

EFFECT OF ADDING MAGNESIUM SULFATE TO BUPIVACAINE ON ULTRASOUND GUIDED INTERSCALENE NERVE BLOCK

By

**Ragab Asaad Hamdan Mahmoud, Anwar Mohamed Mostafa Al-
Hassanin and Amr Soliman Abd El-Maged Hamrosh**

Anesthesiology and Intensive Care Department, Faculty of Medicine, Al- Azhar University

ABSTRACT

Background: An effective pain therapy to block or modify the physiologic responses to stress has become an essential component of anesthesia for adequate postoperative pain relief.

Objective: This work is aimed to evaluate effect of adding magnesium sulfate to long acting local anesthetic as bupivacaine on ultra sound guided inter scalene nerve block undergoing elective upper limb surgery.

Patients and Methods: 60 Adult patients were included study and randomized into two equal groups; Magnesium Group received bupivacaine plus magnesium sulfate, and Saline Group received bupivacaine plus normal saline 2 ml. [The demographic data (age, sex, height, weight and ASA scoring) showed no statistical significance between 2 groups]. The time taken to stimulate the brachial plexus and the onset of block were recorded. The regain of sensation and motor power were checked at regular intervals. Patient and surgeon satisfaction were questioned. The study was conducted in Al-Azhar University Hospitals (Al-Hussein and Bab-Shaarya), from December 2019 till June 2020.

Results: The duration of sensory and motor block, magnesium group was statistically significant compared to saline group [Mean and (standard deviation 789(135), 788(120) minvs710 (150), 720 (135) min, P= 0.038 vs. 0.042 respectively]. Patient satisfaction was statistically significant in favor to the magnesium group. On the other hand, there was no significant difference in surgeon satisfaction between both groups.

Conclusion: The addition of magnesium sulfate to a bupivacaine for interscalene nerve block prolongs the duration of analgesia and reduces postoperative pain.

Keywords: Magnesium Sulfate, Bupivacaine, U/S Guided Interscalene Nerve Block.

INTRODUCTION

An ever increasing demand for regional anesthesia from patients and surgeons matches the growing realization that regional anesthesia can provide superior pain management and perhaps improve patient outcomes to meet evolving expectations for ambulatory, cost-effective surgery (*Jee et al., 2013*).

Aging population presents with an increasing range of co-morbidities, demanding a wider choice of surgical

anesthetic options including the use of a variety of regional techniques in conjugation with general anesthesia to optimize clinical care, while at the same time reducing the risks of complications. Thus, the practice of regional anesthesia remains an art for many practitioners and consistent success with these techniques often appears to be limited to anesthesiologists who are regional anesthesia enthusiasts (*Gupta et al., 2013*).

With modern anesthetic techniques, recovery after surgery can be rapid, smooth and complete. However, in many day-case patients, regional anesthetic techniques might be preferable. Regional anesthesia can reduce or avoid the hazards and discomfort of general anesthesia including sore throat, airway trauma, and muscle pain, but it also offers a number of advantages to outpatients undergoing surgery. These techniques provide analgesia without sedation, prolonged postoperative analgesia and allow earlier patient's discharge. Regional anesthesia reduces the requirements of opioids, reducing the incidence of postoperative nausea and vomiting. It can be used alone, in combination with sedation or as a part of balanced analgesia with general anesthesia (*Stewart et al., 2012*).

The ideal in the practice of regional anesthesia would be the ability to precisely deliver to the target nerve exactly the right dose of local anesthetic without incurring any risk of damage to the nerve or its related structures taking in consideration that nerves are not blocked by the needle but by the local anesthetic around. The introduction around 30 years ago of electric stimulation (ES) as an objective means for identifying needle-nerve proximity was an integral step towards transforming regional anesthesia into a 'science' (*Griffin and Nicholls, 2010*).

Interscalene brachial plexus block (ISBPB) is indicated for anesthetic and analgesic purposes for shoulder and upper arm surgeries. The technique was modified and used a more cranial puncture site with a more tangential orientation of the needle (*Marhofer et al., 2011*).

