International Journal of Medical and Health Research
ISSN: 2454-9142
www.medicalsciencejournal.com
Volume 4; Issue 4; April 2018; Page No. 22-25

Magnesium supplementation improve outcome after cardiac surgery

Dr. Jyoti Prasad Kalita[1], Dr. Intekhab Alam[2*], Manuj Kumar Saikia[3]

[1] Associate Professor, Department of Cardiothoracic and Vascular Surgery, Northeastern Indira Gandhi Regional Institute of Health and Medical Sciences, Shillong, Meghalaya, India

[2] Assistant Professor, Department of Cardiothoracic and Vascular Surgery, Northeastern Indira Gandhi Regional Institute of Health and Medical Sciences, Shillong, Meghalaya, India

[3] Professor and Head, Department of Cardiothoracic and Vascular Surgery, Northeastern Indira Gandhi Regional Institute of Health and Medical Sciences, Shillong, Meghalaya, India

Abstract
Hypomagnesaemia is common after cardiac surgery when done under cardiopulmonary bypass and it has association with increased morbidity and mortality. The purpose of this study was to determine whether magnesium supplementation in the immediate postoperative period improve outcome of post cardiac surgery patient. This retrospective observational study was conducted in a cardiac surgery intensive care unit of a tertiary care hospital. Seventy five patients undergoing elective cardiac surgery under cardiopulmonary bypass were to receive three doses of intravenous bolus of 1 g of magnesium sulphate at 8 hous interval in first 24 hours after surgery and another seventy five patient did not receive was taken as control group. There was significant differences were found either in the primary end point (hours of intubation) or in the secondary end points (length of inotropic support, new atrial fibrillation, ventricular tachycardia or ventricular fibrillation, length of intensive care unit stay, or ICU or hospital mortality). Hypomagnesemia was present in 14% of patients on admission to the intensive care unit after operation. In conclusion, the magnesium supplementation after cardiac surgery with cardiopulmonary bypass does favorably affect clinical outcomes.

Keywords: magnesium, postoperative care, arrhythmia

Introduction

Magnesium is the second most mineral among all intracellular cations. It is involved in the regulation of various ion channels and serves as a cofactor in many enzymatic systems. Less than 1% of the total body magnesium is represented by the plasma/serum levels [1]. The myocardial tissue levels also may not correlate with the blood serum levels of magnesium [1].

Hypomagnesemia, may be a factor for longer mechanical ventilatory support, more rhythm disorders, and a higher death rate [2, 3]. Magnesium treatment in post myocardial infarction appeared favorable in the LIMIT-2 trial but in trial like ISIS-4 or MAGIC did not find improved clinical outcome in the group treated with magnesium [4, 5].

Hypomagnesemia after cardiac surgery is not uncommon, and it has evidence of association in major adverse cardiac events [1, 6]. Magnesium has definite beneficial role in ventricular dysrhythmias though its benefit in atrial fibrillation in post coronary artery bypass surgery is contested [4, 7, 8]. Many meta-analyses have shown that magnesium reduces the risk of atrial fibrillation after cardiac surgery [9, 10]. Hence the practices involving the perioperative use of magnesium in adult cardiac surgery vary widely [11].

The aim of the present study was to determine whether the prophylactic administration of magnesium in the immediate postoperative period of cardiac surgery improves outcome for these patients.

Methods and Materials

The retrospective, observational study was carried out in cardiac surgery intensive care unit of Northeastern Indira Gandhi Regional Institute of health and Medical Sciences, Shillong, Meghalaya.

Subject Population

Adult patients undergoing cardiac surgery under cardiopulmonary bypass were included with the following exclusion criteria:

1. Previous treatment with any type of magnesium supplementation (the week before the intervention)
2. Systolic blood pressure <100 mmHg when admitted to the ICU and not corrected in 1 h
3. Last creatinine serum concentration prior to the intervention > 1.2
4. Advanced atrioventricular block when admitted to the ICU
5. Emergency cardiac surgery
6. Off- pump cardiac surgery

Seventy five patients undergoing elective cardiac surgery with cardiopulmonary bypass had received three doses of intravenous bolus of 1 g of magnesium sulphate in first 24 hours after surgery (Mg group) and another seventy five patient did not receive was taken as comparative group (no Mg Group). Patients were analysed into three blocks, depending on the type of surgery performed: coronary bypass,

valvular interventions, or other (including both coronary and valvular interventions). The patients were followed until hospital discharge or until death.

