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Decreased Incidence of C_8, T_1 Dermatomal Sparing in Interscalene Block with the Use of Magnesium Sulphate as an Adjuvant: An Interesting Fact

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Abstract

Background: Interscalene brachial plexus block is usually associated with sparing of C_8, T_1 dermatomes and ulnar nerve. This study have compared the effect of adding magnesium sulphate with bupivacaine on the blockade of individual dermatomes in interscalene block. *Materials and Methods:* 60 patients were randomly divided into two Groups. Interscalene block was given to all the patients. Group 1 received 20 *ml* of 0.5% bupivacaine with 0.5 *ml* of 50% $MgSO_4$ (Total volume = 20.5 *ml*). Group 2 received 20 *ml* of 0.5% bupivacaine with 0.5 *ml* of normal saline (Total volume = 20.5 *ml*). Block was evaluated every 3 *minutes* till 15 *minutes* after the injection of local anesthetic or till minimum Grade 3 sensory and motor blockade was achieved. *Results:* In our study, the mean time of onset of sensory and motor blockade (achievement of minimum Grade 2 blockade) was comparable between the two Groups. The mean time of onset of complete sensory blockade (achievement of minimum Grade 3 sensory blockade) was also comparable between the two Groups ($p > 0.05$). Grade 3 sensory blockade to C_8 and T_1 dermatomes was achieved in 70% of patients ($n = 21$) in Group I and 23.3% of patients ($n = 7$) in Group II at 15 minutes and the difference was significant ($p = 0.001$). Grade 3 motor blockade (by Modified Bromage Scale) was achieved in 70% of patients ($n = 21$) in Group I and 23.3% of patients ($n = 7$) in Group II at 15 *minutes* which was statistically significant ($p = 0.001$). *Conclusion:* Magnesium sulphate as an adjuvant tobupivacaine in interscalene block decreases the incidence of C_8 and T_1 dermatomal sparing and increases the chances of complete motor blockade.

Keywords: Magnesium sulphate; Interscalene block; Dermatomal sparing; Ultrasound guided.

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Introduction

Interscalene brachial plexus block is used commonly for the surgeries involving the shoulder, proximal humerus as well as latral two third of clavicle.[1] In this technique, brachial plexus is blocked at the level of the nerve roots or trunks which lie between anterior scalene and middle scalene muscle.[2] Roots C_5–C_7 are most densely blocked with this approach, however, the ulnar nerve originating from C_8 and T_1 may be spared.[3,4] It may provide inadequate analgesia in the ulnar distribution which limits its usefulness for distal surgical procedures and may need supplementation during the surgery.[5,6]

In this study, we have used magnesium sulphate as an adjuvant to bupivacaine in ultrasound guided interscalene brachial plexus block. We have studied the blockade of individual dermatomes after giving

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interscalene block. We found out that the incidence of sparing of C_8, T_1 dermatomes is decreased when we used magnesium sulphate as an adjuvant to local anesthetic.

To the best of our knowledge, this is the first reported study which showed that addition of an adjuvant in interscalene block can decrease the incidence of dermatomal sparing of C_8, T_1. This can further improve its effectiveness in upper limb surgeries and will decrease the incidence of partial effect.

Materials and Methods

It was a prospective, randomized, double blinded study. 60 patients aged *20–60 years*, of either sex with ASA Grade I-II were scheduled for upper limb surgery. The patients were allocated to one of the two Groups using computer generated random number list. The investigator administering the drug and observing the effects was unaware of the drug injected. The drug was loaded in the syringes by a person not involved in administering the injections and in further evaluation of the patients and the drugs given were disclosed at end of the study. The study was commenced after obtaining institutional ethical committee approval and written informed patient consent. Patients were allocated in two Groups of 30 patients each by using computer generated random number list.

Preanesthetic evaluation and written informed consent was taken from the patients one day prior to the surgery. After routine fasting and premedication, patients were shifted to operation theatre. Standard monitors were attached and intravenous line was secured. Premedication with midazolam *2 mg* was given intravenously before procedure. Ultrasound guided, in plane interscalene brachial plexus block was given to all the patients. Group 1 received *20 ml* of 0.5% bupivacaine with *0.5 ml* of 50% magnesium sulphate (total volume = *20.5 ml*). Group 2 received *20 ml* of 0.5% bupivacaine with *0.5 ml* of normal saline (total volume = *20.5 ml*). Block was evaluated every *3 minutes* till *15 minutes* after the injection of local anesthetic or till minimum Grade 3 sensory and motor blockade was achieved. Motor blockade assessment was performed with modified bromage scale (Grade 1 - Able to raise the extended arm to *90 degrees* for a full two seconds, Grade 2 - Able to flex the elbow and move the fingers but unable to raise the extended arm, Grade 3 - Unable to flex the elbow but able to move the fingers, Grade 4 - Unable to move the arm, elbow or the fingers). Onset of motor blockade means minimum Grade 2 and complete blockade means minimum Grade 3.

