

# A Randomized, Controlled Research Comparing between Lidocaine and Magnesium Sulfate for Induced Hypotension during Middle Ear Surgery

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## ABSTRACT

**Background:** Controlled hypotension is a strategy to minimize blood loss and improving operative field visibility. The aim of the study is to see the effectiveness and safety of lidocaine and magnesium as hypotensive drugs during middle ear surgery.

**Patients and methods:** This study was conducted on 75 participants, ASA I or II planned for middle ear operation, participants were divided randomly into 3 groups. Lidocaine group (group L) received bolus of 1 mg/kg IV lidocaine then 2 mg/kg/h infusion of lidocaine. Magnesium group (group M) received a 15 mg/kg/h infusion after receiving an IV 35 mg/kg bolus in 150ml saline within 15 minutes. Control (group C) was infused with normal saline 10 mg/kg/h.

**Results:** Lidocaine group offers better surgical field exposure with better surgeon's satisfaction than magnesium and control groups. There was insignificant variation among investigated groups regarding mean arterial pressure (MAP) immediately post induction. Intraoperative MAP revealed insignificant variations among lidocaine and magnesium groups but substantial differences between both and control group. Regarding heart rate (HR) there was insignificant variation among investigated groups at baseline and after induction however there was significant decrease in HR from baseline post intubation and all the study time. Lidocaine group's intraoperative blood loss was less than other two groups, patients in magnesium and control groups needed more fentanyl doses. The operating time, emergent and recovery time was substantially shorter in the lidocaine group than magnesium and control groups.

**Conclusion:** During middle ear operations, lidocaine has superior results due to significant reduction in operative field bleeding, optimal field exposure, and shorter procedure times than magnesium and control groups.

**Keywords:** Lidocaine, Controlled Hypotension, Magnesium Sulfate, Middle ear Surgery.

## INTRODUCTION

Middle ear surgery is a surgical procedure in which a fiberoptic camera used to perform all essential maneuvers <sup>(1)</sup>. The bleeding reduces operative field visibility, making it so difficult to determine anatomical landmarks also putting the surrounding structures at danger. Uncontrolled bleeding lengthens the operative time <sup>(2, 3)</sup>. As a result, it's critical to keep bleeding to a minimum.

Hypotensive technique is one of the most common methods done to keep surgical field dry. The ideal agent for hypotensive technique must be inexpensive, familiar for anesthetist <sup>(4)</sup> easy to use with minimal side effects <sup>(5)</sup>. Several drugs were used to induced hypotension e.g., inhalational anesthesia, remifentanyl, dexmedetomidine, nitroglycerine, esmolol, magnesium sulfate and lidocaine <sup>(6, 7)</sup>.

Lidocaine is an amide type of local anesthetics and antiarrhythmic drug. It used intravenous to avoid the stress response that occurs with intubation <sup>(8)</sup>. Hypotension was noticed after lidocaine submucosal injection <sup>(9, 10)</sup>, after that Lidocaine was used to induced controlled hypotension <sup>(6, 11)</sup>.

Magnesium sulfate activates the Na<sup>+</sup>-K<sup>+</sup> ATPase and Ca<sup>++</sup> ATPase enzymes, which play a key role in transmembrane ion exchange throughout the depolarization and repolarization phases <sup>(12, 13)</sup>. Magnesium lowering the release of norepinephrine due to the N-type Ca<sup>++</sup> channels blocked at nerve ending <sup>(14)</sup>. Also increased production of prostacyclin & inhibition of angiotensin-converting enzymes which cause vasodilation & hypotension <sup>(15)</sup>.

The research's objective is to see how the effectiveness and safety of lidocaine and magnesium sulfate as hypotensive drugs in participants undergoing middle ear surgery.

## PATIENTS AND METHODS

A prospective, randomized, controlled clinical trial was conducted on 75 participants, was conducted between May 2021 and February 2022 at Al-zahraa University Hospital. All participants signed an informed consent after they were provided a detailed explanation of this study.

**Inclusion criteria:** Seventy-five participants between 21 and 48 years of age, BMI 19- 28.9kg/m<sup>2</sup>. All participants met the criteria of class I or II as per the physical status of American Society of Anesthesiologists (ASA) scheduled for middle ear surgery with general anesthesia.

