

# Effects of Intravenous Magnesium Sulfate and Lidocaine on Hemodynamic Variables Following Direct Laryngoscopy and Intubation in Elective Surgery Patients

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**Background:** Laryngoscopy and intubation incur hemodynamic changes like increase in heart rate, arterial blood pressure, pulmonary artery pressure, wedge capillary pressure and arrhythmias. Anesthesiologists are continually in search of ways to alleviate such complications. Several medicinal methods have been suggested that serve the purpose including the administration of intravenous magnesium sulfate to minimize these unfavorable responses. This study compares the effects of intravenous administration of lidocaine and magnesium sulfate on unwanted hemodynamic responses following laryngoscopy and intubation in elective surgery candidates.

**Materials and Methods:** This randomized double-blind clinical trial was conducted on 60 ASA-I and ASA-II candidates who received 60 mg/kg (based on Lean Body Mass) magnesium sulfate or lidocaine randomly before intubation. Values of systolic and diastolic blood pressures, mean arterial pressure, and heart rate were recorded for both groups during the 5 minutes following administration, and compared with baseline values.

**Results:** In both groups, systolic blood pressure increased compared to the baseline value. However, there was a significant difference between the two groups as this increase occurred within the first 3 minutes in the lidocaine group, while within the first minute in the magnesium sulfate group. The increase in diastolic blood pressure was not significant. But there was a significant difference in the mean arterial pressure increase between the two groups since in the magnesium sulfate group this increase occurred in the first minute whereas in the lidocaine group it occurred during the first two minutes. There was no significant difference in the heart rates after intubation between the two groups.

**Conclusion:** Magnesium sulfate is more effective than lidocaine in controlling hemodynamics, although it may increase the heart rate.

**Key words:** Magnesium sulfate, Lidocaine, Laryngoscopy, Intubation, Hemodynamics

## INTRODUCTION

Unfavorable hemodynamic changes such as increase in heart rate, arterial blood pressure, pulmonary artery pressure, wedge capillary pressure, and arrhythmias are common following laryngoscopy and tracheal intubation.

Thus, anesthesiologists have always been seeking ways to avoid these complications (1-3). Numerous pharmacological methods have been suggested to diminish these side effects including use of adrenergic receptor

blockers, calcium channel blockers, opioids, and vasodilators (2, 4,5).

Magnesium sulfate is a bivalent salt that produces vasodilatation and causes a drop in blood pressure by diminishing sympathetic excitability of muscle cells (6). It has been approved as a medication for treatment of preeclampsia and blood pressure management. Its positive effects on ischemic infectious endocarditis and for management of hemodynamic variables in patients with heart disease are being gradually recognized (7-10).

Due to its inhibiting effects on release of catecholamines from adrenergic nerve endings and adrenal medulla, magnesium has been an option for minimizing adverse cardiovascular responses during laryngoscopy and intubation (11). Various studies have compared the administration of intravenous magnesium sulfate before intubation with beta-blockers and lidocaine and concluded that despite theoretical justifications, its efficacy remains controversial, and some even go as far as declaring it ineffective in alleviating unwanted cardiovascular responses (2, 12,13).

Myocardial function due to the direct effect of elevated concentration of magnesium is uncommon. Hypoxia seems to play the main role in cardiac malfunction in humans due to apnea rather than the direct effect of magnesium. Therefore, by proper ventilation, heart will function well, even at excessive plasma levels of magnesium (14).

It is certain that magnesium inhibits catecholamine release from adrenergic and adrenal medulla nerve endings, and studies have indicated that magnesium may have a vasodilatation effect on the cardiovascular system (15-17).

The aim of this study was to compare the effects of intravenous administration of magnesium sulfate with lidocaine on hemodynamics during intubation.

