The Egyptian Journal of Hospital Medicine (July 2022) Vol. 88, Page 2861-2870

Magnesium Sulphate, Lidocaine or Nitroglycerin for Controlled Hypotension and Quality of the Surgical Field in Patients Undergoing Tympanoplasty

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ABSTRACT

Background: Intraoperative bleeding impairs surgical field visibility during tympanoplasty; several methods have been used to decrease blood loss and improve the quality of the surgical field, one of them is usage of hypotensive anesthetic agents.

Objective: This study aimed to compare the effect of magnesium sulphate, lidocaine or nitroglycerin for controlled hypotension on hemodynamics, quality of the surgical field and blood loss in patients undergoing tympanoplasty.

Patients and methods: A prospective double blind randomized clinical study included 45 patients of both genders, ASA I&II undergoing tympanoplasty were allocated into Three groups (15 patients each) group (**M**) received magnesium sulphate by giving loading dose 40 mg/kg then the maintenance dose 15 mg/kg/hr, group (**L**) received lidocaine by giving an infusion dose of 2 mg/kg/hr and group (**N**) received nitroglycerin by giving an infusion dose of 5-10 μg/kg/min. For each group (mean arterial blood pressure "MABP", heart rate "HR", quality of the surgical field, total IV fluids given, total blood loss, intraoperative complications, duration of the surgery and the extubation time) were recorded.

Results: The studied doses of the drugs achieved the target mean arterial pressure (50–65 mmHg) with superior hemodynamic stability in the lidocaine group. Group L showed a statistically significant decrease in blood loss ($p<0.05$) , a statistically significant better quality of the surgical field ($p<0.05$) and a statistically significant less complications ($p<0.05$) compared to the other studied groups**.**

Conclusion: It was showed that using any of these three drugs can be effective for controlled hypotension in patients undergoing tympanoplasty but lidocaine has the priority for the achieving stablility of the hemodynamics, the best quality of the surgical field and the least blood loss.

Keywords: Tympanoplasty, controlled hypotention, magnesium sulphate, lidocaine, nitroglycerin.

INTRODUCTION

Bleeding is a common complication during surgery, particularly in the paranasal sinuses, middle ear cavity, and spine. It is preferable to control the bleeding rather than to expose the patient to the hazards of blood transfusion [(1)]. Controlled hypotension, in which arterial blood pressure is decreased reliably during surgery, is becoming more popular [(2)].

Ideally, a hypotensive medication should be simple to use, have a fast start, have effects that fade quickly when treatment is stopped, be rapidly eliminated without hazardous metabolites, have little effects on essential organs, and have predictable and dose-dependent effects [(3,4)].

Magnesium sulphate was historically used to cause hypotension on purpose [(5)]. Magnesium works as a hypotensive by reducing calcium outflow from the sarcoplasmic reticulum and as a vasodilator by enhancing prostacyclin production and lowering angiotensin converting enzyme activity [(6)].

Lidocaine is one of the most commonly used amide anesthetics. It can be safely given systemically to treat ventricular arrhythmias [(7)] and blunt the pressor response of endotracheal intubation [(8)]**.** Hypotension has been observed to occur after submucosal injection of lidocaine [(9)]**.** The site of action of lidocaine is at sodium ion channels on the internal surface of nerve cell membranes. The uncharged form diffuses through neural sheaths into the axoplasm before it then ionizes by combining with hydrogen ions. The resulting cation binds reversibly to sodium channels from the inside, locking them in the open state and preventing nerve depolarization interacting with hydrogen ions. From the inside, the resultant cation binds reversibly to sodium channels, locking them open and preventing nerve depolarization [(10)].

Nitroglycerine is a directly acting vasodilator and it is used to produce controlled hypotension because it is easily treatable and having very rapid onset as well as rapid offset of action. However the disadvantages of nitroglycerine are reflex tachycardia and venous congestion leading to increased blood loss [(11)]**.** Nitroglycerin converts to nitric oxide (NO) in the body. NO then activates the enzyme guanylyl cyclase, which converts guanosine triphosphate (GTP) to guanosine 3',5'-monophosphate (cGMP) in vascular smooth muscle and other tissues. cGMP then activates many protein kinase-dependent phosphorylations, ultimately resulting in the dephosphorylation of myosin light chains within smooth muscle fibers. This activity causes the relaxation of smooth muscle within blood vessels, resulting in the desired vasodilatory effect [(12)]**.**

Therefore, this study aimed to compare the effect of magnesium sulphate, lidocaine and nitroglycerin for controlled hypotension on hemodynamics, quality of the field and amount of blood loss in patients undergoing unilateral tympanoplasty.

