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Research Article

To Study the Effect of Magnesium Sulfate on Rhythm Disturbances While Coming off Cardio Pulmonary Bypass in Patients Undergoing Cardiac Surgery

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Abstract: **Objective**: To evaluate the effect of intravenous magnesium sulfate on post-operative complications when given prophylactically while coming of cardio pulmonary bypass (CPB) in patients undergoing cardiac surgery. **Methodology**: A double-blinded randomized study conducted at a tertiary care center in western Maharashtra from Nov 2017 to Feb 2019. Patients were divided into two groups. Group A (Magnesium sulfate group) (n=130) & Group B (control group) (n=130). Patients undergoing on pump Coronary artery bypass grafting (CABG), Mitral valve replacement/repair (MVR), Aortic Valve Replacement (AVR) or both AVR & MVR (DVR) on CPB were included in the study. Once surgery was over, aortic cross clamp taken out & temperature of 36°c was attained, Group A patients received Injection Magnesium sulfate 1 gm IV slowly over 10 minutes. Patients were monitored for heart rate, intra-arterial blood pressure oxygen saturation, continuous electrocardiograph with automatic ST segment analysis apart from this ECG mapping was done. **Results:** There was no significant Statistical difference regarding the demographic data, comorbidities & ejection fraction between the two groups. The result shows a statistically significant difference (P=0.032) between the two groups with regards to the incidence of atrial fibrillation. In group A 10 patients (7.70%) had atrial fibrillation compared to group B where 28 patients (21.6%) had atrial fibrillation. Weaning from CPB was easier in group A patient compared to group B & also group A patient needed smaller doses of pharmalogical support, than group B. **Conclusion:** A single bolus 1Gm dose of magnesium sulfate while coming off from CPB has an excellent effect in reducing the incidence of atrial fibrillation. Further magnesium reduced the amount of pharmacological support which was required to come off CPB.

Keywords: *CABG: Coronary artery bypass grafting, MVR: Mitral valve replacement/ repair, AVR: Aortic valve replacement, DVR: Dual valve replacement, IABP: Intra-aortic balloon pump, CPB:Cardio-Pulmonary Bypass.*

INTRODUCTION

Magnesium is an intra-cellular cation and it is mainly involved in stabilization of cell membrane. Whenever there is an increase in the level of stress hormones as in cases of patients undergoing cardiac surgery there is an increased excretion of magnesium in urine leading to hypomagnesaemia which is in turn associated with severe complications (Chadda, K. D. *et al.*, 1973; Satur, C. M. *et al.*, 1993).

Other perioperative causes which may lead to hypomagnesaemia in cardiac surgical patients includes hemodilution, blood loss, blood transfusion, chelation of magnesium due to catecholamines, intracellular shift of magnesium induced by extra corporeal circulation &hypothermia during surgery (Inoue, S. *et al.*, 2004).

The aim of the present study was to evaluate the effect of intravenous magnesium sulfate on post-operative complications when given prophylactically as a bolus dose while coming of cardio pulmonary bypass (CPB) in patients undergoing cardiac surgery

MATERIAL & METHOD

After obtaining informed written consent & approval of ethics & research committee, a double-blinded randomized study was conducted at a tertiary care center in western Maharashtra from Nov 2017 to

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Feb 2019. Patients were divided into two groups. Group A (Magnesium sulfate group) (n=130) & Group B (control group) (n=130). Patients undergoing on pump Coronary artery bypass grafting (CABG), Mitral valve replacement/repair (MVR), Aortic Valve Replacement (AVR) or both AVR & MVR (DVR) on CPB were included in the study. Patients undergoing redo & emergency CABG, renal insufficiency (serum creatinine ≥ 1.5 mg/dl), any history of respiratory illness (Bronchial asthma/Chronic obstructive lung disease), any history of cardiac dysrhythmias were excluded from the study. Group A patients received 1gram of magnesium sulphate Intravenous once the aortic cross clamp was off & temperature was 36°C. Group B did not receive any Mgso4.