Different technical modalities are used for identifying and locating the brachial plexus in the interscalene area. Conventional methods include electric stimulation and patient-reported paresthesia which rely on surface landmark identification in a semi-blind manner (*Gupta et al., 2013*).

Ultrasound guidance has improved the success and decreased the complication rate in regional anesthesia in general. The use of two-dimensional ultrasonic imaging to localize the brachial plexus has been highly successful in several approaches. Modern ultrasound machines are capable of imaging individual roots to their cords in the infraclavicular region. The sonographic image can be used to guide the injection needle while minimizing the risk of injury of adjacent structures (*Cullen and Ferguson, 2012*).

The use of Ultrasound for nerve blocks was first reported by *Griffin and Nicholls*. (2010) that performed supraclavicular. Brachial plexus block with the help of a Doppler US blood-flow detector to aid identification of the subclavian artery and vein.

Sheppard and colleagues in 1998, while not specifically describing ultrasound for nerve blocks, evaluated the ability of ultrasound to visualize components of the brachial plexus.

Most of the studies of ultrasound guidance in regional anesthetic practice have looked at one or more of the various approaches to the brachial plexus, some using ultrasound to identify and mark the skin over blood vessels and others using it to guide the needle or catheter to the nerve (*Marhofer et al., 2011*).

The aim of the study was to evaluate the effect of adding magnesium sulfate to long acting local anesthetic as bupivacaine on U/S guided Inter scalene nerve block for anesthesia, prolongation the duration of analgesia and improving the analgesia Quality.

PATIENTS AND METHODS

A prospective, randomized controlled clinical trial was conducted in Al-Azhar University Hospitals. It included 60 patients aged (18 to 60 years) undergoing scheduled for upper limb injury repair. A written informed consent was obtained from every patient after explaining the procedure.

Patients were divided into 2 equal groups receiving different anesthetic techniques.

Magnesium Group received 0.5% bupivacaine 20 mL (1: 200,000 epinephrines) plus 10% magnesium sulphate 2 mL, and saline Group received 0.5% bupivacaine 20 mL (1: 200,000 epinephrine) plus normal saline 2 mL. All local anesthetic solutions were prepared immediately before administration upon arrival in the preoperative regional block room, standard monitoring was applied and patients received midazolam 0.02 mg/kg IV before the procedure.

The time corresponding to the end of local anesthetic administration was recorded as the baseline for the time interval. All of the interscalene nerve blocks were performed by a single anesthesiologist who was experienced in this technique and blinded to group allocation.

The study data was recorded and patients were evaluated every minute until 30 min after the end of local anesthetic injection by the anesthesiologist who performed the interscalene nerve block and blinded to group allocation.

Sensory block was assessed by pinprick test using a three-point scale in the C4 and C5 sensory dermatome distribution and compared with the contralateral arm as a reference: 0 = normal sensation; 1 = loss of sensation of pinprick (analgesia); and 2 = loss of sensation of touch (anesthesia).

After surgery, patients were evaluated every ten minutes until complete resolution of sensory and motor blockade. The duration of sensory block was defined as the time interval between the end of local anesthetic administration and restoration of normal sensation (i.e., sensory score 0 compared with the contralateral arm as a reference).

The duration of motor block was defined as the time interval between the end of local anesthetic administration and the recovery of complete motor function. Block success was defined as loss of sensation to pinprick (sensory score C1) in the C4 and C5 sensory dermatome distributions measured 30 min after the end of local anesthetic injection.

Inclusion criteria:

- Age: between 18-60 years of age.
- Undergoing Upper limb injury repair.
- Patients of ASA I-II.

Exclusion criteria:

A history of cardiac, hepatic, or renal disease; chronic treatment with calcium channel blocker; hypomagnesaemia;

contraindications to interscalene nerve block (bleeding disorders local or systemic infection); and inability to comprehend the numeric rating scale (NRS) for pain assessment.

