SERUM MAGNESIUM LEVELS IN OFF-PUMP CORONARY ARTERY BYPASS GRAFTING

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ABSTRACT: Magnesium plays an essential role in cardiac protection. Magnesium has many beneficial effects like it improves contractility and reduces the number of cardiac arrhythmia episodes. The aim of the study was to analyze the magnesium concentration in patients undergoing off-pump CABG. The study included 110 patients who underwent general anesthesia and coronary artery bypass graft. Magnesium level was 2.0mg/dl at baseline, 2.18 mg/dl, 2.02 mg/dl and 1.94 mg/dl respectively on 3 consecutive days post-operatively. The lowering of magnesium recommends routine serum magnesium determination to prevent complications.

KEYWORDS: Magnesium, Off-pump, CABG.

INTRODUCTION: Magnesium is 4th most abundant essential mineral in the body and second most abundant intracellular cation. It is distributed approximately one half in the bone, one half in the muscle and other soft tissues; less than one per cent is in the blood. Magnesium is an important regulator of multiple cardiovascular processes, including myocardial conduction and conductivity, transmembrane calcium flux, potassium transport, vascular smooth muscle tone, coronary reactivity and nitric acid synthesis. Its disorders may cause many life threatening arrhythmias.^[1]

Magnesium is an essential cofactor for the maintenance of myocardial transmembrane potential, magnesium deficiency decreases the threshold of arrhythmias.^[2] In cardiac surgery, hypomagnesaemia has been associated with the presence of supraventricular cardiac arrhythmias, atrial fibrillation, lengthened P-R and Q-T segments or ventricular fibrillation. Hypomagnesemia is observed after cardiac surgery.

Off-pump coronary artery bypass (OPCABG) is a technique of performing coronary anastomosis on a beating heart without instituting cardio pulmonary bypass.^[3]

Despite substantial improvement in surgical techniques, perioperative managements and postoperative atrial fibrillation is among the common complication encountered early after coronary artery bypass grafting (CABG).^[4] It generally occurs between 24 and 96 hours postoperatively with a peak incidence on the second postoperative day. Atrial fibrillation potentially leads to complications, including stroke, extended duration of hospitalization and increasing costs. The etiology of atrial fibrillation after CABG is unclear. The cause may be multifactorial such as advanced age, male sex, hypertension, hypothyroidism, withdrawal of β - blockers, impaired cardiac function, chronic lung disease, chronic renal failure, diabetes, cardioplogia, myocardial ischemia and reperfusion, myocardial ischemia right coronary artery disease, local inflammatory reaction, metabolic disorder excessive catecholamine and electrolyte imbalance, particularly hypomagnesemia, which has also been identified as an independent predictor of postoperative atrial fibrillation.^[5,6] magnesium administration has proved beneficial in preventing ventricular and supraventricular tachyarrhythmia after coronary artery bypass grafting.^[7] Oral magnesium supplementation improves endothelial

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function, exercise tolerance and exercise induced chest pain in patients with Coronary Artery Disease.^[8]

MATERIALS AND METHODS: The prospective study was conducted at NRI Heart Center, NRI General Hospital on 110 consecutive patients who underwent elective cardiac surgery. The study was approved by Institutional Ethics Committee and informed consent was obtained from all patients. 67 males and 43 females with age group of 42 to 76 years were included in the study.

PREOPERATIVE PATIENT DEMOGRAPHICS:

Inclusion Criteria: Elective off-pump CABG with EF > 35%.

Exclusion Criteria: Emergency surgeries and patients receiving oral or injectable magnesium.

All the patients were premeditated with tab diazepam 5 mg and tab pantoprazole 40 mg, the night before surgery. On the day of surgery patient was shifted to Operation Theater with supplemental oxygen and standard monitoring like ECG, pulse oximetry were initiated. Under local anaesthesia radial artery and central venous cannulation was done. Patient was induced with midazolam (0.05mg/kg), fentanyl (2µg/kg), thiopentone (5mg/kg) and paralyzed with vecuronium (0.1mg/kg). Patients were intubated with appropriate size endotracheal tube. Right femoral artery was cannulated. After urinary catheterization patient was draped for surgery. Anesthesia was maintained with midazolam, fentanyl and sevoflurane. The vitals were maintained with the use of dobutamine, noradrenaline and nitroglycerine.

Anticoagulation is achieved with heparin 2mg/kg to maintain ACT of more than 300. Adequate MAP and urine output is maintained during surgery.

After the 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 ABG was maintained. Adequate hemostasis was achieved before chest closure. After skin closure patient was shifted to post-operative ICU for elective ventilation. Most of the patients are extubated within 6-8 hrs of surgery. Inotropes are gradually weaned off.