Assessment of sensory block was done by using Hollmen's scale (Grade 1 - Normal sensation of pin prick, Grade 2 - Pin prick felt as sharp pointed but weaker compared with the same area in other extremity, Grade 3 - Pin prick felt as touch with blunt object, Grade 4 - No perception of pin prick). Onset of sensory blockade means minimum Grade 2 and complete blockade means minimum Grade 3. Sensory block assessment of sensory dermatomes was performed by pin prick method at specific test points: C_5 - Lateral Antecubital Fossa, C_6 - Thumb, C_7 - Middle Finger, C_8 - Little Finger, T_1 - Medial Antecubital Fossa.

After confirmation of Grade 3 of sensory and motor blockade or completion of *15 minutes*, patients were given general anesthesia with the standard drugs. Patients were extubated at the end of surgery and shifted to post anesthesia care unit. All the patients were observed intraoperatively and postoperatively.

Statistical Analysis

The data of the study was recorded in the record chart and results were evaluated using statistical tests (Student *t* - test and Chi-square test).

Results

Demographic data and baseline parameters were comparable between both the groups. In our study, the mean time of onset of sensory blockade (achievement of minimum Grade 2 by Hollmen's scale) was *6.56 ± 0.306 minutes* in Group I and *6.68 ± 0.280 minutes* in Group II ($p > 0.05$) which was comparable, (Table 1). The mean time of onset of complete sensory blockade (achievement of minimum Grade 3 sensory blockade) to C_5 and C_6 dermatomes was *10.87 ± 0.77 minutes* for Group I and *11.08 ± 0.46 minutes* for Group II and the difference was not statistically significant ($p > 0.05$). The mean time of onset of complete sensory blockade to C_7 dermatome was *13.28 ± 1.10 minutes* for Group I and *13.44 ± 0.70 minutes* for Group II, which was also statistically insignificant ($p > 0.05$). Grade 3 sensory blockade to C_8 and T_1 dermatomes was achieved in 70% of patients ($n = 21$) in Group I and 23.3% of patients ($n = 7$) in Group II at *15 minutes* ($p = 0.001$), (Table 3). Minimum time for onset of complete sensory blockade to C_8 and T_1 dermatomes was *13.99 ± 0.82 minutes* in 21 patients of Group I and *14.46 ± 0.34 minutes* for 7 patients of

Group II ($p > 0.05$), (Table 2). Only 28 out of total 60 patients (46.67% of patients) included in the study achieved Grade 3 sensory blockade within *15 minutes* for C_8 and T_1 dermatomes. Thus, there was sparing of C_8 and T_1 dermatomes for sensory blockade in 53.33% of patients at *15 minutes*, (Table 3). But the sparing was less in Group I in which magnesium sulphate was used as an adjuvant (30%) as compared to Group II (76.7%).

The mean time of onset of motor block (achievement of minimum Grade 2 by modified bromage scale) was *7.81 ± 0.291 minutes* in Group I as compared to *7.92 ± 0.289 minutes* in Group II ($p > 0.05$) and was comparable between the two Groups, (Table 1). Grade 3 motor blockade (by Modified Bromage Scale) was achieved in 70% of patients ($n = 21$) in Group I and 23.3% of patients ($n = 7$) in Group II at 15 minutes which was statistically significant ($p = 0.001$) (Table 4). So, minimum time of onset of complete motor blockade for 21 patients in Group I was *14.48 ± 0.65 minutes* and *14.82 ± 0.19 minutes* for 7 patients in Group II which was statistically insignificant ($p > 0.05$), (Table 1). Thus, only 28 patients out of 60 patients (46.67% of patients) achieved Grade 3 motor blockade within *15 minutes*.

Table 1: Comparison of block characteristics between the two groups

	Group I Mean ± SD	Group II Mean ± SD	*p* - value
Mean onset time for sensory block - Grade 2 *(in min)*	6.56 ± 0.306	6.68 ± 0.280	0.128
Mean onset time for motor block - Grade 2 *(in min)*	7.81 ± 0.291	7.92 ± 0.289	0.153
Mean completion time for motor block onset - Grade 3 *(in min)*	14.48 ± 0.65	14.82 ± 0.19	0.180

$p > 0.05$ = not significant, $p < 0.05$ = significant, $p < 0.00$ = highly significant.

Table 2: Comparison of completion of sensory blockade onset (Grade 3 by Hollmen's Scale) in different dermatomes (at *15 minutes*).