## MATERIALS AND METHODS

In this randomized double-blind clinical trial, 60 patients (30 in each group) were selected among elective

surgery candidates in hospitals affiliated to Shahid Beheshti University of Medical Sciences. Subjects with diabetes, blood pressure history, or addiction, and those on medication for kidney failure, and cardiac arrhythmias were excluded. All patients were in the age range of 20 to 40 years and in ASA-I or II stage. Patients' pre-anesthetic non-invasive blood pressure was measured by sphygmomanometer and recorded along with their pulse rates based on EKG. Any recent heart infection or respiratory disorders were detected with auscultation and ruled out. Once patients' health was confirmed, they were prepared for anesthetic induction. After venipuncture and intravenous infusion of Ringer's solution, 0.01 mg/kg midazolam and 1mg/kg fentanyl were administered, and after 3 minutes of pre-oxygenation, the patient was ready for anesthetic induction. Then, 5 mg/kg sodium thiopental was intravenously administered and after loss of consciousness, 0.2 mg/kg atracurium (a muscle relaxant) was given. Magnesium sulfate or lidocaine was administered intravenously over a 3 minute period. The anesthesiologist was blinded to the administered drug. The dose of magnesium sulfate was calculated as 60 mg based on Lean Body Mass, which was measured using height, weight, and arm circumference. The control group received 1.5 mg/kg lidocaine. Patients were intubated with direct laryngoscopy 3 minutes after administration of lidocaine or magnesium sulfate. Had laryngoscopy taken over 15 seconds or did not succeed the first time; the patient would be excluded from the study. Patients' pulse rate and blood pressure were measured and recorded every minute during the first 5 minutes following intubation.

SPSS version 11.5 software was used for data analysis and variables were analyzed by student t-test and paired t-test.  $P < 0.05$  was considered statistically significant.

## RESULTS

Patients were divided into two groups according to the mean age, risk of surgery, and variables of heart rate,

systolic and diastolic blood pressures, and mean arterial pressure (Table 1).

In the lidocaine group, mean systolic pressure increased after intubation compared with baseline blood pressure and then gradually decreased. This increase compared to the baseline value in the first 3 minutes was statistically significant. In the 4<sup>th</sup> and 5<sup>th</sup> minutes, although the mean value of blood pressure was higher than the baseline mean value, this difference was not significant. Diastolic blood pressure in the lidocaine group also showed an increase, but the difference between the baseline diastolic pressure and blood pressure measured 5 minutes after intubation was not statistically significant.

Heart rate after intubation showed an increase, and in comparison to the baseline value in the first two minutes, this increase was significant. In the 3<sup>rd</sup> minute, there was a borderline difference ( $p=0.068$ ), and in the 4<sup>th</sup> and 5<sup>th</sup> minutes, the difference was not statistically significant.

In the lidocaine group, after intubation, mean arterial pressure (MAP) showed an increase, and in the first and second minutes, this increase was statistically significant compared to the baseline MAP, but in the 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> minutes, this difference was not significant despite higher values of MAP (Table 2).

In the magnesium sulfate group, mean systolic pressure after intubation showed an increase compared with the baseline blood pressure and then gradually decreased. However, this increase was only significant in the first minute.

Diastolic blood pressure in the magnesium sulfate group also showed an increase after intubation, but the difference between the baseline diastolic pressure and

blood pressure measured at 5 minutes after intubation was not significant.

In the magnesium sulfate group, the heart rate after intubation increased, but this increase remained statistically significant for 4 minutes, and in the 5<sup>th</sup> minute the difference between mean heart rate and the baseline value was not significant.

Although after intubation, mean arterial pressure in the magnesium sulfate group increased, this increase was only significant during the first two minutes (Table 3).

A comparison of these variables was also made between the two groups. Accordingly, mean systolic blood pressure in the first and second minutes after intubation was lower in the magnesium group, and despite this value being higher in the 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> minutes in the lidocaine group, the difference was not significant (Table 4).

Comparison of diastolic blood pressure changes in lidocaine and magnesium groups after intubation are shown in table 5.

Comparison of heart rates between the two groups showed an almost equal increase in heart rate in both groups in the first minute after intubation, and no significant difference was found between the two in this regard. But, at the 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> minutes, heart rate was significantly lower in the lidocaine group, and no significant difference existed at 5 minutes (Table 6).

Comparison of mean arterial pressure between the two groups revealed higher values of MAP in the lidocaine group in the first and second minutes, and in the 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> minutes. Although MAP continued to be higher in the lidocaine group, the difference between the two groups was not statistically significant (Table 7).

Table 1. Initial and basic values of patients based on the medication group.

