



ORIGINAL ARTICLE

Phentolamine versus Magnesium Sulphate for Controlled Hypotension in Patients During Lumbar Spine Fixation Surgery under General Anesthesia

Noha Mohamed Ali Mohamed Abdelkareem*, Hala Abd-Elsadek Elattar, Heba Mohamed Fathi, Mona A. Shahin, Hatem Ahmed Nazmy

Anesthesia, Intensive Care and Pain Management Department, Faculty of Medicine, Zagazig University, Egypt

*Corresponding author:

Noha Mohamed Ali
Mohamed Abdelkareem

E-mail:

nohaabdelkareem414@gmail.com

Submit Date: 24-09-2025

Revise Date: 18-10-2025

Accept Date: 23-10-2025

ABSTRACT

Background: Controlled hypotension is commonly employed to minimize blood loss and improve the quality of the surgical field. This study aimed to evaluate the effectiveness of phentolamine versus magnesium sulphate in achieving controlled hypotension during lumbar spine fixation surgery under general anesthesia. **Methods:** In this prospective, randomized, double-blind clinical trial, sixty-two adult patients (ASA I–II) undergoing elective lumbar spine fixation at Zagazig University Hospitals were included. At random, the patients were split into two equal groups: While Group P received an infusion of phentolamine, Group M received an infusion of magnesium sulphate. **Results:** Both groups achieved and maintained the target MAP (60–65 mmHg) intraoperative with no significant differences. In the early postoperative period (up to 60 min), MAP was significantly lower in the phentolamine group ($p < 0.05$). Heart rate was significantly higher in the phentolamine group during the first two intraoperative hours and throughout the first two postoperative hours ($p < 0.05$). No significant differences were found between the groups in surgical field quality, surgeon satisfaction, intraoperative blood loss, transfusion requirements, hemoglobin or hematocrit changes, PACU discharge time, Ramsay sedation scores, or the incidence of intra- and postoperative adverse events. **Conclusion:** Both phentolamine (0.1–2 mg/min) and magnesium sulphate (40mg/kg loading then maintenance 15mg/kg/hr) are effective and safe agents for controlled hypotension during lumbar spine fixation surgery, providing comparable surgical field quality and blood conservation. Magnesium sulphate was associated with greater heart rate stability intra- and postoperatively, whereas phentolamine produced lower MAP in the early postoperative period.

Keywords: Controlled hypotension, phentolamine, magnesium sulphate, lumbar spine fixation, hemodynamics, surgical field quality.

INTRODUCTION

Controlled hypotension is an established anesthetic technique which is employed to decrease the need for blood transfusions and intraoperative blood loss and improve surgical field, which will help the surgeon perform better. It has been used in several surgical disciplines, such as endoscopic sinus and middle ear microsurgery, oromaxillofacial surgeries like mandibular osteotomy and facial repair, spinal fixation, neurosurgical interventions like aneurysm clipping, major orthopedic

surgeries including hip and knee replacement, as well as cardiovascular and liver transplantation surgeries [1]. In normotensive patients, A drop to 60–65 mmHg in mean arterial pressure or a decrease in systolic blood pressure to 80–90 mmHg are common definitions of managed hypotension, or 30% below baseline[2].

Many techniques have been described to achieve deliberate hypotension, ranging from physical maneuvers that decrease venous return to pharmacological strategies involving volatile anesthetics,

intravenous agents, vasodilators, and β -adrenoceptor antagonists. Regional anesthetic techniques such as intrathecal anesthesia have also been employed, either alone or in combination with pharmacologic agents [3]. The ideal hypotensive drug should be easy to take, start working quickly, and have a consistent dose-dependent response, and resolve quickly after discontinuation without leaving toxic metabolites or exerting deleterious effects on vital organs. Several clinical benefits have been attributed to controlled hypotension, including shortening operative duration, minimizing tissue edema related to cautery or ligation, and improving myocardial function by reducing both preload and afterload [4].

Despite these advantages, controlled hypotension carries potential hazards. Excessive lowering of blood pressure may compromise cerebral perfusion, leading to hypoxia, delayed recovery, and in severe cases permanent neurological injury or death [5]. These concerns are particularly relevant in orthopedic procedures such as lumbar spine fixation, when large visible veins are not the primary source of blood loss, but rather the surfaces of raw bone and muscle [6]. The proximity of the surgical field to vital and easily traumatized neurological structures further accentuates the importance of maintaining optimal visibility, as a clear operative field reduces operative time and thereby decreases overall bleeding and surgical complications [7].

Phentolamine, an imidazole derivative, is a moderately short-acting competitive nonselective α -adrenergic antagonist that reduces peripheral vascular resistance by vasodilation [8]. It has been used clinically in the management of hypertensive crises, the diagnostic evaluation of pheochromocytoma, and in reversing pharmacologically induced mydriasis. Various routes of administration have been described, including intravenous, intramuscular, submucosal, and topical applications [9]. Magnesium sulphate, on the other hand, has been proposed as a

promising agent for controlled hypotension. Its processes include inhibiting calcium release from the sarcoplasmic reticulum and modulating transmembrane ion transport by stimulating Ca^{2+} -ATPase and $\text{Na}^{+}\text{K}^{+}$ -ATPase. Vasodilation is facilitated by these actions, which increase prostacyclin synthesis and decrease angiotensin-converting enzyme activity [10]. Moreover, magnesium exerts analgesic properties through antagonism at N-methyl-D-aspartate (NMDA) receptors, contributing to intraoperative and postoperative analgesia [11].