Statistical Analysis:

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23.Armonk, NY; IBM Corp. Numerical data will be explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smimov and Shapiro-Wilk tests). The quantitative data were presented as mean, standard

deviations, Median and ranges when data found parametric. Also qualitative variables were presented as number and percentages. The comparisons between groups with qualitative data were done by using Chi-square test. The comparison between two groups with quantitative data and parametric distribution were done by using Independent t-test. For non-parametric data, Mann Whitney U Test will be used to compare between the two groups. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as when $P \leq 0.05$

RESULTS

The demographic data (sex, age, height, weight, ASA) showed no statistical significance between groups; as

the p-value were (0.194, 0.410, 0.193, 0.392 and 0.713 respectively) **Table (1)**.

Table (1): Comparison between groups as regard demographic data

Demographic data		Groups	Bupivacaine +Saline	Bupivacaine +Mg	Test value	p-value
			No. = 30	No. = 30		
Sex	Female		14 (46.7%)	19 (63.3%)	1.684*	0.194
	Male		16 (53.3%)	11 (36.7%)		
Age (years)	Mean±SD		59.07 ± 11.98	56.20±14.65	0.831•	0.410
	Range		20.0 - 82.0	28.0-75.0		
Height (cm)	Mean±SD		169.70±11.95	173.53±10.55	1.316•	0.193
	Range		150.0-186.0	160.0-190.0		
Weight	Mean±SD		80.57±13.70	77.73±11.70	-0.863•	0.392
	Range		60.0-120.0	68.0-108.0		
ASA	I		13 (43.3%)	15 (50.0%)	0.676*	0.713
	II		15 (50.0%)	12 (40.0%)		

There was a statistically significant difference higher mean in Bupivacaine plus saline compared to Bupivacaine plus

Mg according to onset of sensory block (min), P-value 0.037 (**Table 2**).

Table (2): Onset of sensory block

Onset of sensory block (min)	Groups	Bupivacaine +Saline	Bupivacaine +Mg	Test value	p-value
		No. = 30	No. = 30		
Mean±SD		4.25 ± 1.98	3.27 ± 1.45	2.187	0.037
Median(IQR)		4(2)	3(2)		
Range		0 – 7	1 – 6		

A statistically significant higher mean in Bupivacaine plus saline compared to Bupivacaine plus Mg according to onset

of motor block (min), with P-value 0.029 (Table 3).

Table (3): Onset of motor block

Onset of motor block (min)	Groups	Bupivacaine +Saline	Bupivacaine +Mg	Test value	p-value
		No. = 30	No. = 30		
Mean±SD		7.20 ± 2.4	5.8 ± 2.7	2.552	0.029
Median (IQR)		7 (2)	6 (3)		
Range		1 – 8	3 – 10		

The block was considered a failure if it required supplementations with local anesthetic infiltration, intravenous opioids, or administration of general anesthetics. The block was complete and successful in 15 patients in Bupivacaine saline group (50%) and 23 patients in Bupivacaine Mg group (76.3%), with total of 63.15%. Supplementary analgesia needed for 10 patients in Bupivacaine

saline group (33.3%) and 6 patients for Bupivacaine Mg group (20%), with total of 26.6%. Another attempt or technique was needed for 5 patients in Bupivacaine saline group (16.7%) and 1 patient in Bupivacaine Mg group (3.3%), with total of 9.8%. This showed statistical significance as the P value was 0.041 (Table 4).

Table (4): Success or failure of the block

Block success	Groups	Bupivacaine +Saline		Bupivacaine +Mg		Total	
		No.	%	No.	%	No.	%
0		0	0.0%	0	0.0%	0	0.0%
1		15	50.0%	23	76.7%	38	63.3%
2		10	33.3%	6	20.0%	16	26.7%
3		5	16.7%	1	3.3%	6	10.0%
Total		30	100	30	100	60	100
Chi-square test				6.410			
P-value				0.041			

Time to sensory regression was confirmed by regaining sensory response to pin prick test. This showed statistical

significance as the P value was 0.038 (Table 5).

