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ORIGINAL RESEARCH

To Assess and Evaluate the Effectiveness of Magnesium Sulphate and Dexamethasone as Adjuvants To Ropivacaine In Supraclavicular Brachial Plexus Block At A Tertiary Centre

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Abstract

Background: The supraclavicular block is a reliable and efficient method for administering anaesthetic to the brachial plexus, allowing for sensory and motor blockage in the hands, wrist, and forearm. Ropivacaine is a propyl derivative of bupivacaine that exhibits equivalent anaesthetic strength but has a prolonged duration of effect and reduced risk of cardiac and central nervous system damage compared to bupivacaine

Aim: To assess and evaluate the effectiveness of magnesium sulphate and dexamethasone with ropivacaine as an adjuvant in supra clavicular block.

Materials and Methods: The research included a total of 80 patients, evenly divided into two groups with 40 patients in each group. The participants were placed into two equal groups using random assignment. Group RM received a mixture of 30 ml of 0.5% ropivacaine and 300 mg of magnesium sulphate (diluted to 2 ml with 0.9% saline), whereas Group RD received a mixture of 30 ml of 0.5% ropivacaine and 8 mg of dexamethasone in 2 ml. This research comprised patients who were having elective orthopedic operations of the hand and had a supraclavicular brachial plexus block.

Results: The RM group was given a combination of 30 cc of 0.5% ropivacaine and 300 mg of magnesium sulphate, resulting in an average onset time of 14.55 minutes (±1.84). In contrast, Group RD, which received a combination of 30 cc of 0.5% ropivacaine and 8 mg dexamethasone, had a substantially faster onset of sensory block, with an average time of 5.03 minutes (±0.71). Moreover, there was a significant discrepancy in the time it took to achieve motor blockage across the different groups. Group RM had a motor blockade onset time of 16.30 minutes (±4.52), whereas Group RD had a faster motor blockade onset time, with a mean of 6.64 minutes (±0.98). Group RD had a substantially prolonged duration of sensory suppression in comparison to Group RM. Group RM had an average duration of sensory block of 437.68 minutes (±65.20), whereas Group RD had a much longer duration of sensory block, averaging 1022.05 minutes (±100.05). The post-operative Visual Analog Scale (VAS) values within 24 hours were significantly lower in the RD group ($P < 0.05$). The RM group exhibited higher overall use of diclofenac sodium injection in comparison to the RD

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group. Both groups effectively finished the block without experiencing any issues during or after the surgery.

Conclusion: Dexamethasone administration in supraclavicular brachial plexus block enhances the duration of sensory and motor block, delays the initiation of analgesic usage, and decreases the total quantity of analgesics needed. Magnesium sulfate may be recommended as an adjunct for short surgical procedures, such as closed reduction and internal fixation of a simple hand fracture, as well as for k wire fixations, enabling early discharge of the patient.

Keywords: Magnesium sulphate, Dexamethasone, Ropivacaine, Supraclavicular block.

Introduction

The supraclavicular block is a reliable and efficient method for administering anaesthetic to the brachial plexus, leading to sensory and motor blockage in the hands, wrist, and forearm. Ropivacaine is a propyl derivative of bupivacaine that exhibits equivalent anaesthetic strength but has a prolonged duration of effect and reduced risk of cardiac and central nervous system damage compared to bupivacaine.[1] Various adjuvants, including clonidine, opioids, neostigmine, midazolam, and dexamethasone, may be used to extend the duration of the supraclavicular brachial plexus block (BPB).[2,3] Ropivacaine, a topical anaesthetic, inhibits the entry of sodium ions in a reversible manner, thereby stopping the transmission of nerve impulses in nerve fibers.[4] Compared to other long-acting local anaesthetics, it has a lower level of toxicity on the heart and the Central Nervous System (CNS).[5] While local anaesthetics are effective for supraclavicular brachial plexus block (BPB), their drawback lies in their limited duration of postoperative pain relief. Hence, in order to establish a prompt, profound, and enduring block, several supplementary substances such as opioids, clonidine, neostigmine, dexamethasone, midazolam, etc., have been included. However, the outcomes have been ambiguous or linked to adverse consequences. Magnesium is essential for the presynaptic release of acetylcholine from nerve terminals and may provide comparable effects to medications that inhibit calcium entry.[6] It is used for its pain-relieving, blood pressure-lowering, and numbing properties.[7,8] Dexmedetomidine has a much higher specificity ratio for the α2 receptor (α2/α1 1600:1) in comparison to clonidine (α2/α1 200:1), hence classifying it as a full α2 agonist. Intravenous (i.v.) sedation and analgesia is used in critical care units and for non-intubated patients undergoing surgery and other operations.[9]