Although both agents have been individually investigated for their hypotensive and anesthetic properties; direct comparative evidence regarding their efficacy and safety in lumbar spine fixation remains limited. Therefore, the efficiency of magnesium sulphate and phentolamine in producing controlled hypotension during lumbar spine fixation surgery under general anesthesia was evaluated in this study to fill this gap in the literature.

METHODS

This eleven-month prospective randomized double-blind clinical trial was carried out from May 1, 2024, to March 31, 2025, with the agreement of Zagazig University's Institutional Review Board (IRB#146/25-Feb-2024) and the signed informed consent of each participant. Every technique was carried out in accordance with the Declaration of Helsinki, the World Medical Association's Code of Ethics for research involving human subjects.

Sample size:

The mean $\pm$ SD of the mean arterial pressure in the magnesium sulphate group was 65.27 $\pm$ 13.6 mmHg, according to previously published data that was used to estimate the sample size, while the mean $\pm$ SD in the phentolamine group was 82.3 $\pm$ 28.6 mmHg [12, 13]. Using OpenEpi version 2, a minimum sample of fifty-six patients was required to provide a study power of 80% at a confidence interval of 95% and a significance level of

0.05. To account for a potential dropout rate of 10%, six additional patients were recruited, bringing the total to sixty-two participants.

Inclusion criteria were males and females aged 21–60 years old with a body mass index 25 and 29.9 kg/m², American Society of Anesthesiologists (ASA) physical status I or II and had undergone elective single-level lumbar spine fixations that lasted less than three hours. **Exclusion criteria** included hypersensitivity to study drugs, diabetes mellitus, advanced hepatic, renal, cardiac, or respiratory disease, chronic hypertension, coronary artery disease, drug abuse, chronic therapy with beta-blockers or calcium channel blockers, coagulation disorders, pregnancy, or previous spinal surgery. **Withdrawal criteria** Patients were free to leave the trial whenever they wanted, and their medical or surgical treatment plan would not be negatively impacted.

Randomization

Sixty-two patients who satisfied the eligibility criteria were enrolled and split into two equal groups using a computer-generated randomization table. Group P (n = 31) received phentolamine, and Group M (n = 31) received magnesium sulphate. Allocation concealment was ensured by sealed opaque envelopes, and to reduce bias, the patients and the anesthesiologists in charge of intraoperative care and data gathering were blinded to group assignment.

Preoperative

Prior to surgery, each patient was assessed using a general and systemic examination, as well as their personal and family history, airway assessment, as well as laboratory testing such as coagulation profiles, liver and kidney function tests, and total blood counts. Heart rate and mean arterial pressure were among the baseline vital indicators that were noted. Following an explanation of the study's goals and anesthetic strategy, written informed consent was acquired. Every patient followed the recommended fasting

schedule, which calls for two hours for clear drinks and eight hours for solid food.

Intraoperative

Standard monitoring, as soon as the patient entered the operation room, noninvasive arterial blood pressure monitoring, pulse oximetry, and electrocardiography were used. Supplementary oxygen was given via a facemask. A 20-gauge intravenous cannula for fluid delivery and a 22-gauge cannula for study medication infusion were obtained. Three minutes prior to induction, as part of the premedication, intravenous midazolam 0.05 mg/kg was given. Propofol 2–3 mg/kg, fentanyl 1 µg/kg, and atracurium 0.5 mg/kg were used to induce anesthesia. After facemask breathing with 100% oxygen, a cuffed oral tube was used for endotracheal intubation.

To monitor blood pressure continuously, a radial arterial line was inserted. Intravenous fluid was given based on body weight and fasting hours to replenish the fluid deficit and maintain balance using 4-2-1 formula taking in consideration, the amount of fluid infused with the studied drugs in each group.

Isoflurane 1.2% in 60% oxygen was used to maintain anesthesia, the neuromuscular relaxation was maintained by administering atracurium at a dose of 0.1 mg/kg every 20 minutes.

A range of 35 to 40 mmHg was maintained for end-tidal carbon dioxide. 15 minutes prior to induction, Group P received a placebo infusion of 100 ml saline. They received a continuous intravenous infusion of phentolamine at a rate of 0.1–2 mg/min from the moment of induction to the end of the procedure (20 mg diluted in 48 ml saline, concentration 0.4 mg/ml). Group M received a loading dosage of 40 mg/kg of magnesium sulfate in 100 milliliters of saline 15 minutes before to induction. Next, a maintenance infusion was given at a rate of 15 mg/kg/h. This was made by combining 25 milliliters of 10% solution with 25 milliliters of saline (50 mg/ml).