Received: 20/1/2022
Accepted: 21/3/2022

PATIENTS AND METHODS

This prospective double blind randomized clinical study was done in Ear, Nose and Throat (ENT) operating rooms of Zagazig University Hospitals during the period between July 2019 to January 2020. 45 patients aged 21-50 years old of both genders with physical status ASA I & II and Body Mass Index (BMI) 20-35 kg/m^2 scheduled for unilateral tympanoplasty were included in the study.

Exclusion criteria: Included patients with known history of allergy to studied drugs. Advanced hepatic, renal or respiratory diseases, hypertensive, cardiac or diabetic patients, patients with coagulation defects, pregnancy, previous surgery in tympanic membrane and endocrine and metabolic diseases.

Sample size: Assuming that mean ± SD of mean arterial blood pressure in magnesium sulphate group was 95.27 ± 12.5 mmHg and in lidocaine group was 84.8 ± 10.06 mmHg [14]. So, the sample was 45 for 3 groups (magnesium sulphate, lidocaine and nitroglycerin) using open EPI info with CI 95%, Power of test 80%.

The patients were randomly allocated into three equal groups each group included 15 patients using computer generated randomization table. Group (**M**), 15 patients received magnesium sulphate by giving loading dose as a slow IV bolus of 40 mg/kg in 100 ml normal saline over 10 minutes before the induction of anesthesia then the maintenance dose was given at a dose of 15 mg/kg/hr by continuous IV infusion started at induction of anesthesia till the end of the surgery. Group (**L**), 15 patients received 100 ml of normal saline as a bolus over 10 minutes (placebo) before the induction of anesthesia then infusion of lidocaine was given at a dose of 2 mg/kg/h with maximum of 200 mg/h started at induction of anesthesia and continued till the end of the surgery. Group **(N)** 15 patients received 100 ml normal saline as a bolus over 10 minutes (placebo) before the induction of anesthesia then infusion of nitroglycerin was given at a dose of 5-10 μg/kg/min started at induction of anesthesia till the end of surgery.

All patients were visited the day before surgery, the goal of the study and the anesthetic procedure were explained in details, all patients were asked about medical, surgical and family history. Clinical examination of the patients was done and vital signs (blood pressure and heart rate) "baseline values" were recorded.

In the operating room, monitoring of the vital signs of the patients (MAP, HR and peripheral oxygen saturation) was done. A cannula was inserted in a peripheral venous line and the loading dose of the studied drugs was given 10 minutes before induction according to the group. All patients were preoxygenated for 5 minutes before induction of anesthesia. Anesthesia was induced using 2 mg/kg of propofol and fentanyl (1-2 μg/kg) intravenously, after ensuring adequate ventilation by face mask for 30-90 seconds, atracurium (0.5 mg/kg) was administrated to facilitate endotracheal intubation with a suitable size, cuffed endotracheal tube (size 7 mm for female and 7.5 mm for male). Immediately after intubation, the patient was connected to mechanical ventilation {tidal volume (TV) 7 ml/kg, respiratory rate (RR) 14/min, inspiration to expiration (I: E) ratio 1:2.5} and ventilator parameters were adjusted to keep $EtCO_2$ about 35-45 mmHg.

The maintenance dose of studied drugs was given according to the group. It was given by continuous IV infusion started at induction of anesthesia till the end of the surgery. Anesthesia was maintained with isoflurane 1.2% MAC in all groups and intraoperative muscle relaxation was achieved with incremental doses of atracurium (20% of the induction dose) that were given every 20 minutes. For all patients our target was to maintain mean arterial blood pressure (MABP) between 50 and 65 mmHg. If the mean arterial blood pressure decreased below 50 mmHg, the infusion of either study drug was stopped and an intravenous bolus of ephedrine 10 mg was given. If HR decreased below 50 beat per minute (bpm), an intravenous bolus of atropine 0.5 mg was given. If HR increased above 100 bpm, an intravenous bolus of 50 ug fentanyl was given. If the MABP increased above 65 mmHg, an intravenous bolus of propofol 50 mg was given.

MABP and HR were recorded at specific time intervals, before induction of anesthesia (basal), after induction of anesthesia, after intubation and then every 10 minutes after the start of the studied drugs till end of the surgery, also the quality of the surgical field was evaluated every 15 min using the **Fromm and Boezaart** surgical field rating (SFR) scale of six points proposed**.** **Grade 0:** No bleeding and virtually bloodless field. **Grade 1:** Slight bleeding and no suctioning is required. **Grade 2**: Slight bleeding and occasional suctioning is required. **Grade 3**: Slight bleeding and frequent suctioning is required; bleeding threatens surgical field a few seconds after suction is removed. **Grade 4**: Moderate bleeding and frequent suctioning is required, and bleeding threatens surgical field directly after suction is removed. **Grade 5**: Severe bleeding and constant suctioning is required; bleeding appears faster than can be removed by suction; surgical field severely threatened and surgery usually not possible. Surgical Field was graded as good, fair and poor as following: **Good**: SFR scale 0 or 1. **Fair**: SFR scale 2 or 3. **Poor**: SFR scale 4 or 5 [13]. Intraoperative IV fluids were given and total blood loss were recorded. Number of patients taking intraoperative ephedrine, atropine, fentanyl or propofol (for management of hypotension, bradycardia, tachycardia or hypertension) were recorded. Also, duration of surgery and extubation time (time between discontinuation of anesthesia and extubation) were recorded.