Anesthesia Technique

Under strict aseptic precaution in Operation Theater under local anesthesia a wide bore peripheral IV cannula, Right Radial Artery Cannulation &Right Femoral Artery Cannulation was done to enable continuous hemodynamic monitoring. Patients were induced with Inj etomidate (0.2mg/kg), Inj Fentanyl (3-5 µg/kg) & rocuronium (0.8-1mg/kg). After induction of patients, central venous cannulation & pulmonary artery cannulation was done. Anesthesia was maintained with Oxygen/air (50%) Sevoflurane (1-3%) & Atracurium (0.5-1 mg/kg). After sternotomy & Heparinisation, CPB was established once ACT was ≥ 420 sec by cannulation of Ascending Aorta &Right Atrium. Once surgery was over, aortic cross clamp taken out & temperature of 36°c was attained, Group A patients received Injection Magnesium sulfate1 gm IV slowly over 10 minutes. If there was any difficulty in weaning off from CPB in both the groups, patients were started on pharmacological support like Inj Dopamine, Adrenaline, Noradrenaline, Nitroglycerine or mechanical support with intra-aortic balloon pump(IABP).

Monitoring Of Patients

Patients were monitored for heart rate, intra-arterial blood pressure oxygen saturation, continuous electrocardiograph with automatic ST segment analysis part from this ECG mapping was done. Other monitoring involved central venous pressure, pulmonary artery pressure, pulmonary capillary wedge pressure (PCWP), urine output (UOP) ABG for gases magnesium, potassium & Blood sugar levels. Once the patients were shifted to the ICU a twelve lead ECG was taken immediately & was recorded daily for 6 days or until the onset of new cardiac arrhythmias.

Atrial fibrillation was defined on ECG with no P waves, fibrillatingchaotic F waves with varying R-R intervals. Supra ventricular tachycardia was defined as ECG with P waves with abnormal shape with abnormal PR interval usually regular rhythm. Ventricular tachycardia was defined as more than three ventricular extra systoles with broad complexes in a row at ≥ 120 Bpm. Ventricular fibrillation was defined as broad complexed ventricular dysarrhythmia with a frequency of 400-600 per min and irregular rhythm with AV dissociation.

Statistical Analysis

Data were statistically described in terms of mean± standard deviation or frequencies (number of cases) and percentages when appropriate. Data was analyzed by SPSS (Statistical package for social sciences) version 20.0 for windows. Chi square test &fisher exact test was applied to observe the association of qualitative variables with both groups while for quantitative variables independent t test was applied. P ≤ 0.05 was considered statistically significant.

Results

There was no significant Statistical difference regarding the demographic data (Age, weight, gender), comorbidities (Diabetes mellitus, hypertension, Obesity), Smoking& Ejection Fraction between the two groups (Table-1). Further there was no significant statistical difference in the procedure, preoperative medication (Table-2), Intra operative time &intervention (Table-3).

Table-1 Demographic & Co-Morbidity Conditions

Variables	Group A(N=130) (Mg +)	Group B(N=130)	P
Age (year)	60.70± 12.62	61.15 ± 13.25	0.848
Weight (Kg)	82.82 ± 13.55	81.57 ± 12.95	0.603
Gender(M/F)	78:52	84:46	0.707
DM	43 (31.1%)	33 (25.4%)	0.173
HTN	37(28.5%)	27(20.8%)	0.15
Obesity	32(24.6%)	38(29.2%)	0.402
Smoking	39(30%)	38(29.2%)	0.89
EF ≤ 40%	66(50.8%)	62(47.7%)	0.62

DM: Diabetis Mellitus, HTN: Hypertension, EF: Ejection Fraction

Table-2 Procedures & Pre-Operative Medications

Variables	Group A(n=130) (Mg +)	Group B(n=130)	P
Procedures CABG (On Pump) MVR AVR DVR	 106(81.6%) 5(3.8%) 12(9:2%) 7(5.4%)	 105(80.7%) 5(3.8%) 13(10%) 7(5.4%)	 0.95
Diuretic	80	70	0.081
ACEI	49	40	0.567
BB	96	104	0.518
CCB	64	57	0.716

CABG: Coronary artery bypass grafting, MVR: Mitral valve replacement/ repair, AVR: Aortic valve replacement, DVR: Dual valve replacement, ACEI: Angiotensin converting enzyme inhibitor, BB: Betablockers, CCB: Calcium channel blockers.