The target mean arterial pressure of 60–65 mmHg was maintained by both groups. The study infusion was stopped in order to

manage hypotension (MAP <50 mmHg) and lowering the isoflurane concentration; if it didn't go away in five minutes, An intravenous dose of 6 mg of ephedrine was given. Bradycardia (HR <50 bpm) was treated with 0.5 mg of intravenous atropine. Fentanyl 50 µg was used to treat tachycardia (HR >100 bpm) within the target MAP, and propofol 50 mg IV was used to treat hypertension (MAP >96 mmHg). Study drug infusion were terminated at skin closure and Neostigmine 0.05 mg/kg and atropine 0.02 mg/kg were given to reverse neuromuscular blockade. Patients were extubated as soon as enough spontaneous breathing was achieved then they were then transferred to the recovery unit for observation.

Recovery and readiness for release from the post-anesthesia care unit (PACU) were evaluated using the Modified Aldrete score; a score of nine or higher was necessary for discharge [14].

Primary outcome: Controlled hypotensive anesthesia in patients undergoing lumbar fixation surgery regarding MAP. Secondary outcome: heart rate intraoperative and MAP and HR in the first 2 hours post-operative, duration of surgery, the quality of surgical field and surgeon satisfaction, total amount of blood loss, number of patients taken fentanyl or propofol intraoperative after induction, modified aldrete score and Ramsay sedation scale .

Data collection:

Each patient's age, sex, body mass index, and ASA physical condition were among the data collected. Mean arterial pressure and heart rate were measured and recorded as part of the intraoperative hemodynamic monitoring at baseline at the preoperative visit, right before anesthesia was induced, For the first half hour, every five minutes; after that, every fifteen minutes, until the process was completed. After induction, the amount of time needed to reach the desired mean arterial pressure was recorded. The extubation time was defined as the time between the end of anesthesia and tracheal extubation, whereas the

duration of surgery was defined as the time from the first skin incision to the last closure.

The operating surgeon used the scoring system to assess the surgical field. The amount of blood lost during surgery was assessed visually by evaluating saturated gauze and measuring the amount of fluid collected in suction bottles. Preoperative and postoperative measurements of hemoglobin and hematocrit levels were made, and the need for intraoperative blood transfusions was recorded. A Likert scale with five points, where one represents "very poor" and five "excellent," was used to assess surgeon satisfaction at the end of operation Fromme et al. [15].

The Ramsay Sedation Score was used to gauge the level of sedation in the recovery area Ramsay et al. [16]; a score of four or greater was considered clinically significant. The period of time between admission and meeting discharge requirements was used to calculate the PACU stay.

For the first two hours of postoperative hemodynamic monitoring, heart rate and mean arterial pressure were recorded every 15 minutes. Both intraoperative and postoperative adverse events such as hypotension, hypertension, bradycardia or tachycardia were recorded. Additionally noted were postoperative side effects like tachycardia, bradycardia, hypotension, hypertension, nausea, vomiting, and chills.

STATISTICAL ANALYSIS

SPSS software version 23.0 was used to enter and analyze all of the data (IBM Corp., 2015). Frequencies and percentages were used to represent qualitative variables, and the Chi-square test or Fisher's exact test, as applicable, was used to compare groups. The mean± standard deviation (SD) and range for regularly distributed data or the median and range for skewed data were used to convey quantitative variables. The Shapiro-Wilk test was used to determine whether the distribution was normal. For regularly distributed data, the independent samples t-test was used to compare two independent

groups, and the paired t-test was used to assess paired comparisons. The Mann-Whitney U test was applied to data that were not regularly distributed. A p-value was deemed statistically significant if it was less than 0.05 and non-significant if it was more than 0.05. Each and every statistical test was two-tailed.

RESULTS:

Eleven participants were excluded from the current study after 73 patients had their eligibility evaluated (Five patients did not fit the inclusion criteria, and six patients declined to take part in the trial) (**Figure 1**).

The remaining 62 patients were randomly divided into two groups, each consisting of 31 patients, following that, all 62 patients were contacted again and had their data reviewed.

Patients' Characteristics

There were no statistically significant variations in the baseline patient characteristics between the two groups in terms of age, sex, BMI, or ASA physical status (**Table 1**).

Operative and Recovery Parameters

Between groups P and M, there were no statistically significant differences in the time it took to achieve the desired blood pressure, the length of the procedure, or the time needed for extubation ($p > 0.05$ for all) (**Table 2**).

Intraoperative mean arterial blood pressure:

At every measurement point up until the end of the procedure, (**Table 3**) showed that there were no statistically significant variations in MAP between groups P and M ($p > 0.05$ for all).

Heart rate (beat/min)

At baseline, there were no statistically significant variations in heart rate between groups P and M ($p > 0.05$). Then, within the first two hours intraoperative, group P's heart rate increased statistically significantly more than group M's ($P < 0.05$) for everyone. Following that, there were no appreciable variations in heart rates between the two groups at 135 minutes,

150 minutes, or at the end of the procedure ($p > 0.05$ for all) (**Table 4**).

Postoperative Hemodynamics

At admission to PACU(0 minute) then at 15, 30, 45, and 60 minutes after surgery, group P's MAP value was statistically significantly lower than group M's ($p < 0.05$ for all). At 75, 90, 105, and 120 minutes, there were no statistically significant variations in MAP between groups P and M. (**Table 5**).

