

## EVALUATION OF ANALGESIC EFFECT OF MAGNESIUM SULPHATE IN INTRAVENOUS REGIONAL ANAESTHESIA- A DOUBLE BLIND STUDY

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### ABSTRACT

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#### BACKGROUND

Magnesium antagonizes N-Methyl- D- Aspartate receptor, the receptor known to play an important role in the mechanism of pain. This study was undertaken to determine the effect of magnesium sulphate as an adjunct to lignocaine in Intra-Venous Regional Anaesthesia (IVRA). To evaluate the onset of anaesthesia, dose requirement of lignocaine, postoperative analgesia in upper limb surgeries.

#### MATERIALS AND METHODS

This study was designed as a prospective, double blinded, randomised trial consisting of sixty patients. All selected patients were randomly divided into two groups. Saline group (n=30) who received fifteen millilitres of normal saline intravenously and magnesium group (n=30) who received magnesium sulphate 500mg in fifteen millilitre volume intravenously into the limb to be anaesthetised. Five millilitres of 1% lignocaine (preservative free) was administered every fifteen minutes and patients were assessed for loss of sensory and motor power, lignocaine requirement and postoperative analgesia. Data were analysed using Tukey and multivariate test.

#### RESULTS

The mean time required to achieve surgical anaesthesia in magnesium group was 30.67±5.04 min and 53.17±5.65 min in saline group. Total dose of lignocaine required was 73.33±25.3 mg in magnesium group and 160.00±20.34 mg in saline group. Morphine requirement was 2.44±1.00 mg in magnesium group and 5.65±2.04 mg in saline group. Data showed statistically significant difference between the two groups (p=0.00).

#### CONCLUSION

It was concluded that magnesium as an adjunct fastens the onset of anaesthesia, reduces lignocaine requirement and prolonged postoperative analgesia. However, there was an increased incidence of transient pain with magnesium sulphate.

#### KEYWORDS

Intravenous Regional Anaesthesia, Bier's block, Magnesium Sulphate, Lignocaine.

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#### BACKGROUND

IVRA or Bier's block is used for bloodless limb surgeries. August Bier described the technique in 1908 and injected procaine into the veins between two tourniquets.<sup>1</sup> The mechanism explained was diffusion of local anaesthetic from the injected veins to the capillaries supplying the nerves and ischaemia. In 1982, Health<sup>2</sup> reported five deaths due to bupivacaine in IVRA. Presently, lignocaine 0.5% (preservative free) is used in IVRA. Magnesium Sulphate

potentiates the action of many anaesthetic and analgesic agents.<sup>3-6</sup> This study was aimed to assess the effect of magnesium sulphate as an adjunct in IVRA.

#### MATERIALS AND METHODS

After obtaining the approval of the ethical committee and informed consent from the patients, a prospective, randomised, double blinded study was conducted. Sixty patients included in the study were in the age group of eighteen to sixty years, either sex, scheduled for upper limb surgery with an anticipated time of less than one hour thirty minutes and patients who understand visual analogue scale (VAS). Patients excluded from the study were with renal failure, myasthenia gravis, skeletal muscle disorder, heart block, myocardial ischaemia, peripheral vascular disease, bleeding disorder, history of recent intake of alcohol, sedatives, narcotics and history of allergy to lignocaine.

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All selected patients were randomly divided (by draw of lots) into two groups. Saline group (n=30) these patients received fifteen milliliters of normal saline intravenously. Magnesium group (n=30) these patients received magnesium sulfate 500 mg in fifteen milliliter volume (3.33% w/v) intravenously. Baseline heart rate (HR), noninvasive blood pressure (NIBP) were recorded prior to IVRA. All patients were monitored for continuous ECG, HR, NIBP (systolic, diastolic and mean) and oxygen saturation (SpO<sub>2</sub>) using Colin BP 306 monitor.