Table (5): Duration of the sensory block

Duration of the sensory block (min)	Groups	Bupivacaine +Saline	Bupivacaine +Mg	Test value	p-value
		No. = 30	No. = 30		
Mean±SD		710.70 ± 150.70	789.30 ± 135.60	2.124	0.038
Range		483 – 961	511 – 1093		

Time to motor regression was confirmed by regaining of the ability to move relevant muscles upon verbal

command. This showed statistical significance as the P value is 0.042 (**Table 6**).

Table (6): Duration of the motor block

Duration of the motor block (min)	Groups	Bupivacaine +Saline	Bupivacaine +Mg	Test value	p-value
		No. = 30	No. = 30		
Mean±SD		720.11 ±135.30	788.94 ± 120.40	2.082	0.042
Range		479 – 957	510 – 1088		

No complications happened in 24 patients in Bupivacaine plus saline group (80%), and 26 patients in Bupivacaine plus Mg group (86.7%) with total percentage of 83.3%. Recurrent laryngeal nerve palsy (hoarsness of voice occurred in 1 patient in Bupivacaine plus saline group (3.3%) and never occurred in Bupivacaine plus saline group. Horner syndrome (ptosis, miosis, anhydrosis) due to accidental cervical plexus block occurred in 2patients in Bupivacaine plus saline group (6.7%) and in only 1 patient in Bupivacaine plus Mg group (3.3%)

with total of 5%. paresthesia didn't occur in Bupivacaine plus saline group while it happened in 2 cases in Bupivacaine plus Mg group (6.7%) with total of 3.3%. bloody tap occurred in 1 patients in Bupivacaine plus saline group (3.3%) and didn't happen in Bupivacaine plus Mg group . phrenic nerve stimulation occurred in 2 cases in Bupivacaine plus saline group (6.7%) and in 1 case only in Bupivacaine plus Mg group (3.3%). This showed no statistical significance as the P value was 0.448 (**Table 7**).

Table (7): Occurrence of complications.

Complications	Groups		Bupivacaine +Mg		Total	
	Bupivacaine +Saline		No.	%	No.	%
No complications	24	80.0%	26	86.7%	50	83.3%
Recurrent laryngeal nerve palsy	1	3.3%	0	0.0%	1	1.7%
Horner Syndrome	2	6.7%	1	3.3%	3	5.0%
Paraesthesia	0	0.0%	2	6.7%	2	3.3%
Bloody Tap	1	3.3%	0	0.0%	1	1.7%
Phrenic nerve block	2	6.7%	1	3.3%	3	5.0%
Total	30	100.0%	30	100.0%	60	100.0%
Chi-square test	4.747					
P-value	0.448					

There was a statistically significant higher mean in Bupivacaine plus Mg compared to Bupivacaine plus saline

according to Patient satisfaction, with P-value 0.043 (Table 8).

Table (8): Patient's satisfaction

Patient's satisfaction \ Groups	Bupivacaine +Saline		Bupivacaine +Mg		Test value	p-value
	No.	%	No.	%		
1	9	30.0%	2	6.7%	8.125	0.043
2	5	16.7%	2	6.7%		
4	6	20.0%	10	33.3%		
5	10	33.3%	16	53.3%		

DISCUSSION

Successful peripheral nerve and plexus blockade can provide an excellent anesthetic outcome, either when used alone, or in combination with general anesthesia. In either setting there is the possibility of prolonged post-operative analgesia. When PNB is used as the sole anesthetic technique, additional advantages may be present from the avoidance of general anesthesia complications, such as post-operative nausea and vomiting and cognitive dysfunction. PNB may also result in earlier hospital discharge (*Chandrakantan and Glass, 2011*).

It is helpful to consider what features an ideal peripheral nerve block technique should offer; an ideal peripheral nerve block technique should be safe, successful, easy, acceptable to patients, and economical.