At the end of the procedure, discontinuation of the studied groups and isoflurane then reversal of the muscle relaxant with neostigmine (0.05mg/kg) and atropine (0.02 mg/kg) were done. All patients were extubated in the operating room and were transferred to the recovery room, where they were placed on oxygen mask. All of the patients, surgeon, and the attending anesthetist who was assigned to record the patients' parameters were blinded to the infused drugs. The randomization envelopes, the syringe pumps, and their code labels were prepared by an anesthetist independent in the study.

Ethical consent:

An approval of the study was obtained from Zagazig 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 collected data were computerized and statistically analyzed using SPSS program (Statistical Package for Social Science) version 24.0. Continuous parametric data were presented as mean and standard deviation (SD) and compared using one way Analysis Of Variance ANOVA (F) followed by post-hoc analysis for intergroup comparison and repeated measures of ANOVA was used for intragroup comparison. Non-parametric data were presented as median and range and compared using Kruskal Wallis test. Qualitative data were presented as number and percentage and compared using Chi-square test (X^2). P value ≤ 0.05 was considered significant and all statistical methods were 2 tailed.

RESULTS

In the present study, 58 patients were assessed for eligibility, 13 patients were excluded of them, 8 patients did not meet the inclusion criteria {ASA more than II (n=3), BMI more than 35kg/m^2 (n=2), previous surgery in the tympanic membrane (n= 2) and one patient with endocrine disease} and 5 patients refused to participate in the study. The remaining 45 patients were randomly allocated into 3 equal groups (15 patients in each one); magnesium sulphate group (group M), lidocaine group (group L) and nitroglycerin group (group N).

All 45 patients were followed up and analyzed statistically. Regarding age, BMI, sex and ASA physical status distribution, there was no statistically significant difference among the studied groups **(Table 1)**.

Table (1): Patients' characteristics among the studied groups

Variable	Group M (n=15)	Group L (n=15)	Group N (n=15)	Test	p-value
Age (years) **mean ± SD** **Range**	**34.5±7.1** **(21-45)**	**29.3±4.7** **(21-35)**	**31.8±6.6** **(21-45)**	**2.6^F**	**0.08**
BMI (kg/m2) **Mean ± SD** **Range**	**32.3±6.4** **(21-34)**	**32.1±6.1** **(21-35)**	**31.6±5.7** **(21-35)**	**0.3^F**	**0. 8**
Sex: **Male (n)%** **Female(n)%**	**7 (46.7%)** **8 (53.3%)**	**9 (60.0%)** **6 (40.0%)**	**8 (53.3%)** **7 (46.7%)**	**0.5^{X2}**	**0.7**
ASA Physical status: **ASA I (n) %** **ASA II (n) %**	**9 (60.0%)** **6 (40.0%)**	**10 (66.7%)** **5 (33.3%)**	**9 (60.0%)** **6 (40.0%)**	**0.18^{X2}**	**0.9**

Data were expressed as mean ± Standard deviation (SD) and range or (n): number and percentage (%). F= ANOVA test, χ^2=Chi square test, BMI: Body Mass Index, ASA: American society of anesthesiology.

Regarding the MAP, the three studied groups had comparable basal mean arterial pressure with no statistically significant difference among the studied groups (p>0.05). While Post induction, post intubation and during all the time of surgery there was statistically significant reduction of mean arterial pressure in magnesium sulphate group and lidocaine group compared to nitroglycerin group (p<0.05) with no statistically significant difference between magnesium sulphate and lidocaine groups (p>0.05). Regarding postoperative**,** the three studied groups had increased mean arterial pressure returning to normal ranges with less mean arterial pressure in lidocaine group compared to magnesium sulphate and nitroglycerin groups. This increase was statistically significant (p<0.05) between magnesium sulphate group and nitroglycerin group also between lidocaine group and nitroglycerin group with no statistically significant difference between magnesium sulphate group and lidocaine group (p>0.05) **(Table 2)**.

