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Original Article

Effect of Magnesium Sulfate in Prevention of Postoperative Atrial Fibrillation Arrhythmia among Candidates of CABG Surgery with Abnormal P-wave Duration

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Abstract

Background: Cardiac arrhythmias, especially atrial fibrillation, are among the most common early complications of open-heart surgery. Hypomagnesemia is one of the clinical mechanisms associated with the pathogenesis of postoperative atrial fibrillation. This study aimed to evaluate the effect of magnesium sulfate on the prevention of atrial fibrillation in patients with abnormal P-wave duration who underwent coronary artery bypass graft (CABG)surgery.

Methods: In this clinical trial, 150 patients participated who had undergone CABG surgery at Imam Khomeini hospital in Ahvaz in 2014. According to the inclusion criteria, the intervention and control groups were randomly matched. The intervention group, consisting of 57 patients, received 2.4 g of magnesium sulfate daily for three days and 75 patients of the control group received a placebo. Prevention of postoperative atrial fibrillation by magnesium sulfate was evaluated in patients and data were analyzed using SPSS software.

Results: The two groups did not have a significant difference in terms of gender, diabetes, hyperlipidemia, and hypertension. Also, mean P-wave duration, length of intensive care unit stay, the total length of hospitalization, left ventricular ejection fraction (LVEF), distribution of creatinine, atrial fibrillation, and aortic clamp time in intervention and control groups were not statistically significant. Only, the total pump duration difference was reported to be statistically significant between groups.

Conclusion: The results of our study showed that the administration of magnesium sulfate alone cannot be helpful in the prevention of atrial fibrillation among patients with long P-wave duration.

Trial Registration: https://www.irct.ir/, Identifier: IRCT2015092814190N9

Keywords: Magnesium sulfate, Atrial fibrillation, Coronary artery bypass, Cardiac surgery, Arrhythmias

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Introduction

Atrial fibrillation (AF), namely a supraventricular arrhythmia, is one of the most common complications after coronary artery bypass graft (CABG) surgery with an incidence rate of 20%-40% that usually occurs after open heart surgery (1). The prevalence of AF in the general population is 0.51% which increases with age. This type of arrhythmia affects the life quality of patients and even increases the risk of death after surgery (2,3). Despite many advances in surgical techniques, the incidence of AF after CABG surgery has not decreased. Embolism, stroke, prolonged hospital stay, increased risk of mortality, and long-term follow-up along with high economic costs for patients are among the major complications of this type of arrhythmia (4). Therefore, identifying patients at high risk of postoperative AF and interventional therapeutic strategies to reduce its incidence seems necessary. The exact mechanisms of postoperative AF are not well understood but it is of note that many pre-, intra-, and post-operative factors might affect the development of such arrhythmias (5). Electrolyte disorders such as hypomagnesemia have been attributed to the pathogenesis of AF after CABG (6-8). Magnesium is an important cofactor for the Na-K ATP pump involved in numerous physiological processes modulating cardiovascular functions such as regulation of myocardial excitability (9). In this regard, studies have shown an association between low blood magnesium levels and the occurrence of arrhythmias following cardiac surgery (10). The administration of magnesium sulfate to prevent AF arrhythmia and its complications has been reported in various studies, but there is a difference in results in terms of its effectiveness in reducing the incidence of cardiac arrhythmias (11-13).

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Recently, it has been shown that magnesium sulfate as an adjunctive therapy reduced ventricular rate in patients with rapid AF as well as minor adverse effects in the first-hour management in the emergency department (14). On the other hand, several studies showed significant heterogeneity of magnesium effectiveness in terms of its dose and timing of administration (15,16). This conflicting evidence might be attributed to the lack of pharmacokinetic data and knowledge associated with the optimal dosage of magnesium which might affect the prevention of postoperative AF (17). Since few studies have been performed in Iran in this regard, this study aimed to investigate the effect of magnesium sulfate on the prevention of postoperative AF arrhythmia in candidates for CABG surgery**.** This may help identify patients with a high risk of AF and their length of intensive care unit (ICU) stay and prevent long-term hospitalization and consecutive mortality and morbidity.