In the first two hours after surgery, group P's heart rate was statistically significantly greater than group M's. ($P < 0.05$ for all) (**Table 6**)

Surgical Field and Blood Loss

The two study groups under investigation did not differ statistically significantly in terms of surgical field quality (P-value > 0.05 for all). The two groups under study did not differ statistically significantly in terms of the amount of intraoperative blood loss (ml). For any P-value > 0.05 (**Table S1**)

The two study groups under investigation did not differ statistically significantly in terms of their pre- and post-operative HB levels; all were $p > 0.05$. With a p-value of less than 0.05 for every group, group P's post-operative HB value (10%) was substantially lower than group M's (10.9%) within each group (**Table S8**). The pre- and post-operative HCT levels did not differ statistically significantly between the two groups all were $p > 0.05$. The post-operative HCT value of group P was 9.6% lower than that of group M, compared to 10.8%, $p < 0.05$ (**Table S2**).

Surgeon satisfaction in the two studied groups:

The two study groups did not differ statistically significantly in terms of surgeon satisfaction ($p = 0.56$) (**Table S3**).

Time of discharge from PACU according to modified Aldrete score and Ramsay sedation score:

Regarding when the two study groups under investigation were discharged from the PACU, there were no statistically significant differences between them, according to the Modified Aldrete Score

($p=0.76$). The two study groups did not differ statistically significantly in terms of the Ramsay sedation score ($p=0.16$). Despite this, group M scored higher on grades 3 and 4 of the Ramsay sedation scale than group P. (Table S4).

Incidence of intra and postoperative side effects in the two studied groups

Between the two groups under study, there was no statistically significant difference in the incidence of intraoperative or postoperative adverse effects ($p>0.05$ for all (Table S11).

Table (1): Patients' characteristics of the two studied groups:

Variables	Group P n=31	Group M n=31	t	p-value
Age (years) Mean $\pm$ SD Range	46.87 $\pm$ 6.9 35-59	48.87 $\pm$ 6.41 34-59	1.17	0.243
BMI (kg/m ₂) Mean $\pm$ SD Range	27.64 $\pm$ 1.35 25.5-29.8	27.397 $\pm$ 1.36 25.5-29.7	0.693	0.490
	n (%)	n (%)	χ^2	p- value
Sex(number) Females Males	19(61.3) 12(38.7)	16(51.6) 15(48.4)	0.59	0.442
ASA I II	19(61.3) 12(38.7)	20(64.5) 11(35.5)	0.069	0.793

χ^2 Chisquare test, t: student' t test, $p \geq 0.05$ was considered no significant, data was expressed as mean $\pm$ standard deviation (SD) and range or number (percentage), group P (phentolamine group), group M (magnesium sulphate group), BMI= body mass index, ASA = American Society of anesthesia.

Table (2): Time to reach the targeted blood pressure, duration of surgery and extubation time in the two studied groups:

	Group P n=31	Group M n=31	t	p- value
Time to reach the targeted blood pressure(min) Mean $\pm$ SD Range	20.65 $\pm$ 6.8 10-45	24.03 $\pm$ 8.796 10-45	1.696	0.095
Duration of surgery (min) Mean $\pm$ SD Range	139.36 $\pm$ 19.44 150-180	132.097 $\pm$ 18.74 150-165	1.497	0.140
Extubation time (min) Mean $\pm$ SD Median(Range)	4.77 $\pm$ 1.36 5(2-7)	5.52 $\pm$ 1.75 5(3-9)	1.865	0.067

t: student' t test, $p \geq 0.05$ was considered no significant, data was expressed as Mean $\pm$ standard deviation (SD) median, and range group P (phentolamine group), group M (magnesium sulphate group).

Table (3): Intraoperative mean arterial blood pressure (MAP) (mmHg) in the studied groups:

Intraoperative MAP (mmHg)	Group P (n=31)	Group M (n=31)	t	p-value
---------------------------	----------------	----------------	---	---------