Table (2): Comparison of the mean arterial pressure (MAP) among the studied groups

MAP (mmHg)	group M (n=15)	group L (n=15)	group N (n=15)	F test	p-value	LSD
Basal *Mean ± SD* *Range*	90.3±3.3 (82-95)	93.5±3.6 (87-99)	91.1±4.3 (85-97)	2.9	0.06	0.3 (1) 0.4 (2) 0.6(3)
Post induction *Mean ± SD* *Range*	81.7±3.1 (78-87)	78.1±3.7 (70-85)	83±5.3 (72-89)	5.6	0.007*	0.4(1) 0.02***(2)** 0.002***(3)**
Post intubation *Mean ± SD* *Range*	83.4±2.9 (82-91)	82.4±3.2 (78-92)	88.5±3.7 (82-93)	4.4	0.01*	0.9(1) 0.03***(2)** 0.02***(3)**
10 Minutes *Mean ± SD* *Range*	63.1±2.2 (57-67)	65.5±2.8 (61-71)	72.7±6.1 (64-82)	22.9	0.001**	0.09 (1) 0.001****(2)** 0.001****(3)**
20 Minutes *Mean ± SD* *Range*	60.3±3.1 (52-64)	59.7±2.6 (53-63)	67.6±2.3 (58-68)	4.8	0.01*	0.6(1) 0.02***(2)** 0.005***(3)**
30 Minutes *Mean ± SD* *Range*	59.5±1.4 (57-63)	60.1±2.1 (57-65)	65.2±3.9 (52-66)	3.6	0.04*	0.7(1) 0.03***(2)** 0.04***(3)**
40 Minutes *Mean ± SD* *Range*	59.4±1.4 (57-62)	57.5±2.9 (53-63)	60.3±3.7 (47-60)	3.8	0.02*	0.07(1) 0.03***(2)** 0.02***(3)**
50 Minutes *Mean ± SD* *Range*	58.8±1.7 (57-64)	57.4±2.5 (54-63)	60.8±3.4 (48-62)	3.7	0.03*	0.01(1) 0.03***(2)** 0.04***(3)**
60 Minutes *Mean ± SD* *Range*	64.8±3.9 (60-73)	62.8±2.8 (55-65)	68.1±3.9 (57-69)	11.1	0.001**	0.02(1) 0.02***(2)** 0.002***(3)**
70 Minutes *Mean ± SD* *Range*	66.7±6.1 (57-77)	65.7±6.1 (57-77)	70.6±8.5 (60-91)	3.1	0.05*	0.6(1) 0.04***(2)** 0.02***(3)**
80 Minutes *Mean ± SD* *Range*	75.8±11.6 (64-94)	72.8±11.6 (64-94)	82.2±9.1 (63-90)	3.1	0.05*	0.2(1) 0.03***(2)** 0.05***(3)**
90 Minutes *Mean ± SD* *Range*	83.1±4.7 (83-92)	79.2±7.7 (75-94)	89.9±7.6 (72-95)	4.8	0.002*	0.3(1) 0.03***(2)** 0.001****(3)**
Postoperative *Mean ± SD* *Range*	87.1±4.7 (83-95)	85.2±7.7 (75-94)	89±7.6 (72-95)	4.8	0.01*	0.2(1) 0.04***(2)** 0.01***(3)**
P value[4]	0.001[#]	0.002[#]	0.001#			
p value[5]	0.04[#]	0.03[#]	0.04[#]			

Data were expressed as mean ± Standard deviation (SD) and range, (1) group M versus group L, (2) group M versus group N and (3) group L versus group N, *: Statistically significant difference (P ≤ 0.05), **: Statistically highly significant difference (P ≤ 0.001), F: ANOVA test, LSD: least significance difference, #: intragroupal statistically significant. p value4 comparing intraoperative with basal of the same group. p value5 comparing intraoperative with postoperative of the same group.

Regarding the mean HR in the three studied groups, it was comparable at basal and post-induction with no statistically significant difference among the studied groups (p>0.05). While, post-intubation, there was statistically significant reduction of mean heart rate in magnesium sulphate group and lidocaine group compared to nitroglycerin group (p<0.05) with no statistically significant difference between magnesium sulphate group and lidocaine group (p>0.05). There was more reduction of heart rate in the three studied groups with no statistically significant difference at 10 and 20 minutes (p>0.05). At 30, 40, 50, 60, and 70 minutes there was statistically significant decrease in mean HR in lidocaine group compared to nitroglycerin group (p<0.05), with no statistically significant difference between magnesium sulphate and lidocaine groups or between magnesium sulphate and nitroglycerin groups (p>0.05). Before the end of the operations (at 80 and 90 minutes), the heart rate began to increase to return to normal with no statistically significant difference among the three studied groups (p>0.05). Regarding post-operative HR, the three studied groups had increased mean heart rate postoperatively with statistically significant decrease in mean HR in lidocaine group and magnesium sulphate group compared to nitroglycerin group (p<0.05), with no statistically significant difference between magnesium sulphate and lidocaine groups (p>0.05) (Table 3).