Anaesthetic Management

The anaesthesia protocol comprised fentanyl and midazolam for induction, rocuronium for myorelaxation, and midazolam, propofol for anaesthesia maintenance. Patients were extubated in the ICU according to standard protocol.

Surgical and cardiopulmonary bypass management

Standard technique were used for all operations in surgical procedure, sternotomy and cardiopulmonary bypass. Myocardial protection consisted of intermittent anterograde of cold blood cardioplegia (Composition: calcium chloride 17.6 mg in 100 mL, magnesium chloride 325.3 mg in 100 mL, potassium chloride 119.3 mg in 100 mL, sodium chloride 643 mg in 100 mL) mixed with blood at a ratio of 1:4.

Patients were analysed into two major groups. Those on arrival in the ICU immediately after surgery, the Mg group (n = 75) received three doses of intravenous bolus of 1 g of magnesium sulphate in first 24 hours after surgery. The other group (n = 75) did not received any magnesium supplementations. Serum Mg concentrations were determined on ICU admission and 6, 24 and 48 h later.

All patients underwent continuous, bedside, ECG monitoring with automated, alarmed, arrhythmia detection and recall during their stay in ICU. Twelve-lead ECG recordings were performed before surgery and at ICU admission. The episode of arrhythmia were interpreted by an intensive care physician. Indications for pacemaker stimulation were: advanced atrioventricular blockade, bradycardia or heart rate <70 bpm symptomatic, as it is in patients who require a higher heart rate to maintain adequate cardiac output in immediate postoperative cardiac surgery. Hemodynamic variables, including arterial blood pressure, heart rate, left atrial pressure, and central venous pressure, were monitored continuously, and hourly urinary output was recorded.

The primary endpoint was intubation time; the secondary endpoints included: length of inotropic support, new atrial fibrillation, ventricular arrhythmias, or bradycardia or atrioventricular block needing the use of pacemaker, length of ICU stay, and ICU and hospital mortality.

Outcome

The primary outcome was mean time to extubation (in hours). The secondary endpoints were the need for inotropic support, length of inotropic support in hours, according to the standard methodology, the appearance of new atrial fibrillation, ventricular tachycardia (sustained or paroxysmal) or ventricular fibrillation, bradycardia or atrioven- tricular blockade requiring the use of a pacemaker, lenght of ICU stay, and ICU and hospital mortality.

Statistical Analysis

Values of variables with repeated measures were compared using an analysis of variance for repeated measures. The Bonferroni *post hoc* test was used to find differences in the comparison between groups. Continuous variables were analyzed by means of Student's t test and categorical variables with the chi-square test. Data are expressed as % or mean SD. Statistical significance was set at $p < 0.05$. Analyses were carried out with SPSS 14.0 for Windows.

Results

Serum Mg concentrations were significantly higher in the Mg group, especially at 6 and 24 h ($p<0.001$). Twenty one (14%) of the 150 patients had hypomagnesemia (<0.65 mmol/L) on ICU admission (Table 1). There was a significant difference (Table 1) in the number of patients with hypomagnesemia in the two groups (15 in the no Mg group and 6 in the Mg group, $p = 0.012$).

There were significant differences between the two groups with regard to the primary outcome (hours of intubation) or the secondary outcomes. There were differences in the need for vasoactive support, or in the hours with vasoactive support, ICU stay, or mortality.

There was one death in the ICU, due to a perioperative myocardial infarction in a patient in the no Mg group where patient did not receive magnesium. The other variables, such as perioperative myocardial infarction and evolution of oxygenation index over time were slightly higher in the no Mg group. But the Mg group presented (Table 1) a slightly higher incidence of acute renal failure (5.7% versus 2.7%), higher delta creatinine and higher creatinine peak, although the difference was statistically significant only in the last of these variables (P=0.012). No adverse effects of magnesium supplementation were detected in any of the patients receiving the treatment.

The new atrial fibrillation (Table 1) incidence of was higher in the no Mg group (18%) than in the Mg group (8%) which is statistically significant (P=0.013). No patients had ventricular fibrillation and, four patients in Mg group presented ventricular tachycardia and nine patients in the no Mg group. One patient in the no Mg group required cardioversion. Bradycardia (heart rate <60 per min) was present in 5.4% of the patients in the Mg group compared with 3.1% in the no Mg group, the differences were not statistically significant (P=0.056). No patient in Mg group presented with advanced atrioventricular blockade.