An eighteen-gauge venous cannula was placed and fixed distally in the upper limb to be anaesthetized. Another eighteen-gauge venous cannula was placed in the contralateral limb for administration of intravenous fluid and drugs. The brachium of the limb to be blocked was wrapped with two layer of cotton padding. A double tourniquet (VBM tourniquet 4500) was applied over the padding and skin contact of the tourniquet edge was avoided. The tourniquet was fastened, secured and tied. In supine position, the exsanguinations of the arm to be anaesthetized was accomplished by elevating the arm above the body level for five minutes and wrapping a rubber bandage (Martin Van Esmarch) around the arm from the tip of the fingers to the level of the tourniquet. The proximal cuff was inflated to a pressure of hundred mmHg above the systolic blood pressure and the Martin Van Esmarch bandage was removed. The patients received either fifteen milliliter of normal saline (Saline group) or magnesium sulphate 500mg in fifteen milliliter volume (Magnesium group) intravenously into the arm to be anaesthetised. The observer for the quality of anaesthesia was blinded to the type of drug injected.

The onset of anaesthesia (loss of sensory and motor power) was assessed every five minutes in both the groups. The sensory parameter assessed were fine touch, deep touch, temperature and vibration. The motor effect was assessed by grading the limb movement on a five-point scale, 0= no movement, 1= flicker of movement, 2= movement with gravity, 3= movement against gravity but not against resistance, 4= movement against resistance, 5= complete motor power. In case the block is inadequate, the patient were administered five milliliter of 1% lignocaine (preservative free) every fifteen minutes, till the desired level of anaesthesia was achieved. Distal cuff of the tourniquet was then inflated to the same pressure as the proximal cuff. The proximal cuff was then deflated, and surgery was allowed to proceed. The total dose of lignocaine required in all patients were recorded.

Patients were monitored for continuous ECG, HR, NIBP (systolic, diastolic, mean), SpO<sub>2</sub> and recording was done every ten minutes till the end of surgery. At the end of surgery, the tourniquet was gradually released, and patients were closely monitored for ten minutes. Postoperatively, pain was assessed using visual analogue scale (VAS), a scale of one to ten, with ten being the worst pain and zero being no pain. Rescue analgesic (injection morphine 0.05 mg/kg body weight) was given if VAS was five or more. The time interval between the end of surgery and first analgesic

requirement was recorded. The patients pulse rate (PR), NIBP (systolic, diastolic, mean) and sedation score were recorded at thirty minutes interval for three hours then, three hourly for twenty four hours. The sedation score used was graded from 0 to 3 with 0= awake and alert, 1= awake but drowsy, 2= drowsy but arousable, 3= unarousable. The side effects like facial flushing, dry mouth, hypotension, tachycardia or bradycardia, prolonged PR, QRS, ST segment, muscle weakness, tourniquet pain were looked for and recorded. On completion of the study, all data were statistically analysed using Tukey and multivariate test.

**RESULTS**

In this study, we approached and enrolled sixty patients. All sixty patients participated in the study till the end and there were no dropouts. The demographic data of the patients in both the groups in respect to age, sex ratio, weight, tourniquet pressure and time, duration of surgery was not statistically significant.

Parameters	Magnesium Group (n=30)	Saline Group (n=30)	p-value
Fine touch	27.83±4.09 min	49.50±3.79 min	0.000
Deep touch	27.83±4.09 min	49.33±4.10 min	0.000
Hot	27.67±4.10 min	49.33±3.88 min	0.000
Cold	27.67±4.10 min	49.17±3.96 min	0.000
Vibration	30.67± 5.04 min	53.33±5.77 min	0.000

**Table 1. Mean±SD of Time (minutes) Required to Get Complete Loss of Different Sensory Parameters**

(p <0.05 significant).