Materials and Methods

The present prospective study was undertaken to examine the effectiveness of magnesium sulphate and dexamethasone when used with ropivacaine in supraclavicular brachial plexus block. The study included 80 patients of both genders. The present study has been carried out at the Department of Anaesthesia, Nalanda Medical College and Hospital, Patna, Bihar, India. All participants were provided with detailed information about the anaesthetic technique and gave their permission in writing after being fully informed. The patient was given permission in a language that they could comprehend. Each patient provided written informed consent. The research received approval from the institutional ethics committee. The study was carried out over an approximate two-year period, from January 2022 to December 2023. Data such as name, age, etc. was recorded.

Inclusion Criteria

- Patients were classified as having ASA grades I and II.
- Age between 45 and 60 years.
- Patients to give written informed consent.
- Available for follow-up.

Exclusion Criteria

- Patients who did not consent to the study.

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- Age < 45 or >60 years.
- Patients who had chronic obstructive pulmonary disease (COPD), stroke, angina, heart attacks, psychiatric illness, severe liver or renal disorders, known hypersensitivity to Lignocaine or its preservatives, undergoing emergency surgical procedures.
- Those unable to attend follow-up.

The research included a total of 80 patients, evenly divided into two groups with 40 patients in each group.

Participants were randomly divided into two equal groups:

Group RM: Received 30 ml of 0.5% ropivacaine plus 300 mg magnesium sulphate (diluted to 2 ml with 0.9% saline) and

Group RD: Received 30 ml of 0.5% ropivacaine plus 8 mg dexamethasone in 2 ml.

This research comprised patients who were classified as ASA risk I and II, aged between 20 and 60 years, of both sexes, and undergoing elective orthopaedic procedures of the hand under supraclavicular brachial plexus block. The research eliminated patients who refused, had ASA III and IV classifications, had contraindications to peripheral nerve blocks, or had cognitive disabilities.

Methodology

Following the acquisition of written informed permission, the designated solution was administered with the use of ultrasound guidance, in accordance with the assigned group. Both the participants and the administrators of the injections were unaware of the group designations. The sensory and motor blockade were evaluated at 2-minute intervals after the injection, continuing for 30 minutes. Afterward, assessments were conducted every 2 hours until the full resolution of the sensory and motor blocks. The Visual Analog Scale (VAS) was used to quantify pain levels at 1, 4, 8, 12, and 24 hours after the operation. The VAS ranges from 0, representing the absence of pain, to 10, representing the most severe agony conceivable. Pain relief during a rescue operation: An intramuscular injection of 75 mg diclofenac sodium was given when the Visual Analog Scale (VAS) score was equal to or greater than 4. The quantity of diclofenac injections administered to each patient during the first 24 hours after the operation was documented (with a maximum limit of two intramuscular injections within this time frame). Adverse effects: Any untoward events seen during the trial were documented.

Statistical Analysis

Statistical analysis was performed on the obtained data using SPSS and Microsoft. A chi-square test and an ANOVA test were used to find the effectiveness of Magnesium Sulphate and Dexamethasone as adjuvants to Ropivacaine in Supraclavicular Brachial Plexus Block**.** A ‘P’ value <0.05 is considered significant.

