

# Role Of Magnesium Sulphate For Brachial Plexus Analgesia

P Goyal, R Jaiswal, S Hooda, R Goyal, J Lal

## Citation

P Goyal, R Jaiswal, S Hooda, R Goyal, J Lal. *Role Of Magnesium Sulphate For Brachial Plexus Analgesia*. The Internet Journal of Anesthesiology. 2008 Volume 21 Number 1.

## Abstract

**BACKGROUND AND OBJECTIVE:** Aims of the study was to evaluate two different doses of magnesium sulphate as a sole analgesic for brachial plexus analgesia and to compare it with diclofenac sodium given intramuscularly. **METHODS:** Ninety patients in age group of 20-60 years of either sex belonging to American Society of Anesthesiologists (ASA) physical status I or II scheduled for upper limb surgery were included in the study. Patients were randomly allocated to one of three groups. Each patient received study drug just before extubation. Morphine was given through PCA pump for rescue analgesia. Group 1 (n=30) Patients received 20 ml of 0.5% magnesium sulphate (MagNeon) given in axillary sheath. Group II (n=30) Patients received 20ml of 1.0 % magnesium sulphate (MagNeon) given in axillary sheath. Group III (n=30) Patients received intramuscular diclofenac sodium 1mgkg<sup>-1</sup>. **RESULTS:** Duration of pain relief was longer in group II (193.83±294.11 min) than other groups (85.33±144.38 and 21.66±58.72 minutes in groups I and III respectively) (p<.05). Morphine consumption in group-II was 16.97±6.61 mg where as in group-I & III were 24.17±7.52 mg and 28.97±11.65 mg. (p<.05). **CONCLUSION:** We conclude that, for the first time magnesium was used independently in a small dose in axillary sheath which results in good analgesia as determined by decreased uses of rescue analgesia without producing any major side effects.

Financial Support From PT B.D.S PGIMS ROHTAK

## INTRODUCTION

Pain is an unpleasant sensation that originates from ongoing and impending tissue damage. Acute pain accompanies almost all surgical procedures. For patients undergoing surgery, postoperative pain is an anticipated and often feared consequence. Prior painful experiences are known predictor of increased pain and analgesia use in subsequent surgery. Moreover even low levels of residual pain are associated with decreased physical and social function as well as decreased overall health. <sub>1</sub>

Postoperative pain is known to impede recovery from surgery and severe pain inhibits movement, an important consideration in limb operations. It can affect all organ systems. In respiratory system, this can result in decreased respiratory rate, potentially leading to poor oxygen saturation of vitals organs, pulmonary collapse and pneumonia. Cardiovascular effects include an increased heart rate, stroke volume, myocardial oxygen consumption and peripheral vascular resistance. In gastrointestinal system, it can result in decreased gastric emptying, reduced gut

motility and constipation. Genitourinary effects include urinary retention. Neuroendocrinal changes can be hyperglycemia, protein catabolism and sodium retention. Reduced mobility, pressure sores and increased risk of deep vein thrombosis (DVT) can occur as musculoskeletal effects while psychological effects include anxiety and fatigue. All of these effects may potentially leads to serious complications such as DVT, pulmonary embolus, respiratory failure and even myocardial infarction. <sub>2</sub>

The goal of postoperative pain relief is to achieve optimal analgesia, facilitating a quick return to normal psychological function. <sub>1</sub>

Postoperative pain management relies heavily on pharmacological interventions administered in response to patient's demands. Traditionally intramuscular, intravenous or epidural injections of opioids, local anesthetics or non steroidal anti-inflammatory drugs (NSAIDS) are in practice. Various drugs have been used alone or in combination for pain management and are inevitably associated with side effects. For the treatment of postoperative pain, the conventional therapy of providing intermittent doses of

analgesics in response to patient's demand is often not sufficient. Hence consistent delivery of effective postoperative pain control still remains a challenge. <sup>3</sup>

In patients undergoing elective or emergency surgery on the upper extremity, axillary approach can be used for continuous postoperative analgesia by putting a catheter inside axillary sheath and giving dilute solutions of local anesthetic through that catheter. <sup>4</sup> In an attempt to prolong the duration of sensory and motor block, a variety of agents (verapamil, opioids and tramadol, midazolam, neostigmine, etc.) with different mechanisms of action have been administered concomitantly with local anaesthetics. <sup>56789</sup>