Table (3): Comparing mean values of the heart rate (HR) among the studied groups

Heart rate (HR)	group M (n=15)	group L (n=15)	group N(n=15)	F test	p-value	LSD
Basal *Mean ± SD* *Range*	87.8±2.9 (85-95)	86.8±3.5 (80-92)	85.5±5.8 (76-89)	1.1	0.3	0.2(1) 0.1(2) 0.4(3)
Post induction *Mean ± SD* *Range*	76.5±2.2 (73-80)	76.1±3.6 (68-80)	79.7±5.8 (68-84)	0.1	0.8	0.7(1) 0.6(2) 0.8(3)
Post intubation *Mean ± SD* *Range*	83.4±3.1 (78-88)	80.5±3.7 (74-88)	84.7±5.6 (68-86)	3.8	0.03*	0.2(1) 0.03* (2) 0.02*(3)
10 Minutes *Mean ± SD* *Range*	80.5±3.1 (75-85)	77.3±7.4 (63-94)	80.8±12.1 (62-107)	2.1	0.1	0.09(1) 0.9(2) 0.08(3)
20 Minutes *Mean ± SD* *Range*	78.8±2.5 (75-85)	76.7±12.1 (54-110)	79.4±10.8 (54-93)	1.7	0.2	0.1(1) 0.8(2) 0.1(3)
30 Minutes *Mean ± SD* *Range*	77.6±13.7 (47-97)	76.6±7.8 (47-85)	79.6±2.4 (76-84)	4.2	0.02*	0.5(1) 0.8(2) 0.4(3)
40 Minutes *Mean ± SD* *Range*	77.2±1.8 (66-83)	75.1±4.9 (66-83)	79.4±13.2 (55-105)	3.9	0.02*	0.06 (1) 0.9 (2) 0.01*(3)
50 Minutes *Mean ± SD* *Range*	76.9±12.3 (72-85)	75.7±4.1 (65-81)	78.7±3.1 (48-87)	3.3	0.04*	0.4(1) 0.9 (2) 0.02* (3)
60 Minutes *Mean ± SD* *Range*	75.8±2.9 (71-84)	74.3±3.4 (68-79)	78.8±6.1 (61-84)	6.8	0.002*	0.8 (1) 0.1 (2) 0.01* (3)
70 Minutes *Mean ± SD* *Range*	79.8±3.2 (73-85)	77±5.1 (60-85)	80.6±5.3 (69-85)	2.5	0.09	0.1(1) 0.8(2) 0.03*(3)
80 Minutes *Mean ± SD* *Range*	80.1±5.2 (78-94)	78.2±7.6 (62-93)	81.2±9.1 (72-99)	1.6	0.2	0.5(1) 0.3(2) 0.4(3)
90 Minutes *Mean ± SD* *Range*	80.5±4.2 (73-96)	78.7±4.9 (68-94)	81.5±7.1 (72-99)	1.7	0.3	0.2(1) 0.4 (2) 0.7(3)
Postoperative *Mean ± SD* *Range*	80.5±2.3 (78-88)	79.6±2.7 (74-88)	84.5±1.7 (82-88)	9.7	0.001**	0.3(1) 0.001**(2) 0.001**(3)
P value[4]	0.001#	0.002#	0.001#			
p value[5]	0.01#	0.03#	0.02#			

Data were expressed as mean ± Standard deviation (SD) and range, (1) group M versus group L, (2) group M versus group N and (3) group L versus group N, *: Statistically significant difference ($P \leq 0.05$), **: Statistically highly significant difference ($P \leq 0.001$), F: ANOVA test, LSD: least significance difference, #: intragroupal statistically significant. p value4 comparing intraoperative with basal of the same group. p value5 comparing intraoperative with post-operative of the same group.

Regarding the quality of the surgical field, there was statistically significant better quality of the surgical field in lidocaine group compared to the other studied groups at 15, 30 and 45 minutes (p<0.05) with no statistically significant difference between magnesium sulphate group and nitroglycerin group (p>0.05). While, at 60, 75 and 90 minutes there was no statistically significant difference among the three studied groups (p>0.05) (Table 4).

