac consumption was lower in Group D (86.3 ± 21.4 vs 128.5 ± 25.6 mg; p<0.001).

Conclusion: Dexmedetomidine provided faster onset, longer sensory and motor blockade, prolonged analgesia, reduced analgesic consumption and better patient satisfaction compared with magnesium sulphate. However, it was associated with greater tendency for bradycardia and sedation, requiring careful perioperative monitoring.

Keywords: Dexmedetomidine, Magnesium Sulphate, Supraclavicular Block, Brachial Plexus Block, Postoperative Analgesia.

Introduction

Regional anesthesia has become an important component of modern anesthetic practice because it provides effective surgical anesthesia, excellent postoperative analgesia, reduced systemic analgesic requirement and avoidance of several complications associated with general anesthesia. For upper limb surgeries, brachial plexus block is a valuable technique because it produces dense anesthesia and muscle relaxation while maintaining consciousness and stable perioperative physiology. Among the different approaches to brachial plexus block, the Supraclavicular approach is widely used for procedures distal to the shoulder joint because the brachial plexus is compactly arranged at this level, allowing rapid and reliable blockade.[1,3]

The use of ultrasound guidance has improved the safety and success of Supraclavicular brachial plexus block by allowing real-time visualization of neural structures, pleura, vessels, needle position and local anesthetic spread. Despite this, a major limitation of single-shot peripheral nerve block remains its finite duration. Once the local anesthetic effect regresses, patients may experience postoperative pain requiring systemic analgesics. Therefore, Adjuvants are frequently added to local anesthetics to improve block quality and prolong postoperative analgesia.[4]

Dexmedetomidine is a highly selective alpha-2 adrenergic receptor agonist with sedative, anxiolytic, sympatholytic and analgesic properties. When used perineurally, it prolongs sensory and motor block, reduces neuronal excitability and may delay systemic absorption of local anesthetic through local vaso constrictive effects. It also provides sedation without significant respiratory depression.[6,8] Magnesium sulphate acts mainly as a physiological calcium antagonist and non-competitive N – methyl – D - Aspartate receptor antagonist. It reduces nociceptive transmission and central sensitization, thereby improving postoperative analgesia.[9]

Although both drugs have been studied individually as Adjuvants in peripheral nerve blocks, direct comparison between magnesium sulphate and dexmedetomidine remains clinically useful. The present study was therefore conducted to compare these two Adjuvants in ultrasound-guided Supraclavicular brachial plexus block for upper limb surgeries below the mid-shaft Humerus.

Aim and Objectives

Aim: To compare the efficacy of magnesium sulphate and dexmedetomidine as Adjuvants in Supraclavicular brachial plexus block.

Objectives

1. To evaluate onset and duration of sensory and motor blockade, duration of analgesia and incidence of side effects.
2. To determine which adjuvant provides better block characteristics, prolonged analgesia and improved patient comfort.

Materials and Methods

This prospective, randomized, double-blind comparative study was conducted in the Department of Anaesthesiology, SRN Hospital, Motilal Nehru Medical College, Prayagraj, from March 2024 to March 2025. The study included adult patients aged 20–60 years, ASA physical status I or II, scheduled for elective upper limb surgeries below the mid-shaft Humerus under Supraclavicular brachial plexus block.

The sample size was calculated using duration of analgesia as the primary outcome variable. Based on previous studies reporting mean duration of analgesia of 860 ± 120 minutes with dexmedetomidine and 740 ± 130 minutes with magnesium sulphate, with 95% confidence level and 80% power, the minimum required sample size was 18 patients per group. After allowing 10% attrition, 20 patients were included in each group, making a total sample size of 40.

Patients were included if they were willing to participate, aged 20–60 years, ASA I or II, weighed 50–80 kg and were undergoing elective upper limb surgery below the mid-shaft Humerus. Patients were excluded if they refused consent, had allergy to local anesthetic or study drugs, coagulopathy, infection at injection site, severe hepatic, renal or cardiac disease, neurological or psychiatric disorder, pregnancy or lactating.

After ethical approval and written informed consent, patients were randomly allocated into Group M and Group D using a computer-generated randomization sequence. Allocation was concealed using sealed opaque envelopes. Study drugs were prepared by an independent anesthesiologist not involved in assessment, maintaining double blinding.

Group M received 30 ml of 0.5% Bupivacaine with 150 mg magnesium sulphate diluted to 1 ml. Group D received 30 ml of 0.5% Bupivacaine with dexmedetomidine 1 µg/kg diluted to 1 ml. All blocks were performed under ultrasound guidance using a high-frequency linear probe and stimuplex needle 10 mm under aseptic precautions. Standard monitoring included ECG, non-invasive blood pressure and pulse oximetry.

Sensory block onset was defined as time from drug injection to loss of pinprick sensation in all relevant nerve distributions. Motor block onset was defined as time to complete motor block corresponding to Bromage grade 3.

Duration of sensory block was measured from sensory onset to return of pinprick sensation. Duration of motor block was measured from motor onset to complete recovery of motor power. Duration of analgesia was defined as time from drug injection to first request for

rescue analgesia when VAS score exceeded 4. Rescue analgesia was given as intravenous diclofenac 75 mg, and total diclofenac consumption in 24 hours was recorded. Sedation was assessed using Ramsay Sedation Score, and adverse effects including bradycardia, hypotension, nausea, vomiting and dizziness were recorded.

Data were analyzed using SPSS version 23. Quantitative variables were expressed as mean ± standard deviation and compared using Student's t-test. Categorical variables were expressed as frequency and percentage and compared using Chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant.

Results

A total of 40 patients were included, with 20 patients in each group. Baseline characteristics were comparable. Mean age was 42.5 ± 11.3 years in Group M and 44.1 ± 10.8 years in Group D (p=0.642). Gender distribution, body weight, BMI, ASA physical status and duration of surgery were also comparable between the groups, confirming baseline similarity.