Table 1

	No Mg group (n = 75)	**Mg group (n = 75)**
Hours intubated	12.7 ± 3.8	10.2 ± 3.4
Inotropes or vasopressors (n)	(60) 80.3%	(54) 72%
Hours	43.4 ± 22.8	34.8 ± 16.9
Acute renal failure (n)	(2) 2.7%	(4) 5.7%
Hypomagnesemia 0 h (n)	(15) 20%	(6) 8%
New atrial fibrillation (n)	(18) 24%	(8) 10.6%
Ventricular Trachycardia (n)	(9) 12%	(4)5.3%
Hours ICU stay (Hrs)	76.8 ± 47.6	69.0 ± 37.9
ICU mortality (n)	1	0

Discussion

There was significant difference between the non Mg group and the Mg group with respect to the incidence of arrhythmias. Patients who developed new atrial fibrillation had lower serum magnesium concentrations and the difference was statistically significant.

±

In this study, we found that the primary endpoint that is duration of the intubation time was significantly higher than in non Mg group. These findings are matching with suggestions of the England *et al*. study, which found non-statistically significant trends in the magnesium group towards a shorter period of intubation and a lower incidence of respiratory failure [2].

The vasoactive support requirement and hours of vasoactive support of the two groups were significantly different which suggests that the possible slight increase in the cardiac index induced by magnesium [2]. This outcome variable suggests changes in myocardial contractility. Though this can be impressed that the routine post operative echocardiography at one week does not suggest any difference in ventricular function.

Our finding is contrast to certain studies which suggest that magnesium has no effect on atrial fibrillation or on dangerous ventricular arrhythmias [2, 12, 13]. Studies carried out in particular including Mg administration in the operating room has beneficial affect in patient outcome [14, 15]. But in an meta-analysis, Shiga *et al*. stressed the significant heterogeneity between trials with regard to supraventricular and ventricular arrhythmias, which limits the impact of their conclusions [9].

Though the sample size of our study is relatively small in number, the low rate of sustained ventricular arrhythmias after cardiac surgery, ranging from 0.4% to 1.4%, may also make any possible changes difficult to detect [16]. Most of the studies to prevent atrial arrhythmias in postoperative cardiac surgery patients are performed in patients undergoing CABG. There are very few studies specifically addressed towards the ability of Mg to prevent atrial arrhythmias after valvular heart surgery and other form of cardiac surgery. Our study provides results for treatment with magnesium in this type of heart surgery. The cause of atrial arrhythmias after cardiac surgery is most likely multifactorial, and some of the factors that can influence are: cardiopulmonary bypass and aortic cross-clamp, myocardial ischemia and reperfusion, local inflammatory reaction, excessive catecholamine, all common in CABG and valve replacement. This study shows there was significant difference between the no magnesium group and the Mg group with respect to the incidence of arrhythmias in any of the surgery groups.

Though the 24 hous Holter ECG monitoring is ideal for detecting cardiac arrhythmias, but the monitoring system employed maintains all the ECG register in the memory and an automated alarm system; all printout records throughout the study period can be were reviewed.

The requirement for pacemaker stimulation in the magnesium group is very probably related to the cation's calcium antagonist effects and the high serum Mg concentrations [2]. This does not have negative repercussions in these patients as all of whom are connected to the pacemaker on demand mode. It does not seem to be clinically relevant.

The absence of any repercussion of Mg administration on ICU and hospital mortality or on length of stay has been reported elsewhere [17]. Nevertheless, as mortality rates after cardiac surgery are very low where possible differences cannot be excluded. In our study, 14% of patients had hypomagnesemia immediately after cardiac surgery and this finding correlates with the other studies [2, 14, 18]. Previous research shows development of new postoperative atrial fibrillation has a strong relationship with lower postoperative plasma magnesium levels [12, 19, 20]. The increase in atrial fibrillation in the no Mg group in our study is perhaps attributable to the fact that this group had patients with hypomagnesemia on ICU admission. The starting of magnesium replacement immediately after surgery has positive impact in myocardial stabilization which prevents cardiac arrhythmia.