basal MAP Mean $\pm$ SD Range	89.55 $\pm$ 10.39 75-115	88.77 $\pm$ 8.09 74-105	0.327	0.745
MAP at induction Mean $\pm$ SD Range	79.03 $\pm$ 9.12 67-104	81.94 $\pm$ 7.67 70-97	1.356	0.180
MAP at 5 min Mean $\pm$ SD Range	78.39 $\pm$ 7.15 69-96	77.90 $\pm$ 6.82 68-96	.273	0.786
MAP at 10 min Mean $\pm$ SD Range	74.00 $\pm$ 6.78 65-90	74.48 $\pm$ 6.14 64-88	.295	0.769
MAP at 15 min Mean $\pm$ SD Range	68.94 $\pm$ 5.66 60-83	69.97 $\pm$ 5.15 60-82	.751	0.456
MAP at 20 min Mean $\pm$ SD Range	66.06 $\pm$ 3.16 61-76	66.94 $\pm$ 4.05 60-77	.944	0.349
MAP at 25min Mean $\pm$ SD Range	63.94 $\pm$ 2.68 60-72	64.65 $\pm$ 2.89 60-73	1.002	0.321
MAP at 30 min Mean $\pm$ SD Range	62.42 $\pm$ 2.42 58-68	63.55 $\pm$ 3.097 50-70	1.600	0.115
MAP at 45 min Mean $\pm$ SD Range	63.90 $\pm$ 4.497 50-72	63.06 $\pm$ 3.62 50-72	.809	0.422
MAP at 60 min Mean $\pm$ SD Range	66.0 $\pm$ 3.75 50-72	64.48 $\pm$ 3.41 60-74	1.701	0.094
MAP at 75 min Mean $\pm$ SD Range	64.94 $\pm$ 2.695 59-70	64.29 $\pm$ 2.74 60-70	.936	0.353
MAP at 90 min Mean $\pm$ SD Range	63.45 $\pm$ 2.28 57-68	63.87 $\pm$ 2.08 60-68	.757	0.452
MAP at 105 min Mean $\pm$ SD Range	62.87 $\pm$ 2.5 60-66	63.71 $\pm$ 1.95 60-67	1.47	0.146
MAP at 120 min Mean $\pm$ SD Range	62.59 $\pm$ 1.57 60-65	63.04 $\pm$ 1.63 60-66	1.06	0.296
MAP at 135 min Mean $\pm$ SD Range	64.71 $\pm$ 1.01 63-67	64.63 $\pm$ 1.93 61-67	.183	0.856
MAP at 150 min Mean $\pm$ SD Range	65.73 $\pm$ 2.05 60-69	65.56 $\pm$ 1.33 64-68	.231	0.819
MAP at end of surgery Mean $\pm$ SD Range	66.25 $\pm$ 2.5 65-70	66.00 $\pm$ 0.82 65-67	.190	0.855

t: student' t test, $p \geq 0.05$ was considered no significant, data was expressed as Mean $\pm$ standard deviation (SD) and range, group P (phentolamine group), group M (magnesium sulphate group).

Table (4): Intraoperative Heart rate (beat/min) in the two studied groups:

Heart rate (beat/min)	Group P n=31	Group M n=31	T	p-value
Basal HR. Mean $\pm$ SD Range	88.77 $\pm$ 7.6 76-110	85.81 $\pm$ 5.77 76-100	1.73	0.098
HR at induction Mean $\pm$ SD Range	99.55 $\pm$ 7.7 88-115	91.58 $\pm$ 7.63 78-98	4.091	<0.001*
HR at 5min Mean $\pm$ SD Range	94.13 $\pm$ 8.55 80-120	87.10 $\pm$ 6.32 75-100	3.682	<0.001*
HR at 10min Mean $\pm$ SD Range	86.74 $\pm$ 6.13 78-100	83.03 $\pm$ 5.81 72-95	2.447	0.017*
HR at 15min Mean $\pm$ SD Range	82.65 $\pm$ 5.81 75-93	78.81 $\pm$ 5.27 68-88	2.725	0.008*
HR at 20min Mean $\pm$ SD Range	79.45 $\pm$ 6.597 71-95	75.06 $\pm$ 4.52 65-81	3.054	0.003*
HR at 25min Mean $\pm$ SD Range	76.13 $\pm$ 6.52 68-90	71.65 $\pm$ 4.24 61-78	3.212	0.002*
HR at 30min Mean $\pm$ SD Range	73.84 $\pm$ 6.86 64-88	69.00 $\pm$ 4.29 58-77	3.329	0.001*
HR at 45min Mean $\pm$ SD Range	74.29 $\pm$ 7.1 50-87	67.48 $\pm$ 4.13 50-75	4.614	<0.001*
HR at 60min Mean $\pm$ SD Range	75.45 $\pm$ 9.37 50-100	66.90 $\pm$ 3.07 50-71	4.829	<0.001*
HR at 75min Mean $\pm$ SD Range	73.19 $\pm$ 7.21 64-95	66.26 $\pm$ 2.58 60-70	5.040	<0.001*
HR at 90min Mean $\pm$ SD Range	71.58 $\pm$ 6.62 60-93	66.35 $\pm$ 2.24 58-70	4.164	<0.001*
HR at 105min Mean $\pm$ SD Range	71.39 $\pm$ 5.57 65-90	67.26 $\pm$ 2.63 62-74	3.731	<0.001*
HR at 120min Mean $\pm$ SD Range	70.69 $\pm$ 5.497 64-85	68.33 $\pm$ 2.34 63-73	2.060	0.044*
HR at 135min Mean $\pm$ SD Range	72.19 $\pm$ 7.06 64-92	69.06 $\pm$ 2.41 65-73	1.744	0.090
HR at 150min Mean $\pm$ SD Range	71.67 $\pm$ 5.48 65-86	69.11 $\pm$ 2.89 65-74	1.267	0.220
HR at end of surgery Mean $\pm$ SD Range	69.75 $\pm$ 4.5 64-75	69.00 $\pm$ 3.92 64-73	0.251	0.810

t: student' t test, $p \geq 0.05$ was considered no significant, * $p \leq 0.05$ was considered significant, data was expressed as Mean $\pm$ standard deviation (SD) and range, group P (phentolamine group), group M (magnesium sulphate group).