**Exclusion criteria:** Known allergic response to the study medications, uncontrolled diabetes, or hypertension, liver or kidney and cerebral impairment. All patients have gone thorough pre-anesthetic assessment, clinical examination and lab tests and kept fasting for 6 hours prior to the operation. Intravenous cannula was inserted for drugs injection and fluid replacement. Premedication comprised 4 mg IV of ondansetron and dexamethasone for nausea and vomiting prevention. In operating theater, Pulse oximetry, electrocardiography, and non-invasive blood pressure are conducted. Mean arterial pressure (MAP) and heart rate (HR) were recorded prior to and

following anaesthesia induction, once the loading dosage started, and then at 15-min intervals throughout the duration of the operation.

Participants were assigned randomly according to table of randomization & Sealed envelopes to three groups (25/each). Participants in lidocaine group (group L) received bolus of 1 mg/kg IV lidocaine then 2 mg/kg/h infusion of lidocaine started upon anaesthetic induction and continued throughout the operative time. Participants in the magnesium sulphate group (group M) received a 15 mg/kg/h infusion during the operative period after receiving an IV 35 mg/kg bolus in 150ml of normal saline within 15 minutes. Participants in the control (group C) were infused with normal saline at a rate of 10 mg/kg/h during the operation.

A team of anaesthesia residents who were not involved in the study prepared the drugs for the hypotensive method. General anaesthesia was performed by 1.5 µg/kg fentanyl, 2-2.5 mg/kg propofol, and 0.15 mg/kg cisatracurium to facilitate tracheal intubation; sevoflurane 2-3%, a 50% oxygen-air mixture, and other medications were administered intraoperatively as needed to maintain anaesthesia. To preserve normocarbia, controlled ventilation was used.

The target was to keep MAP between 55-65 mmHg. MAP<55 mmHg was managed with IV fluid and IV bolus doses of ephedrine 6 -12 mg after stop of the study drugs and this patient was excluded from this study. HR >20% from baseline, was managed with IV 50µg fentanyl with increasing the depth of anaesthesia 1%. Atropine 0.6 mg IV bolus was used to manage the bradycardia (HR<55 bpm). Surgeon (was blinded to group allocation) was asked about the operative field visibility.

The severity of bleeding was appeared on the endoscopic display, and a six-point scale of Fromme and Boezaart was used<sup>(16, 17)</sup>. On a scale of one to six: 0 = indicates that there is no bleeding; 1 = minor bleeding that does not necessitate suction; 2 = minor bleeding that necessitates occasional suction; 3 = minor bleeding that necessitates multiple suction; 4 = moderate bleeding that necessitates multiple suction; bleeding threatens operative field immediately after suction is stopped; 5 = severe bleeding that necessitates constant suction; operative field is so threatened; procedure can't do.

Blood in the suction container was subtracted from saline used to clean the surgical site and soaked gauze to determine the amount of bleeding. On conclusion, Likert Scale<sup>(16)</sup> was used to evaluate surgeon's satisfaction, (1 = poor, 2 = moderate, 3 = good, and 4 = excellent). At the end of operation, the study drugs and inhalation anaesthesia were stopped. To counteract the effects of the muscle relaxant, 0.05-0.07 mg/kg neostigmine with 0.01-0.02 mg/kg atropine

were given; participant was extubated fully awake in the operating theatre.

The time it takes for anaesthesia to wear off till patient open his eyes according to verbal command is called the emergency time. The time until the patient reaches a modified Aldrete score of  $\geq 9$  was used to determine the recovery time.

Primary outcome was operation field visibility; secondary outcomes are MAP and HR, doses of fentanyl intraoperative, Surgeon's satisfaction, time of operation, emergency, and recovery times.

#### **Sample size calculation:**

Based on earlier research, a sample size was determined<sup>(6)</sup> in this research, there was substantial significant variation among the investigated groups regarding operative field visibility, it was 1 in the lidocaine group while in the magnesium group it was 2 with the confidence interval adjusted to 95% and the power to 80%. Although each group required a sample size of 23, we used 25 participants to account for dropouts.

#### **Ethical consent:**

**An approval of the study was obtained from Al-Azhar University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.**

#### **Statistical analysis**

The statistician performed every statistical analysis using SPSS version 23 (Armonk, New York, USA). Quantitative data are given as mean  $\pm$  standard deviation (SD). The number of individuals represents categorical data. Physical features, HR, MAP, as well as the timing of operation, emergency and recovery were all compared utilizing an independent student's t-test. We compared categorical data utilizing the Chi-square test. A p-value equals or less than 0.05 was deemed significant.