Magnesium is a competitive N-methyl-D-aspartate receptor - receptor antagonist and inhibits the voltage dependent ion channels. In addition, it seems that magnesium sulfate increases the length of the block in intravenous regional anesthesia (*Mirkheshti et al., 2012*).

Therefore, improving the quality of local anesthetics in regional and local blocks as well as the management of postoperative acute pain is important for patients who suffer from the pain after surgery such as upper limb injury surgery.

This study investigated the effects of adding magnesium sulfate with 0.5% bupivacaine in inter scalene brachial plexus blocks to prolong the duration of sensory and motor blockage and diminish postoperative acute pain for the patient.

In this study, the mean duration of the sensory and motor blocks in the 0.5% bupivacaine plus magnesium Group was significantly longer than in the 0.5% bupivacaine plus normal saline. We also assessed the onset of the sensory and motor blocks between the two groups.

The onset time of sensory block, i.e. the time from when the injection was completed and the first symptoms of anesthesia in the limb were established, was significantly shorter for the 0.5% bupivacaine plus magnesium group than for the control group who received 0.5% bupivacaine plus normal saline group.

In another study conducted by *Radwan et al. (2012)*, intra-articular injections of

bupivacaine with magnesium resulted in longer periods of analgesia (duration) when compared with the control group that received 0.5% bupivacaine plus normal saline.

Similar study conducted by *Sonali et al. (2012)* reported that the addition of magnesium increased the duration time of an epidural analgesia. *Wahba and Tammam (2014)* investigated the effect of magnesium in intravenous regional anesthesia and reported that the onset of sensory and motor analgesia was faster in the magnesium group than in the saline group.

CONCLUSION

The additions of magnesium sulphate to a bupivacaine for interscalene nerve block prolongs the duration of analgesia, improve quality of analgesia and reduces postoperative pain.

REFERENCES

- Chandrakantan A and Glass PS (2011):** Multimodal therapies for postoperative nausea and vomiting, and pain. *British Journal of Anaesthesia*, 107(1):i27-40.
- Cullen A and Ferguson A. (2012):** Perioperative management of the severely obese patient: a selective pathophysiological review. *Canadian Journal of Anesthesia/Journal canadien d' anesthésie*, 59(10):974-96.
- Griffin J and Nicholls B (2010):** Ultrasound in regional anaesthesia. *Anaesthesia*, 65:1-2.
- Gupta RK, Lane J, Allen B and Shi Y and Schildcrout JS (2013):** Improving needle visualization by novice residents during an in-plane ultrasound nerve block simulation using an in-plane multi angle needle guide. *Pain Medicine*, 14(10):1600-7.
- Jee H, Lee JH, Kim J, Park KD, Lee WY and Park Y (2013):** Ultrasound-guided selective nerve root block versus fluoroscopy-guided trans foraminal block for the treatment of radicular pain in the lower cervical spine: a randomized, blinded, controlled study. *Skeletal Radiology*, 42(1):69-78.
- Marhofer P, Harrop-Griffiths W, Willschke H and Kirchmair L (2011):** Fifteen years of ultrasound guidance in regional anaesthesia: Part 2—recent developments in block techniques. *British Journal of Anaesthesia*, 104(6):673-83.
- Mirkheshti, A., Aryani, M. R., Shojaei, P. and Dabbagh, A. (2012):** The effect of adding magnesium sulfate to lidocaine compared with paracetamol in prevention of acute pain in hand surgery patients under intravenous regional anesthesia (IVRA). *International Journal of Preventive Medicine*, 3(9):616.
- Radwan Y. A., Al feky A.A. and Faramawi M. F. (2012):** Intra articular injection of magnesium sulphate and / or bupivacaine for post-operative analgesia after arthroscopic knee surgery. *Anesth Analg*, 106(5):1548-52.
- Sonali B, Sujata S, Mridula P, Rakesh G and Rajesh S (2012):** Evaluation of single epidural bolus dose of magnesium as an adjuvant to epidural fentanyl for postoperative analgesia: A prospective, randomized, double-blind study. *Saudi J Anaeth.*,(3):273-8.
- Stewart DW, Ragg PG, Sheppard S and Chalkiadis GA (2012):** The severity and duration of postoperative pain and analgesia requirements in children after tonsillectomy, orchidopexy, or inguinal hernia repair. *Pediatric Anesthesia*, 22(2):136-43.
- Wahba, S. S., and Tammam, T. F. (2014):** Intravenous regional anesthesia: effect of magnesium using two different routes of administration. *Ain-Shams Journal of Anaesthesiology*, 7(1), 65.