Methods

This double-blind randomized clinical trial was performed on a study population including 150 patients who underwent CABG surgery at Imam Khomeini Hospital in Ahvaz in 2014. The inclusion criteria consisted of being aged 18 years or older, being a candidate for CABG surgery, and having a P-wave duration of more than 100 milliseconds. All patients with concomitant heart valve surgery, a history of thyroid disorders, SSS, AF, AV block, those treated with antiarrhythmic drugs except beta-blockers, and patients with allergic reactions to magnesium sulfate were excluded from the study. Seventy-five patients treated with magnesium sulfate were considered as the intervention group and 75 other patients were assigned to the control group. Due to the high prevalence of AF after surgery in diabetics and the elderly, the control and intervention groups were matched in terms of clinical characteristics, age, and diabetes. In addition to routine procedures in subjects of both groups, patients in the intervention group received 2.4 g of magnesium sulfate daily for three days before surgery. To assess the symptoms of cardiac arrhythmias, patients were subject to cardiac monitoring 24 hours before surgery, three days postoperatively in the ICU, and also after being transferred to the ward until discharge. If arrhythmia was observed in monitoring, a 12-lead electrocardiogram (ECG) was taken to confirm the diagnosis. The incidence of AF after surgery, P-wave duration distribution, aortic clamp time, and total pump duration of patients in both groups were recorded after final approval by a cardiologist. The length of ICU stay as well as the total hospitalization period and distribution of creatinine and left ventricular ejection fraction (LVEF) of patients in both groups were also recorded in patients' files. In this study, AF is considered a condition in which AF has lasted more than 10 minutes or requires emergency intervention due to unstable hemodynamics. The data were analyzed using SPSS software. Quantitative (mean and SD) and qualitative data (frequency) were reported. Qualitative and quantitative variables were analyzed using Fisher's exact test, *t* test, and Mann-Whitney test. P-values smaller than 0.05 were considered significant in this study.

Results

The mean age of patients in the intervention and control groups were 59.4 ± 10.5 and 58.8 ± 10.2, respectively; implying that there was no statistically significant difference ($P = 0.701$). The difference between patients in intervention and control groups was not significant in terms of gender, diabetes, hypertension, and hyperlipidemia (Table 1). Among the patients in the intervention group who received magnesium sulfate daily, 14 patients (18.7%) developed AF, which was not significantly different ($P = 1$) from the control group including 15 patients (20%) (Table 2). The distribution of mean length of ICU stay in intervention and control groups did not show a significant difference ($P = 0.277$). The mean total hospitalization period was 9.8 ± 4.8 days in the intervention group and 9.5 ± 6.5 days in the control group, showing no statistically significant difference ($P = 0.406$) (Table 3). In Table 4, the distribution of mean P-wave duration, aortic clamp time, and total pump duration difference in patients of the two groups were examined. The study of the above-mentioned variables did not show a statistically significant difference except for the total pump duration difference that was considered statistically significant between groups. As shown in Table 5, the mean distribution of creatinine and LVEF were not significantly different between the two groups.

Table 1. Demographic characteristics and underlying diseases of control and intervention groups

Variable	Intervention group	Control group	*P* value
Age, mean ± SD	59.4 ± 10.5	58.8 ± 10.2	0.701
Gender (male), %	69.3	66.7	0.861
Gender (female), %	30.7	33.3	0.861
Diabetes, %	53.3	60	0.968
High blood pressure, %	52	48	0.744
Hyperlipidemia, %	62.7	68	0.607

P value < 0.05 was considered significant.

Table 2. The incidence of atrial fibrillation in patients of control and intervention groups

Incidence of atrial fibrillation	Intervention group		Control group		*P* value
	Number	Percent	Number	Percent	
Yes	14	18.7	15	20	
No	61	81.3	60	80	1
Total	75	100	75	100	

P value < 0.05 was considered significant.

Discussion

Cardiovascular diseases are one of the most common causes of death occurring mainly due to atherosclerosis of coronary arteries with increasing prevalence according to available data (18). CABG surgery is a treatment option for coronary artery stenosis, and postoperative AF is still one of the most frequent complications of CABG surgery (19,20). Electrolyte disorders such as magnesium deficiency are one of the underlying mechanisms in the occurrence of AF (21). Furthermore, electrocardiographically, P-wave duration is known as an endophenotype for AF (22). Therefore, this study was performed to evaluate the effect of magnesium sulfate on the prevention of AF in patients with abnormal P-wave duration who underwent CABG surgery.

