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Original Research Article

TO COMPARE THE EFFICACY OF MAGNESIUM SULPHATE AND DEXAMETHASONE WITH ROPIVACAINE AS AN ADJUVANT IN SUPRA CLAVICULAR BLOCK

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Abstract

Background: The aim is to compare the efficacy of magnesium sulphate and dexamethasone with ropivacaine as an adjuvant in supra clavicular block. **Materials and Methods:** This prospective, double-blinded, randomized study was conducted to compare the efficacy of magnesium sulfate and dexamethasone as adjuvants to ropivacaine in supraclavicular brachial plexus block. The study was approved by the institutional ethical committee. A total of 60 patients were enrolled in the study, with 30 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 sulfate (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. Patients undergoing elective orthopedic surgeries of the hand under supraclavicular brachial plexus block were included in this study. **Result:** There was a substantial difference in the time it took for sensory blocking to begin between the two groups. Group RM, administered with a combination of 30 cc of 0.5% ropivacaine and 300 mg of magnesium sulfate, had an average onset time of 13.27 minutes (±2.07). On the other hand, Group RD, which was given 30 ml of 0.5% ropivacaine together with 8 mg dexamethasone, experienced sensory blockage significantly more quickly, with an average time of 4.35 minutes (±0.856). Furthermore, there was a considerable disparity in the duration it took to establish motor blockage among the various groups. Group RM had a motor blockade onset time of 15.20 minutes (±5.2), whereas Group RD obtained a much quicker motor blockade onset time, with a mean of 5.92 minutes (±0.23). Group RD had a significantly longer period of sensory suppression compared to Group RM. Group RM had an average sensory block length of 436.21 minutes (±67.99), whereas Group RD had a much longer period of sensory blockade, averaging 1020.4 minutes (±102.40). The post-operative Visual Analog Scale (VAS) values within 24 hours were considerably lower in the RD group ($P < 0.05$). The RM group had a greater total utilization of diclofenac sodium injection compared to the RD group. Both groups successfully completed the block without any intraoperative or postoperative complications. **Conclusion:** The use of dexamethasone in supraclavicular brachial plexus block extends the duration of both sensory and motor block, prolongs the time until the first use of analgesics, and reduces the overall amount of analgesics required. Magnesium sulfate may be suggested as an adjuvant for brief operations such as the closed reduction and internal fixation of a simple hand fracture, as well as for k wire fixations, allowing for early release of the patient.

INTRODUCTION

The supraclavicular brachial plexus block is a frequently used method for administering anesthetic and postoperative pain relief to patients having procedures on the upper limb. Supplementing local anesthetics, such ropivacaine, with adjuvants may improve the effectiveness and duration of the block, minimize the amount of local anesthetics needed, and lower the occurrence of postoperative pain and the need for further pain relief.[1] Furthermore, it not only offers superior pain management but also minimizes the adverse effects of general anesthesia and results in a decreased duration of stay in the post-anesthesia care unit.[2] Kulenkampff brought the supraclavicular brachial plexus block to clinical practice in Germany in 1911. The brachial plexus trunks are targeted for administration of this very effective block, which mostly affects the upper extremities.[3] Ropivacaine, a topical anesthetic, 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 anesthetics, it has a lower level of toxicity on the heart and the Central Nervous System (CNS).[5] While local anesthetics 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

This prospective, double-blinded, randomized study was conducted to compare the efficacy of magnesium sulfate and dexamethasone as adjuvants to ropivacaine in supraclavicular brachial plexus block. The study was approved by the institutional ethical committee. A total of 60 patients were enrolled in the study, with 30 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 sulfate (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.

Inclusion Criteria

- Patients with ASA risk I and II
- Age: 20 to 70 years, both sexes
- Undergoing elective orthopedic surgeries of the hand under supraclavicular brachial plexus block

Exclusion Criteria

- Patient refusal
- ASA III and IV
- Contraindications to peripheral nerve blocks
- Cognitive disability

Methodology: After obtaining written informed consent, the allocated solution was injected slowly under ultrasound guidance according to the group assignment. Both the participants and the administrators of the injections were blinded to the group assignments.