#### **RESULTS**

Eight-five participants were found to be eligible for the trial; however, 6 patients declined to participate, and 4 patients were disqualified due to hypotension. The remaining 75 individuals were divided into three groups, 25/each, the lidocaine group (group L), the magnesium group (group M), and the control group (group C). A non-significant difference in patient characteristics was discovered between the 3 groups under investigation (Table 1).

**Table (1): Patient’s characteristics among the 3 groups.**

Variables	Group L (No.=25)	Group M (No.=25)	Group C (No.=25)	Test value	P-value	Sig.
Age (Years) (Mean ± SD)	35.3 ± 9.5	39.2 ± 5.1	37.4 ± 6.1	1.862*	0.163	NS
Gender, no. (%)						
Females	16 (64%)	14 (56%)	15 (60%)	0.333*	0.846	NS
Males	9 (36%)	11 (44%)	10 (40%)			
BMI (kg/m <sup>2</sup> ) (Mean ± SD)	25.4 ± 2.3	26.1±2.4	25.1 ± 2.5	1.142*	0.325	NS
ASA						
I	20 (80%)	17 (68%)	19 (76%)	0.987*	0.610	NS
II	5 (20%)	8 (32%)	6 (24%)			

BMI: Body mass index; SD: Standard deviation; ASA: American society of anesthesiologists. p<0.05 Significant; \*: Chi-square test; •: One Way ANOVA test

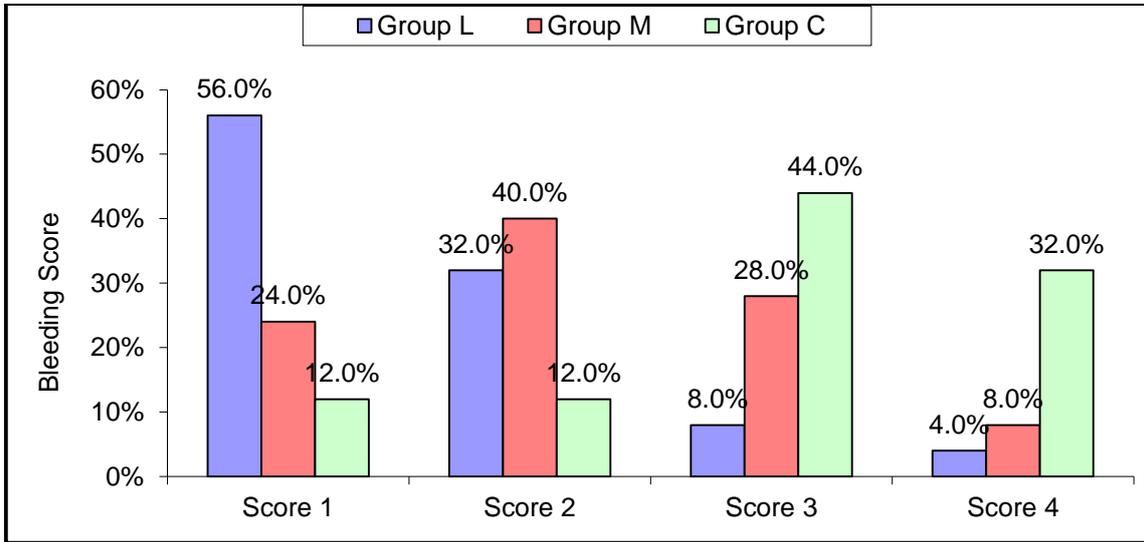
Our findings showed that compared to the magnesium and control groups, the lidocaine group's intraoperative blood loss was much less, and the patients in those groups needed more intraoperative fentanyl doses. The lidocaine group's operating time was significantly shorter than that of the magnesium and control groups. The emergency time was substantially shorter with lidocaine group (7.10 ± 1.20) than with the magnesium group (10.53 ± 1.11) and the control group (15.43 ± 2.03). The recovery time was delayed in the magnesium and control groups (P-value 0.001) compared to the lidocaine group (Table 2).