The findings of the present study showed that daily administration of 2.4 g magnesium sulfate for three days before surgery could not affect the distribution of AF after CABG surgery, since almost one-fifth of patients in both intervention and control groups developed postoperative AF. It is noteworthy that this amount of magnesium sulfate did not cause significant changes in creatinine level, LVEF, and the total length of ICU and hospital stay. Based on a study conducted by Kohno et al on 200 patients undergoing elective CABG surgery, the effect of magnesium sulfate administration on the incidence of postoperative AF was investigated and the results showed that magnesium sulfate can decrease the incidence rate of postoperative AF from 35% to 16% in the control group. They also reported that old age and low LVEF were independent predictors of AF and administration of magnesium sulfate was not effective in reducing the incidence of AF in old-aged patients and those with low LVEF (23). Other studies investigating the effect of magnesium administration on AF following CABG surgery showed that magnesium sulfate significantly reduced the incidence of AF in the study group compared with the controls (24,25). The discrepancy between the results of the above-said findings and the present study may be due to differences in the studied populations. This is because the target population in the present research includes patients with long P-wave duration, which is itself an independent factor in the occurrence of AF after cardiac surgery.

Despite the prevalence of AF after CABG surgery and the fact that old age is a risk factor for heart surgery, the results of the present study showed that administration of magnesium sulfate in old age does not affect preventing AF, which was similar to the results of other studies (13,23). Research has shown that long P-wave duration is one of the predictors of postoperative AF (26). However, in the present study, although patients had a P-wave duration of > 100 milliseconds, the incidence rate of AF was lower than usual, which could be owing to the choice of patients at risk due to long P-wave duration, elimination of other risk factors of AF and also surgical factors, and considering longer duration (10 minutes) of AF as diagnostic criteria. The results of Lancaster et al. concerning the lack of effect of magnesium sulfate on the prevention of AF were similar to our findings. They reported that not only magnesium did not decrease AF after cardiac surgery but also it had an inductive effect on postoperative AF (27). Therefore, the fact that patients' blood magnesium levels were not evaluated was a limitation of the present study.

Table 3. Distribution of mean hospital stays of patients in both intervention and control groups

Variable	Intervention group	Control group	*P* value
Total hospitalization time	9.8 ± 4.8	9.5 ± 6.5	0.406
Hospitalization period in ICU	3.9 ± 3.9	3.8 ± 3.9	0.277

Abbreviation: ICU: Intensive care unit.
Data were presented as mean ± SD. *P* value < 0.05 was considered significant.

Table 4. Mean distribution of P-wave duration, aortic clamp time and pump duration in patients of both groups

Variable	Intervention group	Control group	*P* value
P-wave duration	119.5 ± 10.5	116.8 ± 9.4	0.092
Clamp aorta time	52.3 ± 21.1	58.2 ± 25	0.122
Total pump duration	91.4 ± 36.1	104.1 ± 40.6	0.048*

Data were presented as mean ± SD. *P* value < 0.05 was considered significant.

Table 5. Mean distribution of creatinine and left ventricular ejection fraction in patients of both groups

Variable	Intervention group	Control group	*P* value
Creatinine	1 ± 0.2	1 ± 0.3	0.748
LVEF	45.9 ± 8.6	44.5 ± 8	0.304

Abbreviation; LVEF: left ventricular ejection fraction.
Data were presented as Mean ± SD. *P* value < 0.05 was considered significant.

Limitations of the study

This study had some limitations. First, baseline magnesium level was not considered. Second, a relatively long duration (10 minutes) of AF was one of the inclusion criteria.

Conclusion

Atrial fibrillation occurrence is relatively frequent after CABG in patients with long P-wave duration, and administration of magnesium sulfate alone may not be helpful in the prevention of AF in such patients.

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Conflict of Interests

The authors report no conflict of interest

Ethical Approval

The present study was conducted after obtaining written informed consent from patients along with receiving the ethics code from the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1392.197).

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