Research continues concerning the different techniques and drugs that could prolong the duration of regional anaesthesia and postoperative pain relief. Recent studies suggest the role of magnesium sulphate as an adjuvant to local anaesthetics in spinal anaesthesia. <sup>10</sup> Magnesium sulphate has been used in axillary sheath as an adjuvant along with local anesthetic to prolong its effect. <sup>11</sup>

However none of these studies evaluates the effect of single bolus dose of magnesium sulphate without local anaesthetics as a sole agent for peripheral nerve analgesia. So the present study was designed to evaluate the independent role of magnesium sulphate when given in perineural space.

### METHODS

After institutional approval and informed consent, Ninety patients in age group of 20-60 years of either sex belonging to American Society of Anesthesiologists (ASA) physical status I or II scheduled for upper limb surgery were included in the study. Patients were randomly allocated to one of three groups. Each patient received study drug just before extubation. Patients with history of following disorders like Central nervous system disorders, Neuropathy, Hypersensitivity to local anaesthetics, Coagulopathy, Infection at local site, Shoulder surgery, Shoulder surgery and BMI>25 were excluded in this randomized double blind controlled study.

Group 1(n= 30) Patients received 20 ml of 0.5% magnesium sulphate (MagNeon) given in axillary sheath. Group 2(n=30) Patients received 20ml of 1.0 % magnesium sulphate (MagNeon) given in axillary sheath. Group 3(n=30) Patients received intramuscular diclofenac sodium 1mgkg<sup>-1</sup>.

After assessing the patient for anaesthesia, informed consent was obtained in all patients. Patients were kept fasting for

six hours prior to surgery and received tab alprazolam 0.25mg two hours before surgery with a sip of water. Visual analogue scale (VAS) and patient controlled analgesia pump (PCA) were explained to them. <sup>1213</sup>

In the operation theatre standard monitors were attached to the patient and intravenous cannulation was done. Basal heart rate, systolic and diastolic blood pressure and peripheral arterial oxygen saturation was recorded. Patients were operated under general anaesthesia and 1.0 mg kg<sup>-1</sup> tramadol was given for analgesia. Just before extubation study drug was given as per group protocol. In recovery room PCA pump was connected to all study group patients. VAS score was noted when patient first complains of pain. Then patients received bolus dose of morphine 1.5mg through PCA pump and received the same dose themselves on return of pain with lockout interval of 10min and maximum of 30mg in 4 hours. No background infusion was started through PCA pump. Patients were observed for 24 hours in recovery room and total consumption of morphine was calculated in all the groups and any adverse effect of morphine or otherwise was noted and managed.

In group I&II, with the patient lying in supine position, the arm was abducted to 90 degrees, externally rotated and flexed at elbow. A pillow below arm was used to ensure that the arm was in a relaxed position. The axilla was prepared using betadine and spirit and draped. Axillary artery palpated with a finger on it as high in the axilla as possible. A skin wheal was raised superficial to artery with 2% lignocaine. A needle was advanced slowly from the medial side of the artery at about 30 degree to the skin through the wheal toward the side of the artery. The needle entered the sheath which may be felt as a click, correct placement in the sheath was confirmed if the needle gently pulsates indicating close proximity to the artery. Aspiration was done to exclude intravascular placement of the needle and then 10ml of study drug was injected. During the injection aspiration was done again to ensure that the needle has not changed position and entered a vessel. Similarly second needle was entered lateral to the artery and rest half of the study drug i.e. 10ml was injected. Firm pressure was placed over the sheath below the point of injection to encourage upward spread of local anaesthetic towards the axilla. <sup>14</sup> Group III patients received intramuscular diclofenac sodium 1mgkg<sup>-1</sup>. Study drug was prepared by an anesthesiologist not involved in performing brachial plexus block and data collection. The anesthetist who performed the block was blinded to the treatment group.