Results

The study included a total of 80 patients who were divided into two groups: Group RM and Group RD, with each group including 40 people. In Group RM, the average age of patients was 46.58 years, with a standard deviation of 11.21. In Group RD, the average age was 47.74 years, with a standard deviation of 10.89. Group RM consisted of 22 males and 18 females, whereas Group RD included 20 males and 20 females. Regarding the classification of patients' physical condition by the American Society of Anaesthesiologists (ASA), Group RM had 23 patients classified as ASA I and 17 patients classified as ASA II. Conversely, Group RD consisted of 29 patients categorized as ASA I and 11 individuals categorized as ASA II. The groups did not vary significantly in terms of age, gender, or ASA status, as shown by the P-values of 0.65, 0.74, and 0.41, respectively.

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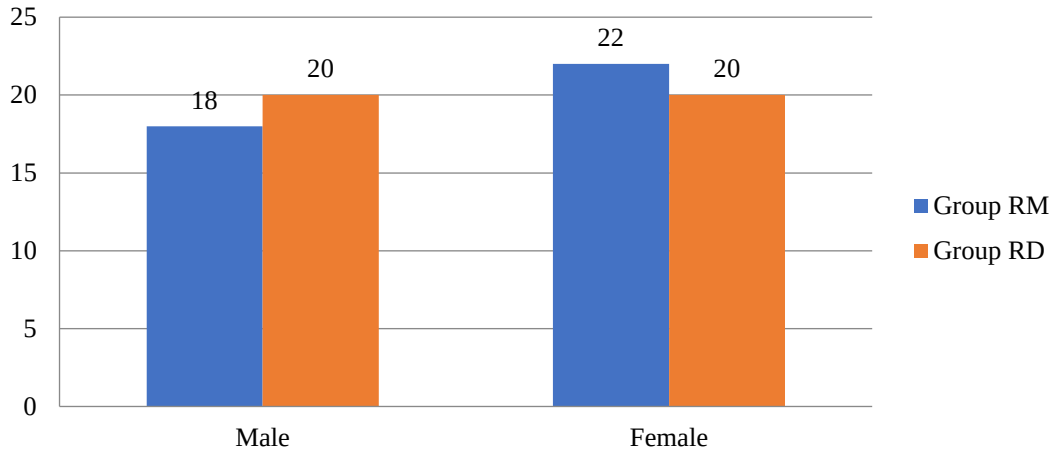
Table 1: Demographics Characteristic of the patients

Characteristic	Group RM (N=40)	%	Group RD (N=40)	%	P-Value
Age (years)	46.58 ± 11.21		47.74± 10.89		0.65
Gender					0.74
Female	18	45	20	50	
Male	22	55	20	50	
ASA					0.41
ASA I	23	57.50	29	72.50	
ASA II	17	42.50	11	27.50	

Figure 1: Gender wise distribution of the patients



There was a significant disparity in the onset time of sensory blockage between the two groups. The RM group was given a combination of 30 cc of 0.5% ropivacaine and 300 mg of magnesium sulphate, resulting in an average onset time of 14.55 minutes (±1.84). In contrast, Group RD, which received a combination of 30 cc of 0.5% ropivacaine and 8 mg of dexamethasone, had a substantially faster onset of sensory blockade, with an average time of 5.03 minutes (±0.71). Group RM had a motor blockade onset time of 16.30 minutes (±4.52), whereas Group RD had a faster motor blockade onset time, with a mean of 6.64 minutes (±0.98). Group RD had a much extended duration of sensory suppression in comparison to Group RM. Group RM had an average duration of sensory block of 437.68 minutes (±65.20), whereas Group RD had a much longer duration of sensory blockade, with an average of 1022.05 minutes (±100.05). The duration of vehicle obstruction exhibited a same trend. In Group RM, the average duration of motor obstruction was 367.02 minutes (±21.47), but in Group RD, it was much longer at an average of 961.14 minutes (±105.49). Patients in Group RD exhibited a prolonged duration before initiating their first request for pain alleviation after the surgical procedure. Group RM had a mean length of 452.23 minutes (±130.16) before requiring further pain medication, whereas Group RD had a mean duration of 1083.71 minutes (±-111.08). Group RD had a reduced need for diclofenac sodium, as seen by the lower dosage of rescue analgesia provided. Patients in Group RM were administered an average dosage of 101.77 mg (±-14.92) of diclofenac sodium, whereas those in Group RD received a comparatively lower dose of 77.35 mg (±-15.84).