Basic variables	Age	HR	Systolic	Diastolic	MAP
Medication	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Lidocaine	31.47±4.88	77±7.8	122.2±13.6	76.3±9.2	91.6±7.3
Magnesium	30.93±4.92	78.27±6.92	122.1±12.6	75.7±9.9	91.1±7.9
PV	0.654	0.478	0.98	0.799	0.804

Table 2. Systolic and diastolic blood pressure changes as well as heart rate and mean MAP changes after intubation compared to baseline value in lidocaine group.

Time after intubation (min)	First	Second	Third	Forth	Fifth
Mean systolic pressure mm/Hg	136.2±10.3	133.8±13.2	131.5±20.3	127.2±14.7	123.7±13.8
PV	0.0001	0.001	0.049	0.161	0.582
Mean diastolic pressure mm/Hg	78.3±7.6	78±7.3	76.7±7.1	76.5±6.3	76.5±5.6
PV	0.076	0.245	0.856	0.926	0.928
Mean heart rate	85.53±5.85	80.73±5.73	80.2±4.92	78.3±7.05	77.97±6.68
PV	0.001	0.027	0.68	0.519	0.579
Mean MAP	97.6±5.4	96.6±6.8	94.9±8.9	93.4±5.3	92.2±5.6
PV	0.0001	0.001	0.138	0.259	0.187

Table 3. Systolic and diastolic blood pressure changes as well as heart rate and mean MAP changes after intubation compared to baseline value in the magnesium group.

Time after intubation (min)	First	Second	Third	Forth	Fifth
Mean systolic pressure mm/Hg	126.8±10.7	126.2±11.3	126.3±8.6	125.7±8.7	123.1±13.8
PV	0.011	0.183	0.189	0.238	0.679
Mean diastolic pressure mm/Hg	80.3±7.4	79.1±6.9	75.3±7.1	77.7±6.3	72.1±7.8
PV	0.118	0.38	0.54	0.67	0.74
Mean Heart rate	85.23±6.31	84.3±6.73	83.27±5.4	82.9±8.04	80.1±8.9
PV	0.001	0.004	0.004	0.037	0.225
Mean MAP	93.6±6.3	93.9±5.4	93.3±5.9	92.1±5.1	92±6.6
PV	0.003	0.095	0.141	0.254	0.567

Table 4. Comparison of systolic blood pressure changes in lidocaine and magnesium groups after intubation.

Time after intubation (min)	First	Second	Third	Forth	Fifth
Systolic pressure					
Magnesium group	126.8±10.7	126.2±11.3	126.3±8.6	125.7±8.7	123.7±13.8
Lidocaine group	126.2±10.3	133.8±13.2	131.5±20.3	127.2±14.7	123.6±13.9
PV	0.001	0.033	0.207	0.6	0.98

Table 5. Comparison of diastolic blood pressure changes in lidocaine and magnesium groups after intubation.

Time after intubation (min)	First	Second	Third	Forth	Fifth
Diastolic pressure					
Magnesium group	80.3±7.4	79.1±6.9	75.3±7.1	77.7±6.3	72.1±7.8
Lidocaine group	78.3±7.6	78±7.3	76.7±7.1	76.5±6.3	76.3±7.5
PV	0.551	0.511	0.919	1	0.821

Table 6. Comparison of heart rate in magnesium and lidocaine groups after intubation.

Time after intubation (min)	First	Second	Third	Forth	Fifth
Heart rate					
Magnesium group	85.23±6.3	84.3±6.73	83.37±5.4	82.9±8.04	80.1±8.92
Lidocaine group	83.53±5.58	80.73±5.73	80.2±4.92	78.3±7.05	77.97±6.68
PV	0.182	0.038	0.027	0.014	0.343

Table 7. Comparison of mean MAP in magnesium and lidocaine groups after intubation.