**Table (2): The information’s of the operation and anesthesia.**

Variables	Group L (n=25) Mean±SD	Group M (n=25) Mean±SD	Group C (n=25) Mean±SD	Test value*	P-value	L vs M	L vs C	M vs C
Intraoperative fentanyl doses (mic)	30.15±10.92	65.7± 30.12	135.2±55.8	51.718	<0.001**	<0.001**	<0.001**	<0.001**
Total dose of muscle relaxant (mg)	85.33±0.83	75.79±0.43	95.46±0.46	685.754	<0.001**	<0.001**	<0.001**	<0.001**
End-tidal sevoflurane concentration	2.3±0.2	3±0.4	3.5±0.6	66.205	<0.001**	<0.001**	<0.001**	0.001**
Intraoperative blood loss (ml)	111.5±12.67	125.83±18.4	166.6±17.6	75.780	<0.001**	0.002**	<0.001**	<0.001**
Operative time (min)	66±2.1	70±1.1	74±2.3	109.991	<0.001**	<0.001**	<0.001**	<0.001**
Emergency time (min)	7.10± 1.20	10.53±1.11	15.43±2.03	193.515	<0.001**	<0.001**	<0.001**	<0.001**
Recovery time (min)	10.7±2.3	14.2±2.2	15.6±4.4	16.200	<0.001**	<0.001**	<0.001**	0.161

\*: Data were presented as mean ± SD. One Way ANOVA test followed by post hoc analysis using LSD test. P <0.05: Significant (S); P <0.01: Highly significant (HS)

In the Lidocaine group, the bleeding score was significantly lower than in the magnesium and control groups (P value 0.001) (Figure 1).



**Figure (1): The bleeding score among the groups.**

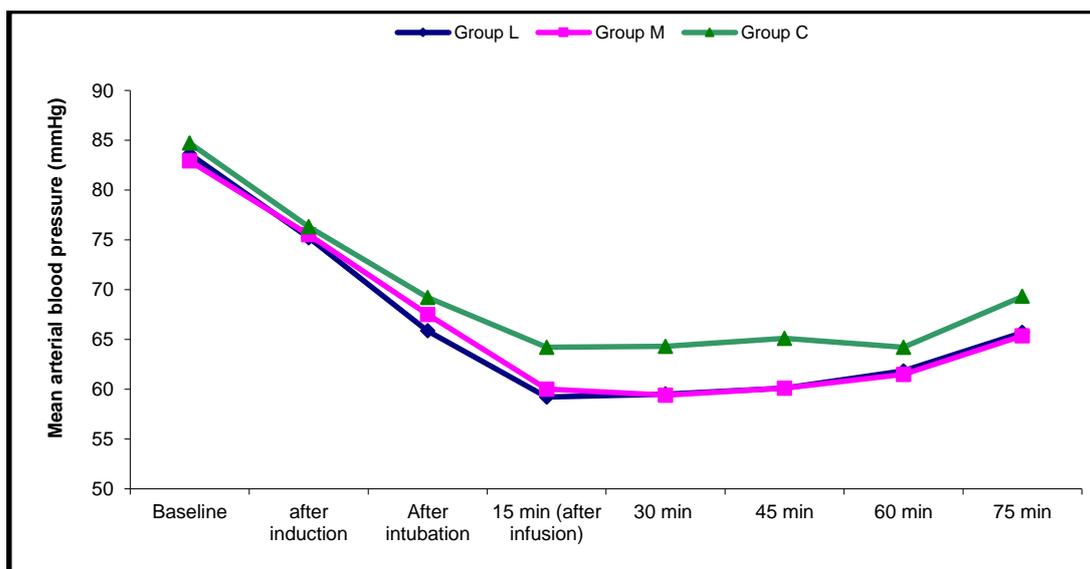
A significant variation between the 3 groups was found regarding the surgeon's satisfaction score ( $P < 0.05$ ) (Table 3).

**Table (3): Surgeon's satisfaction score among the groups.**

Score	Group L (No.=25) (%)	Group L (No.=25) (%)	Group L (No.=25) (%)	Test value*	P-value	Sig.
1 = bad/poor	1 (4.0%)	4 (16.0%)	6 (24.0%)	13.282	0.038*	S
2 = moderate	4 (16.0%)	8 (32.0%)	10 (40.0%)			
3 = good	7 (28.0%)	7 (28.0%)	6 (24.0%)			
4 = excellent	13 (52.0%)	6 (24.0%)	3 (12.0%)			

Data were presented as numbers and percentages; \*: Chi-square test,  $P < 0.05$ : Significant (S).