The length of sensory and motor block in group RD was substantially less than in group RM ($P < 0.05$). In group RD, the duration of sensory and motor block, as well as the time elapsed before the initial administration of analgesics, were significantly longer compared to group

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RM ($P < 0.05$). In addition, the group RD had a decreased total need for rescue analgesics. The post-operative Visual Analog Scale (VAS) values within 24 hours were significantly lower in the RD group ($P < 0.05$). The RM group exhibited higher overall use of diclofenac sodium injection in comparison to the RD group. Both groups effectively finished the block without any issues during or after the surgery.

Table 2: Sensory and Motor Blockade Onset and Duration

Parameter	RM	RD	P value
Time taken to achieve sensory blockade (min)	14.55±1.84	5.03±0.71	0.002
Time taken to achieve motor blockade (min)	16.30±4.52	6.64±0.98	0.005
Duration of sensory blockade (min	437.68±65.20	1022.05±100.05	0.001
Duration of motor blockade (min)	367.02±21.47	961.14±105.49	0.002
Request of first analgesic (min)	452.23±130.61	1083.71+-111.08	0.003
Rescue analgesia as diclofenac sodium (mg)	101.77±14.92	77.35+-15.84	0.002

The assessment of postoperative pain was conducted using the Visual Analog Scale (VAS) at certain time intervals: 1, 4, 8, 12, and 24 hours after the surgical procedure. After 1 hour, Group RM had an average VAS score of 3.21 (±1.08), whereas Group RD had a score of 1.92 (±0.58), with a statistically significant P-value of 0.02. After 4 hours, Group RM had VAS values of 4.47 (±1.34), whereas Group RD had scores of 2.63 (±0.95), with a P-value of 0.004. Group RM had a VAS score of 5.02 (±1.55) at 8 hours, whereas Group RD had a score of 3.24 (±1.47). The P-value, which measures the statistical significance, was 0.002. The scores at the 12-hour mark were 4.88 (±1.20) for Group RM and 3.27 (±1.03) for Group RD, with a P-value of 0.003. After 24 hours, Group RM had an average VAS score of 3.55 (±1.17), whereas Group RD had a score of 2.39 (±0.64), with a statistically significant P-value of 0.001. The results suggest that Group RD consistently had reduced levels of postoperative pain at all assessed time periods.

Table 3: Postoperative Pain (VAS Scores)

Time Postop (hours)	Group RM (N=40)	Group RD (N=40)	P-Value
1	3.21 ± 1.08	1.92 ± 0.58	0.02
4	4.47 ± 1.34	2.63 ± 0.95	0.004
8	5.02 ± 1.55	3.24 ± 1.47	0.002
12	4.88 ± 1.20	3.27 ± 1.03	0.003
24	3.55 ± 1.17	2.39 ± 0.64	0.001

Side effects observed in both groups were minimal and similar. In Group RM, 3 patients (7.50%) experienced nausea compared to 2 patients (5%) in Group RD, with a P-value of 0.64. Vomiting was reported in 2 patients (5%) in Group RM and none in Group RD, with a P-value of 0.25. Dizziness was observed in 5 patients (12.50%) in Group RM and 3 patients (7.50%) in Group RD, with a P-value of 0.78. Pruritus was not reported in Group RM but was noted in 2 patients (5%) in Group RD, with a P-value of 0.20. Both groups had 1 patient (2.50%) each reporting a headache, with a P-value of 1.03. Overall, the incidence of side

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effects did not differ significantly between the two groups, indicating that both treatments were similarly well-tolerated.