Time after intubation (min)	First	Second	Third	Forth	Fifth
Mean MAP					
Magnesium group	93.6±6.3	93.4±5.4	93.3±5.9	92.9±5.1	92±6.1
Lidocaine group	97.6±5.4	96.6±6.8	94.9±8.9	93.4±5.3	92.2±5.6
PV	0.012	0.04	0.414	0.654	0.821

## DISCUSSION

The ability of magnesium ion in inhibiting the release of catecholamines has long been recognized, hence it is considered for use in laryngoscopy and intubation to minimize unwanted cardiovascular responses (16-18). Results of one study (16) showed that in those using magnesium, an increase in systolic blood pressure compared to baseline value occurred in the first minute of intubation; whereas, in the lidocaine group this increase was significant for the first two minutes. Clearly, intubation does cause an increase in systolic pressure, but variables gradually return to normal. Although diastolic blood pressure after intubation increased in both groups, this increase was not significant in either group compared to baseline value. These results may be explained by the fact that magnesium causes vasodilatation directly and also indirectly by sympathetic ganglia blockage and inhibition of release of catecholamines. The difference in mean systolic blood pressure between the two groups can be explained by the effect of magnesium on transient reduction of Systemic Vascular Resistance (SVR) in combination with reduced arterial pressure. Findings of this study regarding heart rate in the two groups indicate that, in addition to a reduction in SVR after administration of magnesium, increased heart rate may be due to inhibition of release of acetylcholine from vagal nerves.

A comparison between the effects of magnesium sulfate and lidocaine on hemodynamic variables and cardiovascular indices was made in a study by Puri et al, on 36 patients with Coronary Artery Disease (CAD) that were candidates for Coronary Artery Bypass Graft (CABG) surgery. It was found that ST segment drop was not significant in the magnesium group but in the lidocaine group 3 patients had this complication (19). Also, increase

in mean arterial pressure was lower in the magnesium group and there was a rise in heart rate in this group, but it was not statistically significant. In this study, mean heart rate in the first minute after intubation in the two groups was not significantly different, but in the 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> minutes it was found that reduction in heart rate in magnesium group was slower than in lidocaine group. However, mean heart rate in both groups returned to the baseline value at the 5<sup>th</sup> minute. The difference between the present study results and others may be due to the differences in patients' age (in this study patients were in the age range of 20 to 40 years).

In a study on the effects of magnesium sulfate on minimizing hemodynamic changes during laryngoscopy, it was emphasized that despite a drop in epinephrine and SVR and naturally diminishing changes in mean arterial pressure, heart rate rises at first but gradually returns to the baseline value (18). The mentioned study lacked a control group; thus, their results regarding the effect of magnesium on heart rate cannot be judged. Results of this study showed that, compared with lidocaine group, heart rate in the 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> minutes was higher in magnesium group, but in the 1<sup>st</sup> minute there was no difference between the two groups. This may have been due to the predominant effect of sympathetic ganglia compared to the inhibitory effects of medication.

Another study showed that after administration of magnesium sulfate, a significant increase occurred in cardiac output and in cardiac index during anesthetic induction and also during endotracheal intubation, and this, in addition to "after load" reduction on the left side, was accompanied by an increase in heart rate (19). Others also showed that administration of magnesium sulfate (whether continuous or single dose) is accompanied by an

increase in cardiac output, which is one of the reasons for increased heart rate (20). However, it should be noted that in the first minute after intubation, heart rate was the same in both groups, but the effect of magnesium on MAP and release of catecholamine in the first minute was not less than its effect on reduction of SVR and after load. Vasodilatation by magnesium has even extended to isolated cardiovascular dilatation. Regarding the lack of a significant drop in ST segment in magnesium group compared to lidocaine group, others have emphasized the direct effect of magnesium ion on cardiovascular dilatation. Magnesium induces systemic and coronary dilatation due to an antagonistic action exerted by calcium ion on extracellular vascular smooth muscles (21), and magnesium ion has the ability to regulate coronary artery tone in healthy subjects as well as in those with angina.

It should be pointed out that administration of lidocaine or magnesium sulfate before anesthetic induction does not prevent increase in blood pressure or heart rate. But results of this study showed that magnesium sulfate was more effective than lidocaine in reducing mean arterial and systolic pressures in the first two minutes after intubation. Although heart rate was higher in the 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> minutes in the magnesium group, in the 1<sup>st</sup> minute when maximum cardiovascular responses occur after intubation, the increase in two groups was not significantly different and only reduction in heart rate in magnesium group was slower compared to lidocaine group. In conclusion, magnesium sulfate is more effective than lidocaine in controlling hemodynamics, although it may increase the heart rate.

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