Table (4): Quality of the surgical field among the studied groups

Qualityof the surgicalfield n (%)	Group Mn=15	Group L n=15	Group N n=15	χ^2	p-value
At 15 minutes					
Good	0 (0%)	3 (20.0%)*	0 (0%)	6.4	0.04*
Fair	15 (100%)	12 (80.0%)*	15 (100.0%)		
Poor	0 (0%)	0 (0%)	0 (0%)		
At 30 minutes					
Good	4(26.7%)	15 (100.0%)**	3(20.0%)	23.7	0.001**
Fair	11 (73.3%)	0 (0%)*	12 (80.0%)		
Poor	0 (0%)	0 (0%)	0 (0%)		
At 45 minutes					
Good	11 (73.3%)	15 (100.0%)*	9 (60.0%)	7.2	0.02*
Fair	4(26.7%)	0 (0%)*	6 (40.0%)		
Poor	0 (0%)	0 (0%)	0 (0%)		
At 60 minutes					
Good	14 (93.3%)	15 (100.0%)	14 (93.3%)	3.2	0.5
Fair	1 (6.7%)	0 (0%)	1 (6.7%)		
Poor	0 (0%)	0 (0%)	0 (0%)		
At 75 minutes					
Good	14 (93.3%)	15 (100.0%)	15(100.0%)	2.1	0.3
Fair	1 (6.7%)	0 (0%)	0 (0%)		
Poor	0 (0%)	0 (0%)	0 (0%)		
At 90 minutes					
Good	15 (100.0%)	15 (100.0%)	14 (93.3%)	2.1	0.3
Fair	0 (0%)	0 (0%)	1 (6.7%)		
Poor	0 (0%)	0 (0%)	0 (0%)		

Data were expressed as number (n) and percentage (%), χ^2=Chi square test. *Statisticallysignificant difference ($P \leq 0.05$) in lidocaine group compared to other groups, **Statistically highly significant difference ($P \leq 0.001$).

Regarding IV fluids and blood loss, there was statistically significant decrease ($p<0.05$) in total IV fluid and total blood loss in lidocaine group compared to magnesium sulphate and nitroglycerine groups. Also, there was statistically significant decrease in magnesium sulphate group compared to nitroglycerin group ($p<0.05$) **(Table 5).**

Table (5): Total IV fluid and total blood loss among the studied groups

Variable	Group M (n=15)	Group L (n=15)	Group N (n=15)	F test	p-value	LSD
Total IVfluid (ml) Mean ± SD Range	996.7±72.8 (900-1150)	923.3±123.7 (750-1200)	1023.3±91.5 (900-1200)	4.1	0.002*	0.04*(1) 0.008*(2) 0.004*(3)
Total blood loss (ml) Mean ± SD Range	151.3±9.5 (130-165)	111.3±14.9 (75-130)	181.1±17.3 (150-210)	89.4	0.001**	0.001**(1) 0.001**(2) 0.001**(3)

Data were expressed as mean ± Standard deviation (SD) and range , (1) group M versus group L, (2) group M versus group N and (3) group L versus group N , *: Statistically significant difference ($P \leq 0.05$), **: Statistically highly significant difference ($P \leq 0.001$) , F: ANOVA test, LSD: least significance difference. ml: milliliter.

Regarding number of patients taking intraoperative ephedrine, atropine or fentanyl, there was statistically significant decrease in lidocaine group compared to magnesium sulphate and nitroglycerin groups ($p<0.05$) with no statistically significant difference between magnesium group and nitroglycerin group ($p>0.05$). Regarding number of patients needed intraoperative propofol, no one needed to take it throughout the operations (Table 6).

Table (6): Number of patients needed (ephedrine, atropine, fentanyl or propofol) among the studied groups

Variables n (%)	Group M n=15	Group L n=15	Group N n=15	χ^2	p- value
Ephedrine Yes No	2 (13.3%) 13 (86.7%)	1 (6.7%)* 14 (93.3%)	4 (26.7%) 11 (73.3%)	6.1	0.03
Atropine Yes No	5(33.3%) 10(66.7%)	1 (6.7%)* 14 (93.3%)	2 (13.3%) 13 (86.7%)	5.8	0.05
FentanylYes No	2(13.3%) 13(86.7%)	0 (0%)* 15 (100.0%)	5 (33.3%) 10 (66.7%)	6.4	0.04
Propofol Yes No	0 (0%) 15(100%)	0 (0%) 15(100%)	0 (0%) 15(100%)	2.3	0.2

Data were expressed as number (n) and percentage (%), χ^2=Chi square test *Statistically significant decrease in lidocaine group compared to the other studied drugs ($P \leq 0.05$).

Regarding duration of surgery, there was statistically significant shortness (p<0.05) in the duration of surgery in lidocaine group compared to magnesium sulphate and nitroglycerin groups. Also, there was statistically significant shortness of the duration in nitroglycerin group compared to magnesium sulphate group (p<0.05). Regarding extubation time, there was statistically significant prolongation in magnesium sulphate group compared to lidocaine and nitroglycerin groups (p<0.05) with no statistically significant difference between lidocaine and nitroglycerin groups (p>0.05) (Table 7).