Data thus collected was compiled and analyzed using ANOVA (for demographic profile of patients and duration of surgery), unpaired t-test (for duration of pain relief and morphine consumption) and Chi-square test for sex distribution & side effects. A ‘p’ value of <0.05 considered significant, <0.001 considered highly significant and >0.05 was taken insignificant.

**RESULTS**

Ninety adult patients of age 20-60 years (30 in each group) scheduled for upper limb surgery under general anaesthesia were included in the study. The groups did not differ in age weight or sex (Table 1). The duration of surgery in all the groups was found to be comparable.

**Figure 1**

Table 1: Clinical characteristics of the patients

	Group 1	Group II	Group III
Age(Yrs)	40.73±10.06	37.53±10.96	37.73±10.44
Gender(M/F)	26/4	25/5	26/4
Weight(Kg)	62.23±6.26	64.03±5.95	63.1±3.97

Note Values are mean±SD

Duration of pain relief in group- I was 85.33±144.38 min. where as in group-III was 21.66±58.72 min. When using unpaired t-test, duration of pain relief in both these groups was statistically significant.

Duration of pain relief in group- II was 193.83±294.11 min. where as in group-III was 21.66±58.72 min. When using unpaired t-test, duration of pain relief in both these groups was statistically significant.

Duration of pain relief in group-I was 85.33±144.38 min. where as in group-II was 193.83±294.11 min. When using unpaired t-test, duration of pain relief in both these groups was statistically insignificant.

Morphine consumption in group-I was 24.17±7.52 mg where as in group-III was 28.97±11.65 mg. When using unpaired t-test, morphine consumption in both these groups was statistically insignificant.

Morphine consumption in group-II was 16.97±6.61 mg where as in group-III was 28.97±11.65 mg. When using unpaired t-test morphine consumption in both these groups was statistically highly significant.

Morphine consumption in group-I was 24.17±7.52 mg where as in group-II was 16.97±6.61 mg. When using unpaired t-test, morphine consumption in both these groups was statistically highly significant (Table 2).

**Figure 2**

Table 2: The mean duration of surgery, pain relief and morphine consumption

	Group 1	Group II	Group III
Duration of surgery(min)	111±19.93	112.5±18.60	111.5±17.28
Duration of Pain relief (min)	85.33±144.38	193.83±294.11	21.66±58.72
Morphine Consumption (mg)	24.17±7.52	16.97±6.61	28.97±11.65

Note Values are mean±SD

Nausea percentage in study groups I&II were 36.6% &20% respectively as compared to 73.3% in control group. Sedation was observed in 0% of patients in study groups as compared to 10% of patients in control group. This showed that percentage of patients developing side effects like nausea and sedation was more in control group than study groups. There was difference among percentage of patients having nausea among different study groups and using chi-square test, the difference was highly statistically significant. It may be due to more consumption of morphine in control group than study group.

**DISCUSSION**

Our results showed that duration of pain relief in magnesium groups were better than control group and duration of pain relief with 200mg was better than 100mg of magnesium sulphate and also morphine consumption was less in both study drugs than control group.

None of our patients showed any neurological deficits in the form of sensory or motor blockade with perineural magnesium sulphate.

Nausea percentage in study groups I &II were 36.6% & 20% respectively as compared to 73.3% in control group. Sedation was observed in 0% of patients in study groups as compared to 10% of patients in control group. This showed that percentage of patients developing side effects like nausea and sedation was more in control group than study group. It may be due to more consumption of morphine in control group than study group.

Many authors have studied the role of magnesium in postoperative period by different routes of administration like intravenous, intrathecal, and epidural in addition to combination with local anaesthetics. Most of these studies showed that systemic application of magnesium is associated with smaller analgesic requirement and less discomfort in the postoperative period. <sup>15161718</sup> Mizutani et al studied the analgesic effect of iontophoresis with magnesium in healthy

adult volunteers. These results support the view that magnesium sulphate has an analgesic effect and produces good pain relief clinically with extended block duration.<sup>19</sup>

Magnesium can block calcium influx and non competitively antagonize N-methyl-D-aspartate receptor channels.<sup>20</sup> The modifications of calcium concentrations can alter local anesthetic nerve block. These effects have prompted the investigation of magnesium as an adjuvant for anesthesia and postoperative analgesia.