Table 4: Side Effects

Side Effect	Group RM (N=40)	%	Group RD (N=40)	%	P-Value
Nausea	3	7.50	2	5	0.64
Vomiting	2	5	0	0	0.25
Dizziness	5	12.50	3	7.50	0.78
Pruritus	0	0	2	5	0.20
Headache	1	2.50	1	2.50	1.03

Discussion

The results indicated that the onset of both sensory and motor blockades was significantly faster in Group RD (administered with dexamethasone) compared to Group RM (administered with magnesium sulphate). The average time for sensory blocking to occur was significantly shorter in Group RD (5.03 minutes) compared to Group RM (14.55 minutes) ($P < 0.001$). Group RD had a faster onset of motor obstruction, with an average time of 6.64 minutes, in contrast to Group RM, which had an average duration of 16.30 minutes ($P < 0.001$). The findings of this study align with previous research, including the study done by Cummings et al.[10] also concluded that the inclusion of dexamethasone with local anaesthetics in peripheral nerve blocks led to a rapid onset of action. Group RD had significantly prolonged durations of both sensory and motor blockades. Group RD had a significantly longer length of sensory blocking, with an average of 1022.05 minutes, compared to Group RM, which had an average duration of 437.68 minutes ($P < 0.001$). The duration of motor obstruction was significantly longer in Group RD, with a mean of 961.14 minutes, compared to Group RM, which had a mean duration of 367.02 minutes ($P < 0.001$). The extended duration of pain relief with dexamethasone is consistent with the findings of Vieira et al.[11] who noted that dexamethasone may prolong the duration of pain relief in peripheral nerve blocks.

The assessment of postoperative pain was conducted using the Visual Analog Scale (VAS) at several time intervals throughout a 24-hour period after the surgical procedure. Group RD consistently exhibited lower Visual Analog Scale (VAS) ratings in comparison to Group RM during all recorded time periods. At 1 hour after the surgery, the average VAS score was 1.92 in Group RD compared to 3.21 in Group RM ($P < 0.01$). After 24 hours, the average VAS score was 2.39 in Group RD and 3.55 in Group RM ($P < 0.001$). The decrease in postoperative pain in Group RD is supported by research such as Parrington et al.[12], who also found improved postoperative pain relief with the use of dexamethasone.

Patients in Group RD required a considerably lower amount of diclofenac sodium for rescue analgesia compared to those in Group RM. In Group RD, the average dosage of diclofenac was 76.25 mg, but in Group RM it was 100.82 mg ($P < 0.001$). In addition, a smaller number of patients in Group RD (15 patients) needed rescue analgesia compared to Group RM (23 patients), suggesting that dexamethasone has a superior analgesic profile.

In a study done by Mukherjee K et al.[13], it was discovered that the group receiving magnesium required a reduced amount of rescue analgesics.

Magnesium sulphate has been used as an adjuvant along with local anaesthetics in both spinal and epidural routes for neuraxial anaesthesia, even at different doses.[14,15]

Mukherjee k et al.[16] concluded from his study that adding magnesium sulphate as an adjuvant in Ropivacaine to supraclavicular brachial plexus block may increase the sensory and motor

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block duration and time to first analgesic use, and decrease total analgesic needs, with no side effects.

The incidence of negative effects was minimal and comparable in both groups. The occurrence of nausea, vomiting, dizziness, pruritus, and headache was minimal and not statistically significant in both groups. The results suggest that the addition of magnesium sulphate or dexamethasone to ropivacaine did not significantly increase the probability of adverse effects. This is consistent with previous studies that shows both additives have a favourable safety track record.

Limitation of the Study

The shortcoming of the study is the small sample size.

Conclusion

Dexamethasone administration in supraclavicular brachial plexus block enhances the duration of sensory and motor block, delays the initiation of analgesic usage, and decreases the total quantity of analgesics needed. Dexamethasone may be used as an adjunct with ropivacaine for upper limb complicated fractures requiring a prolonged surgical duration and for patients requiring postoperative monitoring and follow-up in hospital wards. Magnesium sulphate led to a reduced duration of sensory and motor blockade in comparison to dexamethasone. Consequently, patients in the magnesium sulphate group had faster mobilization and were released earlier.

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