In terms of MAP immediately following anaesthetic induction, there was a non-significant variation among the 3 investigated groups. The intraoperative MAP revealed non-significant variations among the lidocaine and magnesium groups but substantial differences between lidocaine, magnesium versus control group (Figure 2).



**Figure (2): Mean arterial blood pressure among the investigated groups.**

Regarding to HR our findings revealed that, there was a non-significant variation among the investigated groups at baseline and after induction however there was a significant decrease in HR from baseline value post intubation and at 15, 30, 45, 60, 75 min; Group L showed a lower decrease in HR than Group M and Group C as presented (Figure 3).

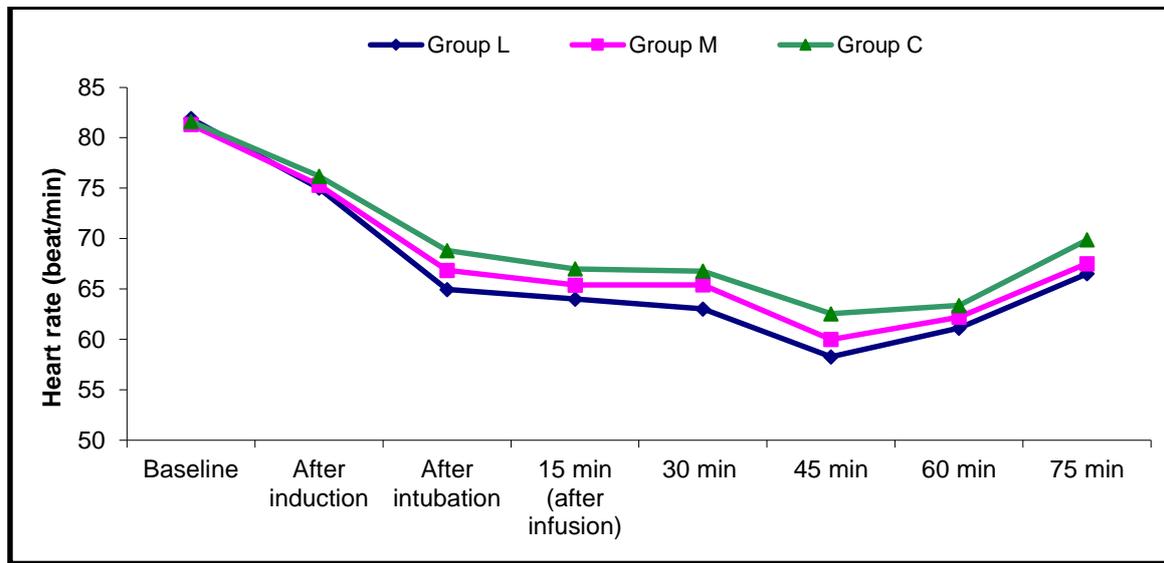


Figure (3): Heart rate among the investigated groups.

## DISCUSSION

Middle ear surgery is a surgical procedure during which all necessary manipulations can be performed by using a fiberoptic camera.<sup>(1)</sup> Controlled hypotension is necessary for a clearer operating field during middle ear surgery,<sup>(3)</sup> because flowing blood impairs vision during ear microsurgery and can make it challenging to put the precise graft during tympanoplasty. To reduce intraoperative blood loss and prevent transfusions, controlled hypotension is frequently employed<sup>(2)</sup>. It is described as a pharmacologically induced drop in mean arterial blood pressure to 50-70 mmHg that is brought on by either altering the contractility of the myocardium (beta blockers or inhaled anaesthetics) or by peripheral vasodilatation (regional anesthesia, sodium nitroprusside, nitroglycerine)<sup>(2,18,19)</sup>. Other drugs were used to induced hypotension e.g., remifentanil, dexmedetomidine, magnesium sulfate and lidocaine<sup>(6)</sup>.

Our study compared the effects of the hypotensive medications lidocaine and magnesium sulphate during middle ear surgery to a saline control group. In the group receiving lidocaine, we saw an objectively superior operating field, a shorter surgical procedure, fewer anaesthetics needed, and a higher surgeon satisfaction rating with improved blood pressure and heart rate control. The magnesium and control groups had a longer emergence and recovery time.

Our findings support **Hamed** and **Omar's** research<sup>(6,11)</sup>, which indicated that a lidocaine infusion is a useful tool for inducing purposeful hypotension in patients scheduled for functional endoscopic sinus surgery (FESS) and ensuring a good surgical field.