The mechanism whereby magnesium prolong the duration of local anesthetic block when injected near a nerve remains unclear. Hypothesis suggests that the analgesic properties of magnesium on the peripheral nerve may include a systemic effect, a direct action on the nerve, or local vasoconstriction. Magnesium injected near peripheral nerves may act by translocation via the nerves (axonal transport) or blood stream. However this mechanism is unlikely the main mechanisms of action in the enhancement of peripheral nerve block. The mechanism is more likely to be at the peripheral nerves. The vasoconstriction theory that results in the reduction of systemic absorption of local anesthetics also seems unlikely, because magnesium produces vasodilatation by directly acting on the blood vessels and by interfering with a range of vasoconstrictor substances.<sup>21</sup>

Magnesium may affect peripheral nerves by interfering with the release of neurotransmitter substances at synaptic junctions or may potentiate the action of local anesthetics.<sup>22</sup> A potentially important interaction between high magnesium concentration and local anesthetic nerve blocks of frog sciatic nerve had been postulated in a study reported by Akutagawa et al.<sup>31</sup> Magnesium ions are known to elevate the firing threshold in both myelinated and unmyelinated axons. Divalent cations have been suggested to reduce the fixed negative surface charge on the outside of nerve membranes and thereby increase the transmembranes potential (i.e. cause a hyper polarization). In that study the authors demonstrated that modulation of external magnesium concentration that bathed a nerve bundle resulted in enhancement of nerve block by local anesthetic.<sup>23</sup> The finding seems to support our result that the higher concentration of magnesium provides a pronounced prolongation of block.

Our study is the first randomized human study of perineural magnesium given as sole analgesic for postoperative analgesia. It has the limitation of evaluating only two dose responses. The safety of magnesium for the central nervous

system has been evaluated in some of the studies.<sup>24,25</sup> Chanimove et al demonstrated that repeated intrathecal injections of magnesium sulphate in a rat model was characterized by a lack of neurotoxicity in histological examination.<sup>26</sup> In another study in which magnesium sulphate was used intramuscularly for the treatment of headache, the authors registered no local side effects of the applied drugs.<sup>27</sup> However knowledge of the toxicity of magnesium applied near peripheral nerve is limited. In our study, no patient reported any local side effect or neurological deficit.

We conclude that, for the first time magnesium was used independently in a small dose in axillary sheath which results in good analgesia as determined by decreased uses of rescue analgesia without producing any major side effects.

These encouraging findings in a small study sample suggest that a low cost, simple change in clinical anaesthesiology practice will do much to decrease patient's post-operative analgesic needs. Further studies are required to determine the optimum doses of magnesium sulphate that can produce greater potentiation of analgesia.

### References

1. Morgan GE, Mikhail MS, Murray MJ, editors. Pain management. In: Clinical Anesthesiology. New York: Lange medical books. 2002:p.309-58.
2. Kehlet H, Holte K. Effect of postoperative analgesia on surgical outcome. *Br J Anaesth* 2001;87:62-72.
3. McQuay H, Justins D, Moore A. Treating acute pain in hospital. *Br Med J* 1997;314:1535.
4. Selander et al: Catheter Technique in Axillary Plexus Block. *Acta Anaesthesiol Scand* 1977;21(4):324-9.
5. Reuben SS, Reuben JP. Brachial plexus anesthesia with verapamil and /or morphine. *Anesth Analg* 2000;91:379-83.
6. McDonald J, Lambert G. Opioid mechanisms and opioids drugs. *Anaesthesia and intensive care medicine* 2008;9:33-7.
7. Kapral S, Gollman G, Waltl B, Likar R, Sladen RN, Weinstabl C et al. Tramadol added to mepivacaine prolongs the duration of an axillary brachial plexus blockade. *Anesth Analg* 1999;88:853-9.
8. Jarbo K, Batra Y, Panda N. Brachial plexus block with midazolam and bupivacaine improves analgesia. *Canadian journal of anesthesia* 2005;52:822-6.
9. Bone HG, Van Aken H, Brooke M, Burkle H. Enhancement of axillary brachial plexus block anesthesia by coadministration of neostigmine. *Reg Anesth Pain Med* 1999; 24: 405-10.
10. Ozalevli M, Cetin TO, Unlugenc H, Guler T, Isik G. The effect of adding intrathecal magnesium sulphate to bupivacaine-fentanyl spinal anaesthesia. *Acta Anaesthesiol Scand* 2005; 49: 1514-9.
11. Gunduz A, Bilir A, Gulec S. Magnesium added to prilocaine prolongs the duration of axillary plexus block. *Reg Anesth Pain Med* 2006; 31:233-6.
12. Marino PL editor. ICU book. 2nd ed. Baltimore (Maryland): Williams & Wilkins; 1997. p. 122-3.(Analgesia and sedation).