Dexmedetomidine produced significantly faster block onset. Sensory block onset was 15.8 ± 3.2 minutes in Group M and 10.1 ± 2.4 minutes in Group D (p<0.001). Motor block onset was 18.5 ± 4.1 minutes in Group M and 12.3 ± 2.9 minutes in Group D (p<0.001). Thus, dexmedetomidine provided superior onset characteristics.

Duration of sensory and motor blockade was also significantly prolonged in Group D. Sensory block duration was 386.5 ± 45.7 minutes in Group M compared with 562.3 ± 61.8 minutes in Group D (p<0.001). Motor block duration was 341.2 ± 38.4 minutes in Group M and 498.6 ± 54.2 minutes in Group D (p<0.001). These findings show that dexmedetomidine markedly prolonged the action of Bupivacaine.

The analgesic profile was better in Group D. Duration of analgesia was 412.7 ± 52.3 minutes in Group M and 598.4 ± 67.5 minutes in Group D (p<0.001). Total diclofenac consumption during the first 24 hours was significantly lower in Group D, 86.3 ± 21.4 mg, compared with 128.5 ± 25.6 mg in Group M (p<0.001). Patient satisfaction was also better in the dexmedetomidine group. However, bradycardia and early postoperative sedation were more frequent in Group D, though manageable with appropriate monitoring.

Table 1: Baseline Demographic and Clinical Characteristics

Characteristic	Group M (Magnesium Sulphate) n=20	Group D (Dexmedetomidine) n=20	p-value
Age (years)	42.5 ± 11.3	44.1 ± 10.8	0.642
Gender (Male/Female)	14/6	13/7	0.741
Weight (kg)	65.2 ± 8.5	67.1 ± 9.2	0.488
BMI (kg/m²)	24.1 ± 2.8	24.6 ± 3.1	0.586
ASA Physical Status (I/II)	12/8	10/10	0.537
Duration of Surgery (minutes)	92.4 ± 21.6	95.7 ± 19.8	0.612

Both groups were comparable with respect to age, gender distribution, weight, BMI, ASA physical status and duration of surgery, indicating baseline similarity between the two groups.

Table 2: Primary Block Characteristics – Onset Times

Parameter	Group M n=20	Group D n=20	p-value
Onset of Sensory Block (minutes)	15.8 ± 3.2	10.1 ± 2.4	<0.001*

Onset of Motor Block (minutes)	18.5 ± 4.1	12.3 ± 2.9	<0.001*

Dexmedetomidine produced significantly faster onset of both sensory and motor blockade compared with magnesium sulphate.

Table 3: Primary Block Characteristics – Duration

Parameter	Group M n=20	Group D n=20	p-value
Duration of Sensory Block (minutes)	386.5 ± 45.7	562.3 ± 61.8	<0.001*
Duration of Motor Block (minutes)	341.2 ± 38.4	498.6 ± 54.2	<0.001*

The duration of sensory and motor blockade was significantly prolonged in Group D compared with Group M.

Table 4: Analgesia Profile and Rescue Analgesic Requirement

Parameter	Group M n=20	Group D n=20	p-value
Duration of Analgesia (minutes)	412.7 ± 52.3	598.4 ± 67.5	<0.001*
Total Diclofenac Consumption in 24 hours (mg)	128.5 ± 25.6	86.3 ± 21.4	<0.001*

Group D showed significantly prolonged duration of analgesia and significantly reduced diclofenac consumption during the first 24 postoperative hours.

*Statistically significant.

Discussion

The present study found that dexmedetomidine was superior to magnesium sulphate as an adjuvant to Bupivacaine in ultrasound-guided Supraclavicular brachial plexus block. Dexmedetomidine provided faster onset, longer duration of sensory and motor blockade, prolonged postoperative analgesia and reduced rescue analgesic requirement.

The faster onset in Group D may be explained by alpha-2 receptor-mediated effects on peripheral nerves, inhibition of hyper polarization-activated cation currents and reduced neuronal excitability. Previous studies by Shukla et al., Yourself et al., Elmaleh et al. and S VM et al. have also reported faster block onset with dexmedetomidine compared with magnesium sulphate.[14,16,17,20]

The prolongation of sensory and motor block in the dexmedetomidine group is consistent with studies by Mangal et al., Sinha et al., Akshara et al. and Sharma et al., who demonstrated prolonged block duration when dexmedetomidine was added to local anesthetics.[10,11,15,22] Magnesium sulphate also has analgesic properties due to NMDA receptor antagonism and calcium channel modulation, but its duration-enhancing effect was less pronounced than dexmedetomidine in the present study.

Duration of analgesia was significantly longer and diclofenac consumption was significantly lower in Group D. This finding is clinically important because prolonged analgesia improves postoperative comfort and reduces systemic analgesic burden. Similar findings have been reported by Elyazed and Mogahed, Shukla et al., Dai et al. and Cai et al.[5,12,18,20]

Dexmedetomidine was associated with better patient satisfaction but a higher tendency for bradycardia and sedation. These effects are consistent with its known sympatholytic and sedative properties. Therefore, while dexmedetomidine is highly effective, careful hemodynamic monitoring is necessary.

Conclusion

Dexmedetomidine, when used as an adjuvant to Bupivacaine in Supraclavicular brachial plexus block, provided faster onset of sensory and motor blockade, significantly prolonged sensory and motor block duration, extended postoperative analgesia, reduced rescue diclofenac requirement and improved patient

satisfaction compared with magnesium sulphate. However, dexmedetomidine was associated with greater tendency for bradycardia and sedation, requiring careful perioperative monitoring.

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