Sensory and Motor Blockade: Assessed every 2 minutes after the completion of the injection until 30 minutes, and then every 2 hours postoperatively until the sensory and motor block had completely worn off.

Pain Assessment: VAS was measured at 1, 4, 8, 12, and 24 hours postoperatively using the Visual Analog Scale (VAS), where 0 indicates no pain and 10 indicates the worst pain imaginable.

Rescue Analgesia: Injection of 75 mg diclofenac sodium was administered intramuscularly when VAS ≥ 4. The number of diclofenac injections given to each patient during the first 24 hours postoperatively was recorded (maximum two IM injections in 24 hours).

Side Effects: Any side effects occurring during the study were recorded.

Statistical Analysis: The data obtained were subjected to statistical analysis. A P-value < 0.05 was considered statistically significant. This method ensures a standardized approach to comparing the efficacy of magnesium sulfate and dexamethasone as adjuvants to ropivacaine in supraclavicular brachial plexus block, providing reliable and reproducible results

RESULTS

The research comprised a total of 60 patients who were separated into two groups: Group RM and Group RD, with each group consisting of 30 individuals. The mean age of patients in Group RM was 45.3 years with a standard deviation of 12.5, while in Group RD, it was 46.1 years with a standard deviation of 11.8. In Group RM, there were 16 males and 14 females, whereas in Group RD, there were 15 males and 15 females. In relation to the American Society of Anesthesiologists (ASA) physical state categorization, Group RM consisted of 18 patients classed as ASA I and 12 patients rated as ASA II. On the other hand, Group RD comprised 20 patients classified as ASA I and 10 patients classified as ASA II. There were no significant differences between the groups in terms of age, gender, or ASA status, as

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shown by the P-values of 0.78, 0.81, and 0.59, respectively.

There was a substantial difference in the time it took for sensory blocking to begin between the two groups. Group RM, administered with a combination of 30 cc of 0.5% ropivacaine and 300 mg of magnesium sulfate, had an average onset time of 13.27 minutes (±2.07). On the other hand, Group RD, which was given 30 ml of 0.5% ropivacaine together with 8 mg dexamethasone, experienced sensory blockage significantly more quickly, with an average time of 4.35 minutes (±0.856). Furthermore, there was a considerable disparity in the duration it took to establish motor blockage among the various groups. Group RM had a motor blockade onset time of 15.20 minutes (±5.2), whereas Group RD obtained a much quicker motor blockade onset time, with a mean of 5.92 minutes (±0.23). Group RD had a significantly longer period of sensory suppression compared to Group RM. Group RM had an average sensory block length of 436.21 minutes (±67.99), whereas Group RD had a much longer period of sensory blockade, averaging 1020.4 minutes (±102.40). The length of vehicle blockage had a similar pattern. The average length of motor blockage in Group RM was 366.62 minutes (±23.1), but Group RD had a much longer period, with an average of 960.0 minutes (±106.74). Patients in Group RD had a greater length of time before making their initial request for pain relief after surgery. Group RM had an average time of 451.71 minutes (±132.27) before needing further pain medication, whereas Group RD had an average duration of 1082.32 minutes (±112.50). Group RD had a reduced need for diclofenac sodium, as shown by the decreased dose of rescue analgesia administered. Patients in Group RM had a mean dosage of 100.82 mg (±15.28) of diclofenac sodium, whereas those in Group RD had a lower dose of just 76.25 mg (±16.32).

The duration of sensory and motor block in group RD was significantly shorter than in group RM ($P < 0.05$). The length of sensory and motor block, as well as the time before the first use of analgesics, were substantially longer in group RD compared to group RM ($P < 0.05$). Additionally, the overall need for rescue analgesics was lower in group RD. The post-operative Visual Analog Scale (VAS) values within 24 hours were considerably lower in the RD group ($P < 0.05$). The RM group had a greater total utilization of diclofenac sodium injection compared to the RD group. Both groups successfully completed the block without any intraoperative or postoperative complications.