Dermatomes	Group	n	Mean completion time of sensory block onset (min) Mean ± SD (*Grade 3 by Hollmen's Scale*)	*p* - value
C_5	I	30	10.87 ± 0.77	0.209
	II	30	11.08 ± 0.46	
C_6	I	30	10.87 ± 0.77	0.209
	II	30	11.08 ± 0.46	
C_7	I	30	13.28 ± 1.10	0.520
	II	29	13.44 ± 0.70	
C_8	I	21	13.99 ± 0.82	0.152
	II	7	14.46 ± 0.34	
T_1	I	21	13.99 ± 0.82	0.152
	II	7	14.46 ± 0.34	

$p > 0.05$ = not significant, $p < 0.05$ = significant, $p < 0.00$ = highly significant.

Table 3: Comparison of Sensory block evaluation for quality of sensory block (at *15 minutes*) between the two groups.

Dermatomes (No %)	Group I		Group II		*p* - value
	Grade 2	Grade 3	Grade 2	Grade 3	
C_5	0	30 (100%)	0	30 (100%)	
C_6	0	30 (100%)	0	30 (100%)	
C_7	0	30 (100%)	2 (6.7%)	28 (93.3%)	0.49
C_8	9 (30%)	21 (70%)	23 (76.7%)	7 (23.3%)	0.001
T_1	9 (30%)	21 (70%)	23 (76.7%)	7 (23.3%)	0.001

$p > 0.05$ = not significant, $p < 0.05$ = significant, $p < 0.00$ = highly significant.

Table 4: Comparison of motor block evaluation for quality of motor block (at *15 minutes*) between the two groups.

	Group I		Group II		*p* - value
	Grade 2	Grade 3	Grade 2	Grade 3	
Modified Bromage Scale (No %)	9 (30%)	21 (70%)	23 (76.7%)	7 (23.3%)	0.001

$p > 0.05$ = not significant, $p < 0.05$ = significant, $p < 0.00$ = highly significant.

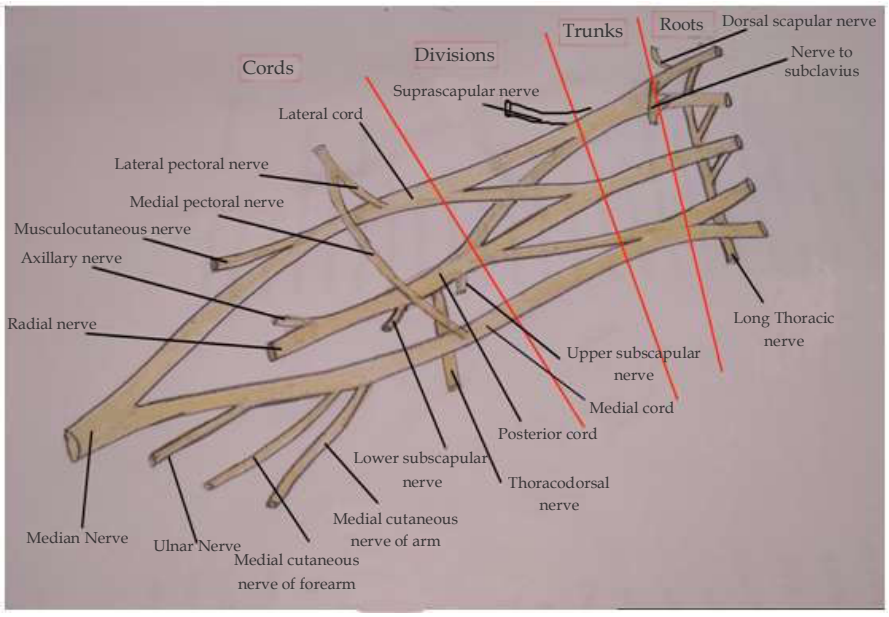

Fig. 1: Anatomy of Brachial Plexus

Discussion

The brachial plexus is a somatic nerve plexus which provides nerve supply to the upper extremity.[7] It originates from the anterior divisions of the lower 4 cervical spinal nerves (C_5–C_8) and the first thoracic spinal nerve (T_1). After coming out of the cervical and thoracic foramina, the nerve roots unite and branch in a well described pattern in the following order: Roots, trunks, divisions, cords, terminal branches and peripheral nerves, (Fig. 1).[7,8] The proximal shoulder girdle muscles receive innervation from the level of the roots, trunks and cords, whereas the terminal branches supply the arm onwards. The shoulder muscles are predominantly supplied by C_5 and C_6 spinal roots, while C_7 contributes to the elbow, wrist and finger extensors; C_8 and T_1 contribute to the long finger flexors and intrinsic muscles of the hand.[9]

In interscalene brachial plexus block, local anesthetic blocks at the level of nerve roots and trunks.[10] It provides anesthesia around the shoulder. But the high incidence of C_8 - T_1 and ulnar nerve sparing limits its effectiveness as sole anesthetic technique for upper limb surgeries.[6,10] We have used magnesium sulphate as an adjuvant to bupivacaine for interscalene block and found out that the incidence of dermatomal sparing is significantly less in the group receiving magnesium sulphate. Moreover, it also increases the incidence of complete motor block (Grade 3 modified bromade scale).