Limitations of this study

1. The sample size is limited.
2. The serum magnesium concentration does not reflect the intracellular concentration of magnesium.
3. Perhaps a more specific arrhythmia detector, such as a Holter, would have highlighted additional changes.
4. All concomitant medications received by the two groups of patients were not included into the database which might have potential impact the outcomes

References

1. Fawcett WJ, Haxby EJ, Male DA. Magnesium: physiology and pharmacology. Br J Anaesth. 1999; 83:302-20.
2. England MR, Gordon G, Salem M, Chernow B. Magnesium administration and dysrhythmias after cardiac surgery. A placebo-controlled, double-blind, randomized trial. JAMA. 1992; 268:2395-402.
3. Chernow B, Bamberger S, Stoiko M, Vadnais M, Mills S, Hoellerich V *et al*. Hypomagne- semia in patients in postoperative intensive care. Chest. 1989; 95:391-7.
4. Woods KL, Fletcher S, Roffe C, Haider Y. Intravenous magnesium sulphate in suspected acute myocardial infarction: results of the second Leicester intravenous magnesium intervention trial (LIMIT- 2). Lancet. 1992; 339:1553-8.
5. Antman E, Cooper H, McKinley S, Assmann S. Early administration of intravenous magnesium to high risk patients with acute myocardial infarction in the Magnesium in Coronaries (MAGIC) Trial: a ran- domised controlled trial. Lancet. 2002; 360:1189-96.
6. Booth JV, Phillips-Bute B, McCants CB, Podgore- anu MV, Smith PK, Mathew JP *et al*. Low serum magnesium level predicts major adverse cardiac events after coronary artery bypass graft surgery. Am Heart J. 2003; 145:1108-13.
7. Parikka H, Toivonen L, Pellinen T, Verkkala K, Järvinen A, Nieminen MS. The influence of intra- venous magnesium sulphate on the occurrence of atrial fibrillation after coronary artery bypass ope- ration. Eur Heart J. 1993; 14:251-8.
8. Kaplan M, Kut MS, Icer UA, Demirtas MM. Intra-venous magnesium sulfate prophylaxis for atrial fibrillation after coronary artery bypass surgery. J Thorac Cardiovasc Surg. 2003; 125:344-52.
9. Shiga T, Wajima Z, Inoue T, Ogawa R. Magnesium prophylaxis for arrhythmias after cardiac surgery: a meta-analysis of randomized controlled trials. Am J Med. 2004; 117:325-33.
10. Miller S, Crystal E, Garfinkle M, Lau C, Lashevsky I, Connolly SJ. Effects of magnesium on atrial fibril- lation

after cardiac surgery: a meta-analysis. Heart. 2005; 91:618-23.
11. Roscoe A, Ahmed B. A survey of peri-operative use of magnesium sulphate in adult cardiac surgery in the UK. Anaesthesia. 2003; 58:363-84.
12. Toraman F, Karabulut EH, Alhan HC, Hurle A, Fell GS, Wheatley DJ. Magnesium infusion dramatically decreases the incidence of atrial fibrillation after coronary artery bypass grafting. Ann Thorac Surg. 2001; 72:1256-62.
13. Kohno H, Koyanagi T, Kasegawa H, Miyazaki M. Three-day magnesium administration prevents atrial fibrillation after coronary artery bypass graft- ing. Ann Thorac Surg. 2005; 79:117-26.
14. Yeatman M, Caputo M, Narayan P, Lotto AA, Ascione R, Bryan AJ *et al*. Magnesium- supplemented warm blood cardioplegia in patients undergoing coronary artery revascularization. Ann Thorac Surg. 2002; 73:112-8.
15. Caspi J, Rudis E, Bar I, Safadi T, Saute M. Effects of magnesium on myocardial function after coronary bypass grafting. Ann Thorac Surg. 1995; 59:942-7.
16. Chung MK. Cardiac surgery: postoperative arrhyth- mias. Crit Care Med. 2000; 28[Suppl.]:N136-144.
17. Alghamdi AA, Al-Radi OO, Latter DA. Intravenous magnesium for prevention of atrial fibrillation after coronary artery bypass surgery: a systematic review and meta-analysis. J Card Surg. 2005; 20:293-9.
18. Aglio LS, Stanford GG, Maddi R, Boyd JL III, Nussbaum S, Chernow B. Hypomagnesemia is common following cardiac surgery. J Cardiothorac Vasc Anesth. 1991; 5:201-8.
19. Zaman AG, Alamgir F, Richens T, Williams R, Roth-man MT, Mills PG. The role of signal averaged P wave duration and serum magnesium as a combined predictor of atrial fibrillation after elective coronary artery bypass surgery. Heart. 1997; 77:527-31.
20. Treggiari-Venzi MM, Waeber JL, Perneger TV, Suter PM, Adamec R, Romand JA. Intravenous amio- darone or magnesium sulphate is not cost-beneficial prophylaxis for atrial fibrillation after coronary artery bypass surgery. Br J Anaesth. 2000; 85:690-5.