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 2.3 (±1.1), whereas Group RD had a score of 1.5 (±0.8), with a statistically significant P-value of 0.01. After 4 hours, Group RM had VAS values of 3.5 (±1.4), whereas Group RD had scores of 2.0 (±1.0), with a P-value of 0.002. Group RM had a VAS score of 4.1 (±1.6) at 8 hours, whereas Group RD had a score of 2.8 (±1.2). The P-value, which measures the statistical significance, was 0.003. The scores at the 12-hour mark were 3.9 (±1.5) for Group RM and 2.7 (±1.1) for Group RD, with a P-value of 0.004. After 24 hours, Group RM had an average VAS score of 3.0 (±1.3), whereas Group RD had a score of 1.8 (±0.9), 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.

Side effects observed in both groups were minimal and similar. In Group RM, 2 patients (6.7%) experienced nausea compared to 1 patient (3.3%) in Group RD, with a P-value of 0.55. Vomiting was reported in 1 patient (3.3%) in Group RM and none in Group RD, with a P-value of 0.31. Dizziness was observed in 3 patients (10%) in Group RM and 2 patients (6.7%) in Group RD, with a P-value of 0.64. Pruritus was not reported in Group RM but was noted in 1 patient (3.3%) in Group RD, with a P-value of 0.31. Both groups had 1 patient (3.3%) each reporting a headache, with a P-value of 1.0. Overall, the incidence of side effects did not differ significantly between the two groups, indicating that both treatments were similarly well-tolerated.

Table 1: Demographics profile.

Characteristic	Group RM (N=30)	Group RD (N=30)	P-Value
Age (years)	45.3 ± 12.5	46.1 ± 11.8	0.78
Gender (M/F)	16/14	15/15	0.81
ASA I/II	18/12	20/10	0.59

Table 2: Sensory and Motor Blockade Onset and Duration

PARAMETER	RM	RD	P value
Time taken to achieve sensory blockade (min)	13.27±2.07	4.35±0.856	0.001
Time taken to achieve motor blockade (min)	15.20±5.2	5.92±0.23	0.003
Duration of sensory blockade (min	436.21±67.99	1020.4±102.40	0.002
Duration of motor blockade (min)	366.62±23.1	960.0±106.74	0.005
Request of first analgesic (min)	451.71±132.27	1082.32+-112.50	0.002
Rescue analgesia as diclofenac sodium (mg)	100.82±15.28	76.25+-16.32	0.003

Table 3: Postoperative Pain (VAS Scores)

Time Postop (hours)	Group RM (N=30)	Group RD (N=30)	P-Value

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1	2.3 ± 1.1	1.5 ± 0.8	0.01
4	3.5 ± 1.4	2.0 ± 1.0	0.002
8	4.1 ± 1.6	2.8 ± 1.2	0.003
12	3.9 ± 1.5	2.7 ± 1.1	0.004
24	3.0 ± 1.3	1.8 ± 0.9	0.001

Table 4: Side Effects

Side Effect	Group RM (N=30)	Group RD (N=30)	P-Value
Nausea	2 (6.7%)	1 (3.3%)	0.55
Vomiting	1 (3.3%)	0 (0%)	0.31
Dizziness	3 (10%)	2 (6.7%)	0.64
Pruritus	0 (0%)	1 (3.3%)	0.31
Headache	1 (3.3%)	1 (3.3%)	1.0

DISCUSSION

The findings revealed that the initiation of both sensory and motor blockades was notably quicker in Group RD (getting dexamethasone) in comparison to Group RM (receiving magnesium sulfate). More precisely, the average time it took for sensory blocking to occur was 4.35 minutes in Group RD compared to 13.27 minutes in Group RM ($P < 0.001$). Group RD had a quicker onset of motor blockage, with a mean time of 5.92 minutes, compared to Group RM which had a mean time of 15.20 minutes ($P < 0.001$). The results of this study are consistent with prior research, such as the study conducted by Cummings et al. (2011), which also found that the addition of dexamethasone to local anesthetics in peripheral nerve blocks resulted in a quick beginning of action.[10]

Group RD had a considerably longer duration of both sensory and motor blockades. The duration of sensory blocking was much longer in Group RD, with an average of 1020.4 minutes, compared to Group RM, which had an average duration of 436.21 minutes ($P < 0.001$). The length of motor blockage exhibited a similar trend, with a duration of 960.0 minutes in Group RD compared to 366.62 minutes in Group RM ($P < 0.001$). The prolonged duration of analgesia with dexamethasone aligns with the results of Vieira et al. (2010), who observed that dexamethasone may lengthen the duration of analgesia in peripheral nerve blocks.[11]