Table-3 Intraoperative Time & Intervention

Variables	Group A(n=130) (Mg +)	Group B(n=130)	P
Cross clamp time ≥ 50 min	30(23.1%)	30(23.1%)	1
CPB ≥ 70min	43(33.1%)	45(34.6%)	0.793
LIMA	89(68.5%)	84(65.1%)	0.568
IABP	6(4.6%)	6(4.6%)	1
Mortality	1(0.8%)	2(1.5%)	1

LIMA: Left internal mammary artery, IABP: Intra-aortic balloon pump

Group B patients had a higher incidence of SVT 22 (17%), Compared to Group A 12 Patients (9.2%) (P≤0.21). The result shows a statistically significant difference (P=0.032) between the two groups with regards to the incidence of atrial fibrillation. In group A 10 patients (7.70%) had atrial fibrillation compared to group B where 28 patients (21.6%) had atrial fibrillation. The association of decreased incidence of atrial fibrillation in group A compared to group B shows an association of intravenous magnesium administration & atrial fibrillation (Table 4). Weaning from CPB was easier in group A patient compared to group B & also group A patient needed smaller doses of pharmalogical support; than group B (Table 5).

Table-4 Association of Post-Operative Arrhythmias

Variables	Group A(n=130) (Mg +)	Group B(n=130)	P
SVT	12(9.2%)	22(17%)	0.21
AF	10(7.70%)	28(21.6%)	0.032
VT	2(1.6%)	6(4.6%)	0.622
VF	0(0%)	2(1.5%)	0.498

SVT: Supra ventricular tachycardia, AF: Atrial fibrillation, VT: Ventricular tachycardia, VF: Ventricular fibrillation.

Table 5: Pharmacological Support between the Groups While Weaning off from CPB

	Group A	Group B	P
Dopamine	6.64±1.28	7.15±1.36	0.035
Adrenaline	0.04±0.02	0.05±0.03	0.032
Noradrenaline	0.05±0.02	0.06±0.03	0.030
Nitroglycerine	0.55±0.43	0.75±0.54	0.025

DISCUSSION

The present study showed that when injection magnesium sulfate is given to patients while coming of CPB, it reduces the incidence of rhythm disturbances& also reduces the amount of pharmacological support required while weaning of CPB.

The main mechanism of action by which magnesium maintainces the resting membrane potential of myocardial tissue is by preventing the outward flow of potassium & inflow of calcium. When the levels of magnesium are reduced it leads to lots of complications like, it increases the risk of arrhythmias, itpredisposes the coronary artery to go into spasm& also contributes to Neurological irritability (Chadda, K. D. *et al.*, 1973). The other beneficial effect of magnesium includes that it reduces platelet aggregation, it inhibits the release of catecholamine's which occurs due to stress (James, M.F. *et al.*, 1989; Sjogren, A. *et al.*, 1986).

Khan *et al.*, (1973) & Scheinman *et al.*, (1969) reported that magnesium plays an important role in reducing the incidence of arrhythmias when given prophylactically and may contribute to improved cardiac contractile indices after CPB.

Many studies have shown that intravenous injection of magnesium as an effective means to correct hypomagnesaemia& to reduce the incidence of atrial fibrillation (Kaplan, M. *et al.*, 2003; Wronska, J. *et al.*, 2005). Fanning *et al.*, (1991) reported that the injection of magnesium sulfate at the dose of 84mmol/96 hrs reduced the incidence of atrial fibrillation from 28% to 14.3% but it was not statistically significant. In another study a complete elimination of AF was noted in patients who received 1 gm of magnesium sulfate in the

priming solution & an infusion of Mgso4 in post-operative period (Speziale, G. *et al.*, 2000). In our study a single bolus of 1 gm of magnesium sulfate was given while coming of CPB when aortic cross clamp was removed and when the temperature was 36^0c. We found out that there was a significant reduction in the incidence of atrial fibrillation and a reduced need for pharmacological support.

CONCLUSION

A single bolus 1Gm dose of magnesium sulfate while coming off from CPB has an excellent effect in reducing the incidence of atrial fibrillation, even if the infusion was not used in the post-operative period. Further magnesium reduced the amount of pharmacological support which was required to come off CPB.

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