Table (5): Postoperative mean arterial blood pressure (MAP) (mmHg) in the two studied groups:

Post-operative MAP (mmHg)	Group P n=31	Group M n=31	t	p-value
at 15min Mean $\pm$ SD Range	78.45 $\pm$ 5.81 68-90	88.68 $\pm$ 9.33 70-103	5.181	<0.001*
at 30min Mean $\pm$ SD Range	78.13 $\pm$ 5.89 65-91	87.45 $\pm$ 8.28 69-97	5.107	<0.001*
at 45min Mean $\pm$ SD Range	78.94 $\pm$ 6.08 67-95	84.74 $\pm$ 6.78 71-96	3.549	0.001*
at 60min Mean $\pm$ SD Range	79.61 $\pm$ 6.16 67-96	83.35 $\pm$ 7.47 70-100	2.153	0.035*
at 75min Mean $\pm$ SD Range	81.13 $\pm$ 5.43 70-95	82.26 $\pm$ 8.14 68-102	0.642	0.523
at 90min Mean $\pm$ SD Range	81.74 $\pm$ 4.89 74-93	82.71 $\pm$ 8.56 70-104	0.547	0.587
at 105min Mean $\pm$ SD Range	82.58 $\pm$ 5.74 71-96	83.97 $\pm$ 9.29 71-105	0.707	0.482
at 120min Mean $\pm$ SD Range	85.39 $\pm$ 9.61 73-105	83.29 $\pm$ 5.33 71-94	1.063	0.292

t: student' t test, $p \geq 0.05$ was considered no significant, * $p \leq 0.05$ was considered significant, data was expressed as Mean $\pm$ standard deviation (SD) and range , group P (phentolamine group), group M (magnesium sulphate group).

Table (6): Postoperative Heart rate (beat/min) in the two studied groups

Post-operative Heart rate(beat/min)	Group P n=31	Group M n=31	t	p-value
at 15min Mean $\pm$ SD Range	95.74 $\pm$ 7.88 85-118	76.26 $\pm$ 4.92 70-88	11.680	<0.001*
at 30min Mean $\pm$ SD Range	92.71 $\pm$ 7.51 79-110	77.16 $\pm$ 5.07 65-88	9.551	<0.001*
at 45min Mean $\pm$ SD Range	88.61 $\pm$ 7.08 75-105	74.90 $\pm$ 5.64 60-86	8.433	<0.001*
at 60min Mean $\pm$ SD Range	85.55 $\pm$ 7.75 69-100	73.90 $\pm$ 5.63 59-90	6.772	<0.001*
at 75min Mean $\pm$ SD Range	81.87 $\pm$ 7.54 66-100	73.68 $\pm$ 6.28 60-100	4.646	<0.001*
at 90min Mean $\pm$ SD Range	79.74 $\pm$ 7.75 70-110	73.13 $\pm$ 6.36 50-91	3.672	0.001*
at 105min Mean $\pm$ SD Range	79.06 $\pm$ 6.84 70-105	73.94 $\pm$ 5.56 64-90	3.239	0.002*

Post-operative Heart rate(beat/min)	Group P n=31	Group M n=31	t	p-value
at 120min Mean $\pm$ SD Range	78.71 $\pm$ 5.798 69-95	74.87 $\pm$ 4.74 68-88	2.855	0.006*

t: student' t test, * $p \leq 0.05$ was considered significant, data was expressed as Mean $\pm$ standard deviation (SD) or range, group P (phentolamine group), group M (magnesium sulphate group).

