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SERUM MAGNESIUM LEVELS IN AORTIC AND MITRAL VALVE REPLACEMENT SURGERIES

Srinivasa Rao Gondi¹, Venkata Sesha Sai Krishna Manne²

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ABSTRACT: BACKGROUND: The purpose of the study was to analyze serum magnesium concentration in patients undergoing Aortic and Mitral Valve replacement surgeries. **METHODS:** This prospective study was conducted in 60 patients who underwent elective Aortic and Mitral valve replacement surgeries. Blood samples from radial artery were collected just before induction of anesthesia and three days post-operatively for estimation of serum magnesium. **RESULTS:** Magnesium level was 2.02mg/dl at baseline, 2.28mg/dl, 2.08mg/dl and 1.90mg/dl respectively on three consecutive days post-operatively. **CONCLUSION:** The lowering of serum magnesium in Aortic and Mitral valve replacement surgeries postoperatively recommends the use of routine serum magnesium determination and administration to prevent post-operative arrhythmias.

KEYWORDS: Aortic Valve Replacement, Magnesium, Mitral Valve Replacement.

INTRODUCTION: Serum Magnesium plays an important role in cardiac protection.

Magnesium has many beneficial effects like it improves contractility and reduces the number of cardiac arrhythmia episodes.

Magnesium is not a trace element but the most abundant essential mineral in the body and fourth most abundant intra cellularcation.

Free magnesium (Mg^{2+}) is involved in numerous processes of cardiac function. However mechanism of regulation by magnesium has not been fully understood.

Physiological roles of magnesium include its action as a regulator of Ca^{2+} , K^{+} and Na^{+} transport channels and pumps in cell membranes.¹

Magnesium is distributed approximately one half in the bone, one half in the muscle and other soft tissues, less than one percent is in the blood.

Magnesium is an important regulator of multiple cardiovascular processes, including myocardial contraction and conductivity, transmembrane calcium flux, potassium transport, vascular smooth muscle tone, coronary reactivity and nitric acid synthesis.

Magnesium is an essential cofactor for the maintenance of myocardial transmembrane potential, magnesium deficiency decreases the threshold of arrhythmia.¹

Magnesium depletion is known to cause supra-ventricular arrhythmias, atrial fibrillation, lengthened P-R and Q-T segments or ventricular fibrillation.²

Atrial fibrillation is the most common cardiac arrhythmia after cardiac surgery. There is a strong association between atrial fibrillation and thrombo embolic complications.

The main cause of thromboembolic complications is multifactorial but may be attributed to a hypercoagulable state with hemostatic abnormalities and endothelial dysfunction in AF.³

Several analyses showed the effectiveness of magnesium on post-cardiac surgeries atrial fibrillation.^{4,5,6}

ORIGINAL ARTICLE

Magnesium has also been considered as a safe adjunct to digoxin in controlling the ventricular response in acute atrial fibrillation.⁶

Magnesium may Influence the Incidence of Cardiac Arrhythmias by:

- a) A direct effect.
- b) An effect on potassium metabolism.
- c) An effect as a calcium blocking agent.

In the event of a magnesium deficiency the cell cannot attract potassium against the transmembrane concentration gradient. The reason may be that a magnesium deficiency interferes with the function of membrane ATP and thus the pumping of sodium out from the cell and potassium into the cell is impaired.

The interference from a magnesium deficiency on the equilibrium of potassium between the intra and extra cellular spaces may result in changes in the resting membrane potential, changes in potassium conductance across the cell membrane as well as disturbances in the repolarization phase. Magnesium is also an essential constituent of many enzyme systems in the body and plays a physiological role in the regulation of coagulation system of the body. It has also been proved that in situation of rapid IV fluid infusion, maintaining the magnesium at the upper limit of normal value attenuates rapid hemodilution-induced coagulation change due to decreased magnesium level in healthy volunteers.⁷

There were also some studies that magnesium interrupted platelet aggregation and adhesion so magnesium sulphate administration induced hypo coagulation state.^{8,9}

The aim of the present study was to determine the serum magnesium level three days post-operatively in Mitral valve repair and replacement surgeries.

MATERIALS AND METHODS: The prospective study was conducted at NRI medical college and hospital on 60 consecutive patients who underwent Mitral valve and Aortic valve replacement surgeries. The study was approved by institutional ethics committee and informed consent was obtained from all patients.

35 males and 25 females with the age group 18–50 years were included in the study.

PRE-OP DEMOGRAPHIC:

Inclusion Criteria: Mitral valve and Aortic valve replacement surgeries with EF>45%.

Exclusion Criteria: Emergency surgeries and patients receiving oral or injectable magnesium, severe hepatic or renal disease (S. creatinine >2.0mg/dl), patients on oral furosemide tablets.

SURGICAL PROCEDURE: Standard surgical procedure was applied for all cases. After midline incision; sternotomy was done followed by pericardial opening. After achieving adequate anticoagulation aorta was cannulated, then followed by superior vena cava and inferior vena cava cannulation. After cross clamping of aorta heart was arrested with infusion of cold blood cardioplegia. After the heart was arrested appropriate surgery was carried out. After surgery the patient was rewarmed gradually to normal body temperature and weaned off the bypass with inotropic support of dobutamine and noradrenaline.

ORIGINAL ARTICLE

After protamine reversal and adequate hemostasis sternum was closed with steel wires. Chest was closed in layers and patient was shifted to post-operative ICU for elective ventilation.