Table (7): Duration of surgery and extubation time among the studied groups

Variable	Group M(n=15)	Group L(n=15)	Group N(n=15)	F test	p- value	LSD
Duration of surgery (min) Mean ± SD Range	92.2±4.1 (80-95)	82.3±7.7 (70-90)	88.4±8.1 (78-95)	6.1	0.004*	0.001**(1) 0.04*(2) 0.002*(3)
Extubationtime (min) Mean ± SD Range	11.3±1.3 (8-12)	8.7±1.1 (7-10)	9.5±0.9 (8-11)	2.1	0.3	0.002*(1) 0.04*(2) 0.1(3)

Data were expressed as mean ± Standard deviation (SD) and range, (1) group M versus group L, (2) group M versus group N and (3) group L versus group N, *: Statistically significant difference ($P \leq 0.05$), **: Statistically highly significant difference ($P \leq 0.001$), F: ANOVA test, LSD: least significance difference.

DISCUSSION

Tympanoplasty is a delicate procedure, it is performed under general anesthesia. So anesthetists have to plan the technique in such way that will enable the operating team for achieving a blood less field for better visualization and minimizing intraoperative bleeding. Because very little bleeding can obstruct the view of the operating endoscope. Hence come the role of controlled hypotension [14,15].

Controlled hypotension is a technique that is used to limit intraoperative blood loss to provide the best possible field for surgery [16].

One of the main goals of hypotensive anesthesia is to lower the blood pressure to a level that causes minimal bleeding, but at the same time, maintain well perfusion to the vital organs [17]. Decreasing the bleeding in the surgical field improves surgical outcomes and decreases the complications [18].

The target MAP between 50 and 65 mmHg was decided after revising previous studies in which metabolic and hormonal responses were investigated in patients who were subjected to controlled hypotension in an attempt to provide bloodless field without the hazard of tissue ischemia [19]. **Newton *et al.*** [20] investigated the metabolic and hormonal responses to middle ear surgery in 30 patients using controlled hypotension to a MAP of 50-65 mmHg and concluded that this level of controlled hypotension produced an endocrine and metabolic response of small magnitude and short duration that did not affect tissue oxygenation but kept it adequate.

The present study was done to compare the effect of magnesium sulphate, lidocaine and nitroglycerin for controlling hypotension on hemodynamics, amount of blood loss and quality of the surgical field in patients undergoing tympanoplasty. This study was carried on 45 adult patients allocated randomly into three equal groups each one had 15 patients. In the current study, the studied drugs (magnesium sulfate, lidocaine or nitroglycerin) were used to induce hypotension in an attempt to provide a good surgical field. In magnesium sulphate group, 15 patients received magnesium sulphate by giving a loading dose as a slow IV bolus of 40 mg/kg in 100 ml normal saline over 10 minutes before the induction of anesthesia then the maintenance dose was given at a dose of 15 mg/kg/hr by continuous IV infusion started at induction of anesthesia till the end of the surgery. In lidocaine group, 15 patients received 100 ml of normal saline as a bolus over 10 minutes (placebo) before the induction of anesthesia then infusion of lidocaine was given at a dose of 2 mg/kg/h with maximum of 200 mg/h started at induction of anesthesia and continued till the end of the surgery. In nitroglycerin group, 15 patients received 100 ml normal saline as a bolus over 10 minutes (placebo) before the induction of anesthesia then infusion of nitroglycerin was given at a dose of 5-10 µg/kg/min started at induction of anesthesia till the end of surgery. The results revealed that the three drugs reached the desired MAP (50–65 mmHg). The findings showed that all of them had a hypotensive effect appropriate for tympanoplasty. Using any of these drugs can be effective in reduction of surgical field bleeding, stability of hemodynamics with subsequent improvement of the quality of the surgical field as assessed by **Fromm and Boezaart** quality scale [(13)]. Furthermore, the results revealed that using lidocaine has been associated with more stable perioperative hemodynamics, least blood loss, the shortest extubation time and the best surgical field quality. Lidocaine is one of the most commonly used amide anesthetics. It can be safely given systemically to treat ventricular arrhythmias and blunt the pressor response of endotracheal intubation. Systemic lidocaine was effective in producing controlled hypotension [(9)]**. Jorfeldt *et al.*** [(21)] found that total systemic vascular resistance increased at plasma lidocaine concentrations of 3–6 mcg/ml, and they postulated that vasoconstriction in some parts of the peripheral circulation should be happened. The doses used in our study were used in previous studies and provided serum lidocaine levels < 4 mcg/ml [(22)]. These plasma lidocaine concentrations caused mucosal vasoconstriction in the tympanic membrane and consequently produced better surgical fields [(23)]. This explain why the group of lidocaine has better surgical field than other groups.