تأثير إضافة الماغنسيوم سلفات إلى البيوبافكين أثناء عملية
حصر العصب داخل عضلة سكاليني باستخدام السونار
رجب أسعد حمدان محمود، أنور محمد مصطفى الحسانين، عمرو سليمان عبد المجيد
حمروش

قسم التخدير والرعاية المركزة، كلية الطب، جامعة الأزهر

خلفية البحث: فى السنوات الأخيرة زاد الوعى بأهمية تخفيف الألم بعد العمليات الجراحية، وتم إستحداث طرق عديدة لذلك حيث أصبح علاج آلام بعد العمليات الجراحية من أجل منع أو تعديل الاتجاهات الفسيولوجية للاجهاد والضغط العصبى عنصرا أساسيا فى علم التخدير.

الهدف من البحث: تقييم تأثير إضافة كبريتات الماغنسيوم إلى المخدر موضعي ببوبيفاكين اثناء تخدير الضفيرة العضدية مقارنة بإضافة المحلول الملحي فقط الي البيوبيفاكين في تخدير عمليات الطرف العلوى من حيث إطالة وتحسين جودة مدة التسكين.

المرضى وطرق البحث: وقد تم إجراء هذه البحث في مستشفيات جامعة الأزهر في الفترة من ديسمبر 2019 إلى يونيو 2020 بعد الموافقة على بروتوكول الدراسة من قبل اللجان العلمية والأخلاقية بقسم التخدير وجامعة الأزهر، وتم اختيار ستون من المرضى المقرر لهم الإجراء الاختياري للعمليات الجراحية للطرف العلوى. وتم توزيع المرضى عشوائياً إلى مجموعتين متساويتين تلقت المجموعة (أ) البيوبيفاكين مع الماغنسيوم سلفات، وتلقت المجموعة (ب) البيوبيفاكين مع المحلول الملحي العادي. وقد تم مراقبة العلامات الحيوية للمرضى وبداية حدوث التسكين الحسي والعضلي ومدة تسكين الألم، كما تم رصد أي مضاعفات ما بعد الجراحة وتسجيلها، وأخيرا درجة رضى المريض والجراح عن هذه الدراسة وتم تسجيل النتائج وتحليلها إحصائياً.

نتائج البحث: بداية حدوث التسكين الحسي والعضلي أقصر بكثير لمجموعة الماغنيسيوم، وكان هناك فرق يعتد به إحصائياً بين المجموعتين حيث كانت مجموعة الماغنيسيوم أطول في مدة تسكين الألم عن المجموعة الأخرى. وأما عن حدوث المضاعفات فكانت على النحو التالي: شلل العصب الحنجري الراجع حدث في المجموعة (أ) ولم يحدث في المجموعة (ب). متلازمة هورنر وتخدير العصب الحجابي حدث كل منهما في حالتين في المجموعة (أ) وحالة واحدة في المجموعة (ب), وأخيراً كان إرضاء المرضى ذات دلالة إحصائية لصالح مجموعة الماغنيسيوم ولم يكن هناك فرق كبير في رضا الجراح بين المجموعتين.

الاستنتاج: إضافة الماغنيسيوم إلى البيوبيفاكين أفضل من إضافة المحلول الملحي فقط إلى البيوبيفاكين بعد جراحة إصلاح إصابة الطرف العلوي مثل عمليات مناظير الكتف. ويساعد هذا الأسلوب في التخدير لأنه يؤدي إلى إطالة وتحسين جودة مدة التسكين.