The Blood Sample was collected from Radial Artery:

1. Just before anesthesia after cannulation.
2. 1st post-operative day.
3. 2nd post-operative day.
4. 3rd post-operative day.

The blood was immediately centrifuged at 3000 rpm at room temperature after clotting and the obtained serum was determined by colorimetric method using xylidyl blue.

ANESTHETIC REGIMEN: On the day of surgery the patients were premedicated with fentanyl (1µg/kg) and midazolam 2 mg then they were induced with thiopentone (5mg kg⁻¹) and vecuronium was used to accomplish endotracheal intubation with appropriately sized tube (Generally 9.0mm for males and 7.5mm for females). Anesthesia was maintained with 50% Nitrous Oxide (N₂O) along with sevoflurane (1.5% MAC) the vitals are maintained with the use of dobutamine, noradrenaline and nitroglycerine. Fentanyl (1µgkg⁻¹) was given before incision for analgesia.

Anticoagulation is achieved with heparin 3mg/kg to maintain activated clotting time of more than 480 seconds. Adequate mean arterial pressure and urine output is maintained during cardiopulmonary bypass and throughout surgery.

After surgery anticoagulation is reversed with protamine with 1:1 ratio with heparin. The target ACT was baseline ACT, hemoglobin was maintained at 10mg/dl. A normal arterial blood gas analysis was maintained. Adequate hemostasis was achieved before chest closure. After that patient was shifted to post-operative intensive care unit for elective ventilation. Most of the patients are extubated within 6-8 hours of surgery. Inotropes are gradually weaned off.

MAGNESIUM ADMINISTRATION: 40mg/dl of magnesium sulphate (50%) in 100ml normal saline was given intravenously over 15 minutes after induction of anesthesia.

RESULTS: The patients in the study were in the age group of 18–50 years with 35 males 25 females.

Age (years)	Male	Female	Total %
10 – 19	2	1	5%
20 – 29	18	14	53.34%
30 – 39	9	6	25%
40 – 49	6	4	16.66%
Total (n)	35 (n)	25 (n)	100%

Table 1: Case distribution according to age and sex

Mean age=30.16.

SD=8.789.

ORIGINAL ARTICLE

Sl. No.	Serum Magnesium levels	Baseline	1 st POD	2 nd POD	3 rd POD
1)	1.51 – 1.70	-	-	-	6
2)	1.71 – 1.90	2	1	1	40
3)	1.91 – 2.10	30	15	42	14
4)	2.11 – 2.30	23	35	16	-
5)	2.31 – 2.50	5	-	1	-
	Total (n)	60	60	60	60

Table 2: The number of patients arranged according to the levels of serum magnesium

The observed difference of serum magnesium levels between baseline value and 3rd POD is statistically highly significant with $P < 0.01$.

DISCUSSION: Magnesium as the second most abundant intracellular cation in the body has an important function of stabilizing the cell membrane.

The effect of magnesium on myocardial tissues leads to many cardiac arrhythmias in valve replacement surgeries. Magnesium deficiency can lead to cardiac arrhythmias, coronary artery spasm, modification of cardiac conduction and neurological irritability^{1,2} magnesium also reduces platelet aggregation, depress catecholamine release and decrease coronary and systemic vascular resistance.^{3,4}

Prophylactic administration of magnesium in heart surgeries may improve cardiac contractile indices after cardiopulmonary bypass.^{5,6} So intravenous magnesium infusion is a good method to correct hypomagnesemia.¹⁰

Kiziltep et al. has proved that magnesium is a safe anti arrhythmic agent in open heart surgeries. So it can be used as a first line anti arrhythmic agent even without measurement of blood levels.

Magnesium has an essential role in numerous cellular procedures and if its metabolism is disturbed it can have serious biological consequences.

Hypomagnesemia is a common disorder after cardiac surgeries and has a higher frequency in patients with AF.^{4,10}

Therefore, a magnesium infusion is highly effective prophylactic therapy for reducing the incidence of AF after cardiac surgery.^{4,11}

It has also been studied that magnesium infusion significantly increases atrial refractoriness.^{12,13}

Some studies have reported that low left atrial wall tension and near normal size of left atrium were important factors to maintain normal sinus rhythm after Mitral valve surgeries.¹⁴

Mitral valvular disease, increased left atrial pressure and volume overload, which lead to left atrial enlargement is frequently associated with AF. The incidence of AF is known as 30–40% in patients presenting with Mitral valve surgery.¹⁵

Pre-operative magnesium infusion was more effective in prevention of post-operative AF, comparing with intra or post-operative magnesium infusion is a meta-analysis by Miller et al.⁴ and post-operative AF usually has a self-limited course.^{16,17}

ORIGINAL ARTICLE

CONCLUSION: The lowering of magnesium after post Coronary Artery Bypass Grafting on cardio pulmonary bypass, three days post operatively recommends the routine serum magnesium administration to prevent complications like atrial and ventricular arrhythmias.

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ORIGINAL ARTICLE

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AUTHORS:

1. Srinivasa Rao Gondi
2. Venkata Sesha Sai Krishna Manne

PARTICULARS OF CONTRIBUTORS:

1. Professor, Department of Anaesthesia, NRI Medical College & General Hospital.
2. Associate Professor, Department of Anaesthesia, NRI Medical College & General Hospital.

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Srinivasa Rao Gondi,
Professor,
Department of Anesthesia,
NRI Medical College & General Hospital,
Chinakakani, Guntur-522503.
E-mail: drsrinivas_g@yahoo.co.in

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