According to **Wormald et al.**<sup>(20)</sup>, under a controlled hypotensive anaesthetic (FESS), MAP and pulse rate both had a substantial impact on the operative field; with stable low HR at the minimal physiological levels.

**Siekiewicz et al.**<sup>(21)</sup> discovered a considerable and strong link between the operative field conditions and MAP and concluded that the operative field bleeding depends on MAP.

On the other hand, some researchers<sup>(22, 23)</sup> discovered that there was no link between surgical field quality and degree of hypotension, and as a result, moderate hypotension did not always result in favorable surgical fields. The two earlier investigations hypothesised that nitroprusside's vasodilator action prevented it from producing an ideal surgical field.

Our results showed that magnesium and lidocaine significantly reduced MAP compared to the control group. However, Lidocaine was delivering a better operating field and a higher surgeon satisfaction rating; this may be attributable to its vasoconstriction impact.

Regarding HR, our findings indicated that there were no significant differences between the three groups at baseline and following induction; however, there was a significant decrease in HR from baseline value following intubation and at 15, 30, 45, 60, and 75 min.

Prior research<sup>(24-25)</sup> has shown that the rise in HR, MAP, and catecholamine levels related to intubation can be reduced by administering a 1.5 to 2 mg/kg of lidocaine from the second to fifth minute prior to laryngoscopy. Other investigations<sup>(26)</sup> revealed that equal dosages of IV lidocaine failed to suppress the hemodynamic response following laryngoscopy and intubation. This debate may be related to how crucial timing is when administering lidocaine.

A higher threshold for airway stimulation, a central suppression of sympathetic transmission, and a direct reduction of cardiovascular responses appears to be the causes of lidocaine's ability to block the sympathetic response brought on by tracheal stimulation<sup>(27)</sup>.

In a study conducted by **Panda et al.**<sup>(28)</sup>, 80 hypertensive patients undergoing elective FESS

surgery were randomly assigned to one of three groups receiving magnesium sulphate infusions at doses of 30, 40, or 50 mg/kg prior to induction of anaesthesia or a group receiving a 1.5 mg/kg lidocaine bolus 90 seconds prior to intubation. Group received 30 mg/kg of magnesium kept MAP within normal ranges; however, groups 40 and 50 mg/kg of magnesium caused a considerable drop in MAP.

According to **Panda et al.** (28), 30-mg/kg magnesium was superior to lidocaine administration in treating hypertensive individuals. However, increasing the dose of magnesium from 30- to 50-mg/kg could result in substantial hypotension and increased medical costs. The results of **Panda et al.** (28); were comparable to those of **Nooraei et al.** (29); they concluded that magnesium sulphate can increase HR.

Lidocaine group offers better field exposure in terms of operation visibility than magnesium and control groups.

**Jorfeldt et al.** (30) discovered that systemic vascular resistance rose when plasma lidocaine concentrations reached 3–6 µg/kg and they hypothesised that vasoconstriction had occurred in some peripheral circulation areas.

The doses employed in this study were utilized in the earlier studies (31, 32), serum lidocaine levels less than 4µg/ml, because of the relatively modest plasma lidocaine concentrations, there may have been some vasoconstriction, which resulted in clean surgical fields.

A dosage response study was conducted by **Montazeri** (33) to determine the ideal dose of magnesium sulphate for the best cardiovascular attenuation noticed the similar results. A comparison of the heart rate and blood pressure in groups who received 10/20/30/40/50 mg/kg of magnesium sulphate and 1.5 mg/kg of lignocaine 5 minutes pre and post intubation. According to the study, magnesium sulphate doses of 40 and 50 mg/kg were the most successful to abolish the response of intubation.

On the other hand, **Dong and Daegu's** (34) investigation search for whether magnesium sulphate affect blood pressure response after laparoscopic cholecystectomy. They discovered no significant differences between the magnesium group and the control group in the blood level of cortisol. Additionally, **Kiaee et al.** (35) disagreed with our findings and showed that magnesium sulphate treatment might preserve hemodynamic stability during endotracheal intubation in elective coronary artery bypass grafting in comparison with lidocaine.

## CONCLUSION

During middle ear operations, lidocaine has superior results due to significant reduction in operative field bleeding, optimal field exposure, and shorter procedure times than magnesium and control groups.

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**Author contribution:** Authors contributed equally in the study.

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