Shukla U et al., (2020) discovered that dexmedetomidine had a faster initiation and more prolonged effect in comparison to those who received $MgSO_4$.[12] According to Nema N et al., the dexmedetomidine group had a faster onset of sensory block (7.20±2.483 min) compared to the control group (14.20±5.229 min). Additionally, the dexmedetomidine group had a faster onset of motor block (11.83±3.824 min) compared to the control group (21.00±8.566 min).[13] Multiple research, including those conducted by Kathuria S et al., Bharti N et al., and Das A et al., corroborate these results.[14-16] Each of these investigations discovered that the inclusion of dexmedetomidine to ropivacaine led to a prompt initiation of motor and sensory blockade during supraclavicular blockade. In the group administered with dexmedetomidine, the onset of sensory and motor blockage occurred sooner in comparison to the control group, which is consistent with the findings of the current investigation.[12-16] Esmaoglu A et al. conducted a research where they combined dexmedetomidine with levobupivacaine for axillary blockade. Their findings showed that this combination increased the duration of blockade and analgesia. These results are similar to the findings of the current study.[17] The researchers Das A et al. found that the duration of sensory and motor blockage in supraclavicular BPB was extended by adding 100 µg of dexmedetomidine to a 0.5% ropivacaine solution.[16]

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 1.5 in Group RD compared to 2.3 in Group RM ($P < 0.01$). After 24 hours, the average VAS score was 1.8 in Group RD and 3.0 in Group RM ($P < 0.001$). The decrease in postoperative pain in Group RD is supported by research such as Parrington et al. (2010), who also found improved postoperative pain relief with the use of dexamethasone.[18]

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 (10 patients) needed rescue analgesia compared to Group RM (18 patients), suggesting that dexamethasone has a superior analgesic profile.

Furthermore, a prior investigation indicated that the inclusion of dexmedetomidine or $MgSO_4$ to ropivacaine led to an extended period of pain relief after surgery.[14] In line with the current research, Das A et al., (2014) showed that the inclusion of dexmedetomidine decreased the need for further pain relief throughout the postoperative phase.[16] Consistent with these findings, Chinnappa J et al. discovered that the duration of sensory and motor block in supraclavicular block was extended when dexmedetomidine was added to ropivacaine in the dexmedetomidine group (630.6±208.2 and 545.9±224.0 min) compared to the ropivacaine group (400.8±86.6 and 346.9±76.9 min).[19] In addition, the

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duration of pain relief was shorter in the group that received ropivacaine (411.0±91.2 min) compared to the group that received dexmedetomidine (805.7±205.9 min). The research conducted by Mukherjee K et al. found that the group receiving magnesium needed a lower number of rescue analgesics.[20] In contrast, a research conducted by Bharti N et al. found that the group treated with dexmedetomidine needed significantly less rescue analgesics over the 24-hour postoperative period ($p < 0.0001$).[15]

The occurrence of adverse effects was modest and similar in both groups. Low and statistically insignificant incidences of nausea, vomiting, dizziness, pruritus, and headache were recorded in both groups. These findings indicate that the inclusion of magnesium sulfate or dexamethasone with ropivacaine did not substantially raise the likelihood of negative effects. This aligns with earlier research that demonstrates both additives have a positive safety record.

CONCLUSION

The use of dexamethasone in supraclavicular brachial plexus block extends the duration of both sensory and motor block, prolongs the time until the first use of analgesics, and reduces the overall amount of analgesics required. Dexamethasone may be used as an adjuvant with ropivacaine for upper limb complex fractures that need an extended surgical duration and for patients who necessitate postoperative monitoring and follow-up in hospital wards. The use of magnesium sulfate resulted in a shorter period of sensory and motor blockage compared to dexamethasone. As a result, patients in the magnesium sulphate group experienced quicker mobilization and were discharged sooner. Magnesium sulfate may be suggested as an adjuvant for brief operations such as the closed reduction and internal fixation of a simple hand fracture, as well as for k wire fixations, allowing for early release of the patient.

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