For many decades, magnesium salts have been used as an adjuvant to general anesthesia and in critical care.[11] Magnesium sulphate has been reported to be effective in perioperative pain treatment and in blunting somatic, autonomic and endocrine reflexes provoked by noxious stimuli.[12] Magnesium, by virtue of its NMDA receptor antagonist property, is being investigated by various routes for providing preemptive analgesia and also to prolong postoperative analgesia.[13] The NMDA receptors play an important role in central nociceptive transmission, modulation and sensitization of acute pain states. In addition to central location, NMDA receptors are found in the muscle and skin, knee joint, and play a role in sensory transmission of noxious signal. The mechanism of magnesium is by its direct action on the peripheral nerve by blocking the release of

excitatory neurotransmitter at the synaptic junction or by potentiating the effect of local anesthetic.[14] Magnesium has shown greater analgesic potential when added to local anesthetics in peripheral nerve blocks, and would appear to have analgesic benefit with minimal adverse effects.[15]

In our study, complete blockade (Grade 3 sensory blockade by Hollmen's Scale) to C_5 and C_6 dermatomes was achieved in 100% of patients in both groups at *15 minutes*. Whereas Grade 3 sensory blockade to C_7 dermatome was achieved in 100% of patients in Group I and 93.3% of patients in Group II at *15 minutes*. Grade 3 sensory blockade to C_8 and T_1 dermatomes was achieved in 70% of patients ($n = 21$) in Group I and 23.3% of patients ($n = 7$) in Group II at *15 minutes* and the difference was significant statistically. Thus, there was sparing of ulnar nerve (C_8 and T_1 dermatomes) in 53.33% of patients. Thus to avoid blockade failure by interscalene approach alone, we combined interscalene block with general anesthesia after *15 minutes*.

We could achieve 100% successful sensory blockade of C_5, C_6 and C_7 dermatomes at *15 minutes*. But for C_8 and T_1 dermatomes, sensory blockade failure was 30% in Group I and 76.7% in Group II at *15 minutes*. Similarly, Grade 3 motor blockade failure was 30% in Group I and 76.7% in Group II at *15 minutes*. Hence, addition of magnesium sulphate seems to have increased the incidence of complete sensory blockade for C_8 and T_1 dermatomes and complete motor blockade (Grade 3 modified bromage scale). It decreases the chances of dermatomal sparing with interscalene block.

The time to onset of sensory and motor block was comparable in our study ($p > 0.05$) which was similar to a studies done by Lee[16] and Famay *et al*.[17] Time of onset of sensory block was between *14* and *16 minutes* in these studies whereas it was *6–8 min* in our study for Grade 2 hollman and modified bromage scale. Onset of Grade 3 block in our study was also at *10–15 min* interval. Our results were not concurrent with those of Klein *et al*.[18] and Casati *et al*.[19] Klein *et al*. had reported shorter onset of less than *6 minutes* but they had used larger volume (*30 ml*) of the drugs with freshly prepared ephinephrine and used premedicants as midazolam (*1–5 mg*) with fentanyl (*50–250 micrgram*) in their patients.[18] Casati *et al*. reported longer onset of blocks (*22–28 minutes*) as they had not used ultrasound but had used nerve stimulators and their patients were not premedicated.[19] In these studies, they had only taken into account Grade 3 sensory blockade and blockade of individual dermatomal level was not mentioned.

In our study, we have checked for effect on individual dermatomes and found out that the chances of incomplete block can be decreased with if we use magnesium sulphate with local anesthetic in ultrasound guided interscalene brachial plexus block.

Conclusion

To conclude, the use of magnesium sulphate (*250 mg*) as an adjuvant to 0.5% bupivacaine in ultrasound guided interscalene brachial plexus block have increased the incidence of complete blockade in C_8 and T_1 dermatomes also. It decreases the incidence of dermatomal sparing and increases the chances of complete motor blockade with interscalene block.

Hence, we strongly recommend the addition of magnesium sulphate (*250 mg*) as an adjuvant to 0.5% bupivacaine in ultrasound guided interscalene brachial plexus block in view of better quality of blockade, decreased C_8 - T_1 dermatomal sparing and increased chances of complete motor blockade.

Limitation of study

In the present study, general anesthesia was given to all the patients after *15 minutes*. Hence, we could not elicit the sensory and motor blockade after *15 min*.

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