The mean time required to achieve surgical anaesthesia in magnesium group was 30.67±5.04 min and 53.17±5.65 min in saline group. There was a significant difference in both the groups (p= 0.000). Table 1 depicts the mean duration required for complete loss of sensory parameter and the time required for loss of fine touch in magnesium group was 27.83±4.09 min and 49.50±3.79 min in saline group with significant difference from each other (p= 0.000). The time required for loss to deep touch sensation was 27.83±4.09 min in magnesium group and 49.33±4.10 min in saline group and was statistically significant between the two groups (p=0.000). The duration for loss of hot sensation in magnesium group was 27.67±4.10 min and 49.33±3.88 min in saline group, the two groups showed a significant difference (p= 0.000). The time for loss of cold sensation was 27.67±4.10 min in magnesium group and 49.17±3.96 min in saline group with a significant difference in the two groups (p= 0.000). The duration to loss of vibration sensation was 30.67±5.04 min in magnesium group and 53.33±5.77 min in saline group with significant difference in both the groups (p= 0.000).

Parameter	Magnesium Group (n=30)	Saline Group (n=30)	p-Value
Motor	30.33± 5.07 min	53.33± 5.77 min	0.000

**Table 2. Mean±SD of Time (Minutes) Required to Get Complete Loss of Motor Power**

Table 2 shows the time required to achieve complete loss of motor power, being 30.33±5.07 min in magnesium group and 53.33±5.77 min in saline group and showed a statistically significant difference between the two groups (p=0.000).

(p <0.05 significant)

Parameter	Magnesium Group (n=30)	Saline Group (n=30)	p-Value
Lignocaine (mg) required to achieve surgical anaesthesia	73.33±25.37	160.00±20.34	0.000
% requirement of lignocaine	47.96%	100%	
Total time required to achieve surgical anaesthesia (minutes)	30.67±5.04	53.33±5.77	0.000

**Table 3. Total Dose of Lignocaine Required in Magnesium and Total Time Required to Achieve Surgical Anaesthesia**

(P<0.05 significant).

Table 3 depict the total dose of lignocaine required in magnesium group being 73.33±25.37 mg and 160.00±20.34 mg in saline group. The total time required to achieve surgical anaesthesia showed that both the groups had a statistical significant difference (p= 0.000).

Parameter	Magnesium Group (n=30)	Saline Group (n=30)	p-Value
Total dose of Morphine(mg) required in 24 hours	2.44±1.00	5.657±2.04	0.000
The duration between receiving magnesium/saline to First dose of morphine(minutes)	365.33±159.06	121.93±41.96	0.000

**Table 4. Showing Mean±SD of Morphine (mg) Requirement and Postoperative Pain Free Period Before Rescue Analgesia**

(P<0.05 significant)

Table 4 depict total dose of morphine required postoperatively, 2.44±1.00 mg in magnesium group and 5.657±2.04 mg in saline group. The pain free period before rescue analgesia was 365.33±159.06 min in magnesium group and 121.93±41.96 min in saline group and was statistically significant between the groups (p= 0.000).

No. of Doses of Morphine	Magnesium Group (n=30)		Saline Group (n=30)	
	No. of Patients	Percentage	No. of Patients	Percentage
No Morphine Required	3	10%	0	0%
One dose	27	90%	3	10%
Two doses	0	0%	23	76.6%
Three doses	0	0%	4	13.3%
Four doses	0	0%	0	0%

**Table 5. Number of Morphine Injections Required by the Patients in Both the Groups in 24 Hours**

Table 5 depicts the total number of morphine injection by the patients in 24 hours, three patients out of 30 in magnesium group required no rescue analgesia. Twenty seven out of 30 patients required one dose of morphine. All patients in saline group required morphine, three required one dose, 23 required two doses and 4 patients required 3 doses of morphine.

There were no statistically differences in HR, NIBP (systolic, diastolic, mean), SpO2 in the preoperative, intraoperative and postoperative period. The sedation score of all the patients in magnesium group was zero. In Saline group, the sedation score of two patients was one at two minutes, one patient had a sedation score of one at four minutes and one patient had a sedation score of one at six minutes. Eleven patients of the magnesium group had

transient pain during the injection of magnesium. Intraoperatively two patients out of thirty in saline group complained of tourniquet discomfort. No other adverse effects were noted in both the groups.