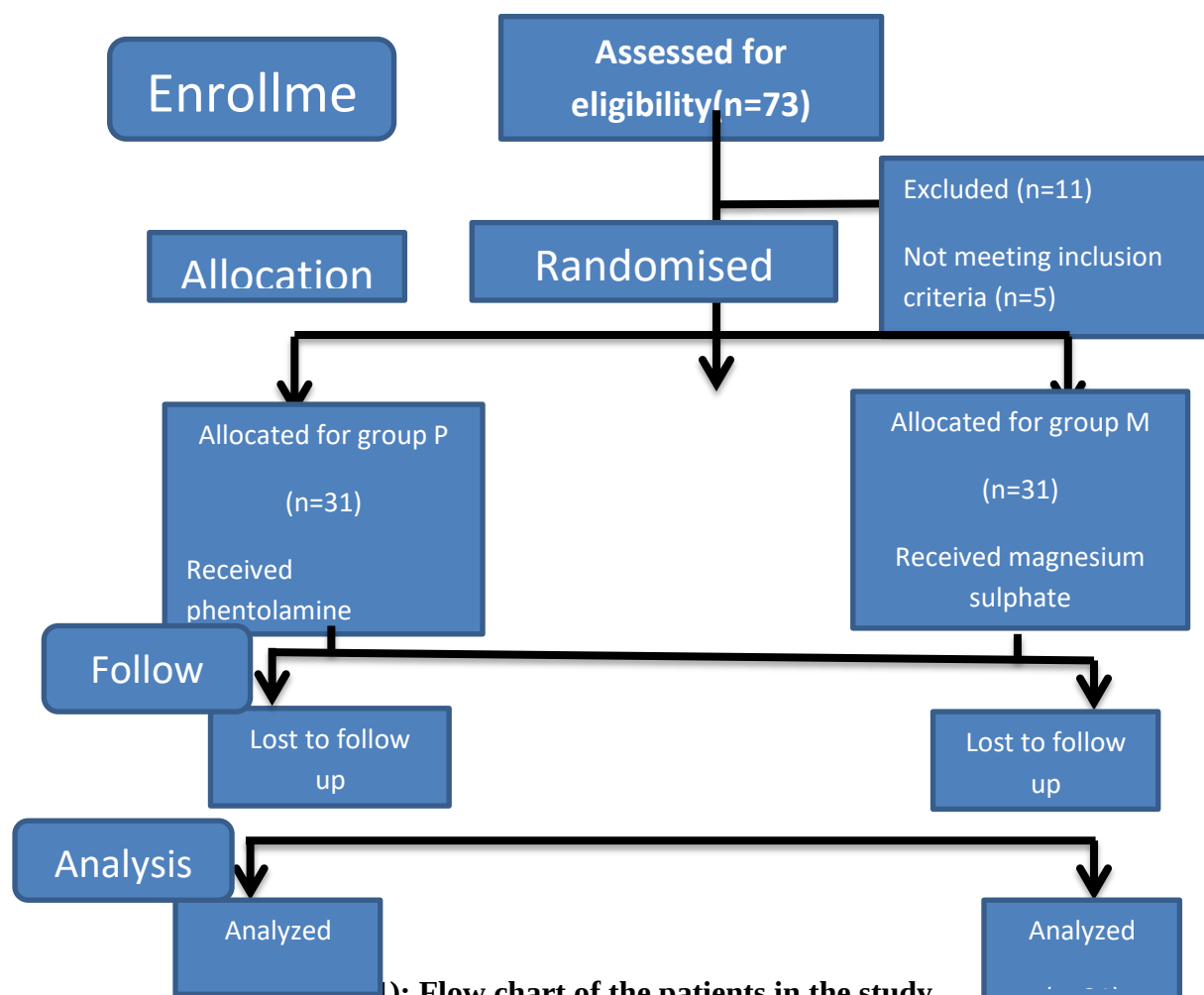


Figure (1): Flow chart of the patients in the study.

DISCUSSION

The findings showed that both medications had a hypotensive effect suitable for lumbar fixation surgery and obtained the desired MAP (60–65 mmHg). Any of these medications may be useful in reducing bleeding in the surgical field, stabilizing hemodynamics, and ultimately improving the surgical field's quality.

There was no statistically significant change in MAP between the two groups under study from the start to the end of operation; nevertheless, in the first hour

following the procedure, group P's MAP value was significantly lower than group M's.

Regarding intraoperative heart rate, for the first two hours of the procedure, group P's heart rate was statistically significantly greater than group M's. There was no noticeable difference between the two groups until the end of the operation. However, group P's heart rate was statistically substantially greater than group M's during the first two hours following the surgery.

The quality of the surgical field, surgeon satisfaction, total intraoperative blood loss, number of patients needing blood transfusions, pre and post-operative HB and HCT, time of discharge from PACU based on modified aldrete score, Ramsay sedation score in both groups, and incidence of intra and post-operative side effects did not differ statistically significantly between the two groups under investigation.

A reversible nonselective α -adrenergic antagonist with a short half-life (10–45 minutes), phentolamine can also cause hypotension by blocking α_1 and causing vasodilation [8].

In addition to having an analgesic effect, Acetylcholine release from presynaptic terminals depends on magnesium sulfate, a noncompetitive antagonist of N-methyl-D-aspartate receptors, which can result in hypotension via a vasodilator action. This ion's vasodilator effect is also brought on by angiotensin-converting enzyme inhibition and enhanced prostacyclin synthesis. Thus, this medication seems to have the potential to lower blood pressure during various surgical procedures [10].

There was limited number of studies and inadequate data available on the use of phentolamine for controlled hypotensive anesthesia, some results are consistent with the current study that phentolamine has role in lowering blood pressure and can be used as hypotensive agent in controlled hypotensive anesthesia Fakhry et al. [12]. In their study enrolled 30 patients candidate for Functional endoscopic sinus surgery in 2 equal groups receiving either phentolamine or nitroglycerin to achieve a mean arterial blood pressure (MAP) of about 50 to 65 mmHg. Founded that phentolamine is safe, efficient and might be advisable option for deliberate hypotensive anesthesia throughout Functional endoscopic sinus surgery.

Also Fathy et al. [17] in their study compared the effect of deliberate hypotensive anesthesia using phentolamine vs. nitroglycerine in 80 patients undergoing septoplasty found that phentolamine is preferred over

nitroglycerin in hypotensive anesthesia in patients scheduled to undergo septoplasty. McMillian et al. [18] According to the case report, a patient with pheochromocytoma received a continuous intravenous infusion of esmolol and an occasional intraoperative bolus injection of phentolamine to manage perioperative hypertension episodes during surgical adrenalectomy. A continuous infusion of phentolamine mesylate (1 mg/hr), adjusted hourly to reach the blood pressure target) was started the day following the procedure. The patient was considered hemodynamically stable four days after a continuous phentolamine infusion was started.