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

SURGICAL PROCEDURE: Standard surgical procedure was applied for all cases. After midline incision, sternotomy was done, followed by vein harvesting along with LIMA (left internal mammary artery) pericardium was opened. Heart is stabilized with octopus and star fish (Tissue stabilizers) and after completion of grafting anticoagulation is achieved with protamine. Adequate homeostasis was achieved and sternum closed with wires. Chest was closed in layers. Patient was shifted to post-op ICU for elective ventilation.

The Blood Samples were Collected from Radial Artery:

1. Just before anaesthesia after artery cannulation.
2. 1st Post-operative day.
3. 2nd
4. 3rd

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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.

RESULT: The patients in the study were in the age group of 42 – 76 years. Cardiac surgeries were performed on 67 males and 43 females. The lowering of magnesium recommends routine serum magnesium determination & administration to prevent complications.

Age	CABG
40-49	10
50-59	35
60-69	45
70-79	20

Table 1

Serum Mg Levels	Baseline	1 st POD	2 nd	3 rd
1.51 – 1.70	-	-	-	10
1.71 – 1.90	8	-	3	68
1.91 – 2.10	52	24	64	32
2.11 – 2.30	35	68	30	-
2.31 – 2.50	15	18	13	-
Total (n)	110	110	110	110

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 plays an important role in cardiovascular physiology. It is an essential co-factor in maintaining the intracellular electrolyte balance and membrane potential by acting on Na-K-ATP channels.^[9] It is also like a natural calcium antagonist. Magnesium is also an antagonist of the N-methyl-D-aspartate (NMDA) receptor and its associated ion channels.^[10] Studies on the pathophysiology of myocardial ischemia-reperfusion injury suggests there is a rational basis for

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magnesium therapy. Magnesium reduces the extent of infarct, but only when administered before reperfusion. The positive effect of magnesium may also result from its significant role in the pathomechanism of reperfusion injury. Thus, it may be suggested that intra-operative magnesium intravenous infusion is important and required in patients undergoing CABG.

Preoperative factors may include the fact that many of cardiac patients receiving diuretics and digitalis cause renal loss of magnesium. During the surgery, patients are exposed to hemodilution, blood loss, blood transfusion and an increase of catecholamines that cause chelation of magnesium. All these factors contribute to the decrease in plasma magnesium levels. During surgery, continuous hemofiltration, modified ultra filtration and administration of large dose of calcium and diuretics can cause depletion of magnesium. Other factor causing hypomagnesemia is the decrease in body temperature during surgery. Postoperative three day magnesium infusion is effective in reducing the incidence of atrial fibrillation & junctional ectopic tachycardia occurring after CABG.^[11,12]

Magnesium reaches its minimum levels on first postoperative day and returns to its preoperative value on 4th POD.^[13]

Studies show about 17% decrease in plasma magnesium persists until the first post-operative day. Hypomagnesemia observed on 1st POD is a relevant symptom preceding atrial fibrillation.^[13]

Hypomagnesemia is known to cause muscle weakness and respiratory failure. It is one factor causing difficulty in weaning the patient from ventilator. Patients with hypomagnesemia needed ventilator support more frequently and for a longer duration. Patients with low muscle magnesium were on ventilator support for more number of days.^[14] Hypomagnesaemia is commonly associated with other electrolyte abnormalities. Hypokalemia, hypocalcemia, hypophosphatemia are said to be the predictors of hypomagnesemia. Heart manipulation during off-pump CABG may cause hemodynamic instability.^[15]

Magnesium supplementation before beating heart can stabilize the plasma membrane of the myocardium and thereby mediate the protective effect. Low levels of magnesium cause not only cardiac arrhythmias like atrial fibrillation,^[14] but also hypertension and vasoconstriction.

Administration of a single dose of magnesium during CABG is a safer practice and has a protective effect at the moment of heart reperfusion.

Analyzing the changes in blood magnesium levels, the correlation between magnesium and ischaemic heart area is worth stressing. This seems to be very important in patients with post-bypass with stunned hearts, who require inotropic drug infusion. High blood magnesium concentration may result in an increasing cardiac contractions strength, and thus it is likely to decrease the demand for Dopamine & Dobutamine infusions.^[16]

Studies demonstrated that intravenous magnesium infusion was capable of reducing the infarct extent by more than 50% and it also had positive effects on ejection fraction and left ventricular function.^[17] Thus magnesium supplementation is particularly relevant in patients with impaired heart function after off-pump coronary artery bypass.

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