Magnesium sulphate is a noncompetitive antagonist of N-methyl-D- aspartate receptors that has an analgesic effect and is important for the release of acetylcholine from presynaptic terminals [(24)]**.** According to previous studies, magnesium can cause hypotension through a vasodilator effect. The vasodilator effect of this ion is caused by increased production of prostacyclin and inhibition of angiotensin-converting enzymes. So it seems that this product could be beneficial for lowering blood pressure during several surgical procedures [(25)]**.**

Nitroglycerin, a directly acting vasodilator, has been used to achieve induced hypotension as it has rapid onset, rapid offset, and titrability. However, it causes reflex tachycardia as well as venous congestion in the surgical site thus causing more blood loss [(11)]**.** As in our result in nitroglycerin group, there was more blood loss in the surgical field compared to magnesium sulphate or lidocaine groups. It was revealed that controlled hypotension by heart rate control is thought to be superior for decreasing systemic vascular resistance. Many results stated that increased heart rate can lead to increased surgical bleeding that interfere with the quality of the operative field and increasing the duration of surgery. Nitroglycerin cause increase in heart rate, it has a strong effect on the smooth muscles of the blood vessels. The vasodilator effect has created more oozing in the surgical field and causing increase of the duration of surgery [(17, 18, 26)]. In agreement with the current study. **Hamed** [(23)] had 80 patients scheduled for fundus endoscopic sinus surgery [FESS] and randomly allocated to receive either an iv-bolus dose of magnesium sulfate 50 mg/kg in a total of 100 ml saline over 10 min followed by infusion of 15 mg/kg/h until the end of surgery in magnesium group and received lidocaine 2 mg/kg/h with maximum of 200 mg/h starting at induction of anesthesia and continuing until the end of surgery in lidocaine group. They concluded that, both magnesium sulfate and lidocaine successfully induced controlled hypotension in FEES, with superiority for lidocaine with better quality of the surgical field, decreasing doses of anesthetic requirements and shorter extubation time.

Kiaee *et al.* [(27)] study compared the effect of lidocaine and magnesium sulphate in perioperative hemodynamics. In their study 150 patients undergoing elective coronary artery bypass graft (CABG) were enrolled. Included patients were randomly allocated into three groups and received lidocaine (1.5 mg/kg), magnesium sulfate (50 mg/kg within five minutes), or normal saline. It was founded that the administration of magnesium sulfate might result in maintaining hemodynamic stability after endotracheal intubation compared to lidocaine, in contrast with our study as there was hemodynamic stability in lidocaine group compared to magnesium sulphate group. Our limitation was the type of operations in cardiothoracic surgeries also small sample size compared to this study and different doses of lidocaine were used.

The results of **Omar** [(28)] correspond with that of the current study as the study investigated 48 patients undergoing FESS and they had been allocated into two groups lidocaine (L) and control (C) groups, using 10 ml syringe for boluses contained either 1.5 mg/kg lidocaine for group L or equal volume of normal saline for group C and 50 ml syringe for infusion. The 50-ml infusion syringes contained either 1% lidocaine (10 mg/ml) in group L to be given in a rate of 1.5 mg/kg/h (0.15 ml/kg/h) or equal volumes of normal saline in control group. It was found that the quality of the surgical field was better in lidocaine group than in control group at all intraoperative time points, extubation time was shorter and intraoperative fentanyl dose was lower in lidocaine group compared to controlled group. lidocaine infusion is an effective method in producing deliberate hypotension in patients scheduled for FESS surgery and providing good surgical field.

In our study, magnesium sulphate group showed prolongation of the duration of surgery and extubation time and less blood loss compared to nitroglycerin group. Regarding the quality of the surgical field, there was no statistically significant difference between magnesium sulphate group and nitroglycerin group. **Shoukry and Mahmoud** [(29)] and **Noor El-Din *et al.*** [(30)] compared the effect of magnesium sulphate and nitroglycerin during FESS. They reported that both drugs produced the desired hypotension. In magnesium group, there were better operative conditions and reduced fentanyl consumption, however there was longer extubation time in comparison to the nitroglycerin group. Heart rate values were significantly higher in the nitroglycerin group compared to magnesium group. The authors concluded that, both magnesium sulphate and nitroglycerin are safe for controlled hypotension during FESS, but magnesium sulphate was superior than nitroglycerin as it provides optimum surgical conditions and low tachycardia and this is in agreement with the result of the present study.

CONCLUSION

It was found that using magnesium sulphate as a loading dose 40 mg/kg then a maintenance dose of 15 mg/kg/hr, or lidocaine as an infusion dose of 2 mg/kg/hr or nitroglycerin as an infusion dose of 5-10 μg/kg/min can be effective for controlled hypotension in patients undergoing unilateral tympanoplasty. However, lidocaine has the priority for achieving stability of the hemodynamics, the best quality of the surgical field, the least blood loss, the least complications and the shortest duration of the surgery and extubation time.

Conflict of interest: The authors declared no conflict of interest.

Sources of funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contribution: Authors contributed equally in the study.

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