**DISCUSSION**

In this study, we observed that complete loss of sensation to fine touch, deep touch, temperature, vibration and motor

power was significantly shorter in magnesium group compared to saline group. A similar study showed that addition of magnesium sulphate and nitroglycerine to lignocaine for IVRA leads to early onset of sensory block.<sup>7</sup> A study was done where magnesium sulphate as an adjunct to lignocaine for IVRA shorten the onset of sensory and motor block.<sup>8</sup> In our study we observed that the total dose of lignocaine required to achieve surgical anaesthesia was significantly lower in magnesium group compared to the saline group. These observations are similar to the study performed in 2001, the modulation of NMDA receptor function by ketamine and magnesium inhibit functioning of glutamate receptor and combination of both act in a super additive manner.<sup>9</sup> In 2002, a study was done where magnesium was given intravenously to reduce the requirement of propofol, during propofol nitrous oxide anaesthesia. The result of the study suggested that magnesium might have an effect in anaesthesia and analgesia.<sup>10</sup> A study done concluded that the addition of magnesium to ropivacaine in IVRA improved the quality of block.<sup>11</sup>

On statistical analysis, the postoperative requirement of morphine in magnesium group was lower as compared to saline group. Research was done to study the antinociceptive potentiation and attenuation of tolerance by intrathecal co-infusion of magnesium sulfate and morphine in rats. They implicated that the addition of magnesium to morphine provided better analgesia than morphine alone.<sup>12</sup> A study showed that intrathecal magnesium potentiate morphine antinociceptive at the spinal level and concluded that magnesium sulfate can be used as adjunct to morphine.<sup>13</sup> A study concluded that intravenous magnesium during spinal anaesthesia improves postoperative analgesia.<sup>14</sup> A similar study showed that intravenous infusion of magnesium sulphate 65 mg/kg prolong spinal block and decrease VAS scores in patients undergoing abdominal hysterectomy.<sup>15</sup>

The haemodynamic parameters of the patients in both the groups remained stable. These results correlate with the study which concluded that IVRA was a safe and simple method of producing analgesia of the limbs.<sup>16</sup> A retrospective review concluded that IVRA was safe and effective when used appropriately.<sup>17</sup> A study concluded that Bier's block is safe, effective and reliable in outpatient primary care setting.<sup>18</sup> A study done in paediatric forearm fracture reduction using Bier's block concluded that it is a safe technique.<sup>19</sup> There was no incidence of haemodynamic disturbances in the form of hypotension, bradycardia or other side effects at any time throughout the study. Thus, indicating that magnesium sulphate is a safe drug.

A double-cuff pneumatic tourniquet with timer was used in both the groups. Initially, the proximal cuff was inflated and once a satisfactory anaesthesia was achieved the distal cuff was inflated and the proximal cuff was deflated. Two patients in saline group complained of tourniquet discomfort. This correlated well with the study performed in 1963, a single cuff tourniquet was used in thirty patients and thirteen patients complained of tourniquet discomfort.<sup>16</sup> In 1964,

IVRA was performed in five hundred fourteen patients using single cuff tourniquet and observed that the patients withstood comfortably.<sup>20</sup> A survey from 1963 to 1969 in nine hundred and sixty three patients using single cuff tourniquet found that thirty five patients complained of tourniquet pain.<sup>21</sup> Another study concluded that placement of forearm tourniquet resulted in less pain and fewer sedation requirements than upper arm tourniquet.<sup>22</sup>

Postoperatively, the sedation score of the magnesium group was zero and in the saline group four patients had score of one. This can be attributed to the increase dose of lignocaine requirement in this group. Eleven patients of the magnesium group had transient pain during the injection of magnesium. A similar study concluded that there is increased incidence of transient pain on magnesium sulphate injection.<sup>23</sup>

## CONCLUSION

Magnesium, when added to lignocaine in IVRA, fastens the onset of anaesthesia, reduces the dose of lignocaine and provides longer postoperative analgesia. Thus, we can recommend the use of magnesium sulfate as an adjunct to lignocaine for intravenous regional anaesthesia.

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