13. Macintyre PF. Safety and efficacy of patient controlled analgesia. *Br J Anaesth* 2001;87(1):36-46.
14. Tindinwebwa JVB. Axillary brachial plexus block. Update in anesthesia [serial online]1995[cited1995];1-2. Available from: URL nda.ox.ac.uk
15. Tramer MR, Schneider J, Marti RA, Rifat K. Role of magnesium sulphate in post operative analgesia. *Anesthesiology* 1996; 84:340-7.
16. Buvanendran A, Mc Carthy RJ, Kroin JS, Leong W, Perry P, Tuman KJ. Intrathecal magnesium prolongs fentanyl analgesia: a prospective, randomized, controlled trial. *Anesth Analg* 2002; 95 : 661-6.
17. Arcioni R, Palmisani S, Tigano S, Santorsola C, Sauli V, Romano S et al. Combined intrathecal and epidural magnesium sulphate supplementation of spinal anesthesia to reduce post operative analgesic requirements: a prospective, randomized, double blind, controlled trial in patients undergoing major orthopedic surgery. *Acta Anaesthesiol Scand* 2007; 51: 482-9.
18. Bilir A, Gulec S, Erkan A, Ozcelik A. Epidural magnesium reduces post operative analgesic requirements. *Br J Anaesth* 2007; 98: 519-23.
19. Sirvinskas E, Laurinaitis R. Use of magnesium sulphate in anesthesiology. *Medicina* 2002;38:147-50.
20. Fawcett WJ, Haxby EJ, Male DA. Magnesium: physiology and pharmacology. *Br J Anaesth* 1999; 83: 302-20.
21. Mizutani A, Taniguchi K, Miyagawa A, Ikebe H, Yoshitake S, Honda N. The analgesic effect of iontophoresis with magnesium sulphate. *Masui* 1995;44:1076-9.
22. James MFM. Clinical use of magnesium infusions in anesthesia. *Anesth Analg* 1992; 74:129-36.
23. Akutagawa T, Kitahata LM, Saito H, Collins JG, and Katz JD. Magnesium Enhances Local Anesthetic Nerve Block of Frog Sciatic Nerve. *Anesth Analg* 1984; 63:111-6.
24. Altura BM, Altura BT. Magnesium and vascular tone and reactivity. *Blood vessels* 1978;15:5-16.
25. Simpson J, Eide TR, Schiff GA, Clagnaz JF, Hossain I, Tverskoy A et al. Intrathecal magnesium sulphate protects the spinal cord from ischemic injury during thoracic aortic cross clamping. *Anesthesiology* 1994; 81:1493-9.
26. Lejuste MJLR. Inadvertent intrathecal administration of magnesium sulphate. *S Afr Med J* 1985;64:715-30.
27. Chanimov M, Cohen ML, Grinspun Y, Herbert M, Reif R, Kaufman I et al. Neurotoxicity after spinal anaesthesia induced by serial intrathecal injections of magnesium sulphate. *Anaesthesia* 1997; 52:223-8.

**Author Information**

**Parveen Goyal, M.B.B.S D.A**

Senior Resident, PGIMS Rohtak

**Rajmala Jaiswal, M.B.B.S M.D**

Professor, PGIMS Rohtak

**Sarla Hooda, M.B.B.S M.S**

Senior Professor And Head Of Department, PGIMS Rohtak

**Ruchi Goyal, M.B.B.S M.D**

Assistant Professor, PGIMS Rohtak

**Jatin Lal, M.B.B.S., M.D.**

Assistant Professor, PGIMS Rohtak