Magnesium sulphate also effective in hypotensive anesthesia, many results also consistent with our study Ghodraty et al. [19] Their study's findings, which compared the efficacy of remifentanyl and magnesium sulfate in producing controlled hypotension after lumbar fusion surgery, showed that magnesium is as beneficial in this respect. Additionally, magnesium was successfully employed by Yosry and Othman [20] to create controlled hypotension during surgery for choroid melanoma, an extremely vascular tumor that is prone to bleeding. They examined magnesium and nitroprusside and demonstrated that magnesium had an equivalent effect on choroidal blood flow reduction to nitroprusside. To lower their blood pressure to the appropriate levels, neither group needed a prescription supplement.

The mg sulphate group had lower HR during the first two hours intraoperative and the first two hours postoperatively than the phentolamine group, according to our analysis, which showed a significant difference in HR between the two groups.

According to Shoukry and Mahmoud [21] nitroglycerin and magnesium sulfate can both safely induce controlled hypotension during functional endoscopic sinus surgery (FESS). However, magnesium sulfate produced less tachycardia than nitroglycerin.

In line with our research, a statistically significant drop in heart rate was seen by

Ali et al. [22] in a study examining the effect of magnesium sulfate on perioperative hemodynamic responses in patients undergoing laparoscopic cholecystectomy. This could be the result of giving mg sulphate intravenously, which has an effect that lasts for a long time even after surgery.

Additionally, in a study to evaluate the impact of magnesium sulfate on anesthetic requirements and postoperative analgesia in patients undergoing total IV anesthesia (TIVA), Ryu et al. [23] found that the magnesium sulfate group experienced decreased intraoperative and postoperative heart rates.

Also Noor El-Din et al. [24] found that both nitroglycerine and magnesium sulphate caused hypotension in their research on their use as hypotensive medications in middle ear procedures. In contrast to nitroglycerin, magnesium sulfate was superior because it offered the best surgical field, reduced tachycardia, and required a lower dosage of propranolol.

The effects of intravenous magnesium sulfate and lidocaine on hemodynamic variables in patients undergoing elective surgery after direct laryngoscopy and intubation were assessed by Nooraei et al. [25], in contrast to our study. The results showed that the heart rate increased in the mg sulfate group after intubation, and that this increase remained statistically significant for four minutes. This could be because intravenous magnesium sulfate injection caused a marked rise in cardiac output during anesthesia induction and endotracheal intubation, which resulted in a left-side "after load" reduction and an increase in heart rate. In contrast to our findings, Moawad et al. [26] investigated the effects of magnesium sulfate and propofol in 50 individuals undergoing elective endoscopic sinus surgery and discovered no appreciable variations in the two groups' perioperative heart rates.

In a comparative investigation of magnesium sulfate and nitroglycerin during shoulder arthroscopic surgery in the beach chair posture, Awad and Mohamed

[27] found that magnesium sulphate provided a better surgical field and surgeon satisfaction than nitroglycerin. Furthermore, Fakhry et al. [12] found that the administration of phentolamine was associated with improved surgical field and surgeon satisfaction when comparing it to nitroglycerin in 30 patients undergoing functional endoscopic sinus surgery.

Total blood loss and pre- and post-operative HCT did not significantly differ between the two groups in our analysis.

Modanlou et al. [28] the study had 52 consecutive orthognathic surgery patients and was randomized, double-blind, and placebo-controlled. Between the two groups of subjects randomly assigned to receive intravenous magnesium sulfate and the second group, which got a placebo of normal saline, there was no appreciable difference in the amount of blood loss or need for a blood transfusion.

Hamed [29] investigated the differences between magnesium sulfate and lidocaine in terms of controlled hypotension during functional endoscopic sinus surgery. The patients' intraoperative blood loss and the condition of the surgical field were monitored. The findings demonstrated that lidocaine group had statistically significant less blood loss than magnesium sulphate group and significantly improved surgical field clarity. These results were similar to those of the Faranak et al experiment, which showed that the dexmedetomidine group outperformed the magnesium group in terms of bleeding score and surgeon satisfaction[30].

Our findings indicate that neither the Modified Aldrete score nor the Ramsay sedation scores at the time of PACU release differed significantly between the two groups. When controlled hypotension is induced during functional endoscopic sinus surgery with magnesium sulfate and dexmedetomidine, Bayram et al. [31] found no difference in the time it took to obtain a modified aldrete score greater than 9.

However, in a study comparing the effectiveness of magnesium sulfate and dexmedetomidine in controlling blood

pressure (BP) during rhinoplasty, Rokhtabnak et al. [32] discovered that patients in the magnesium group were less sedated at all recording periods in the PACU based on the Ramsay sedation score and that they took less time to reach the modified Aldrete score ≥ 9 . When comparing the effects of magnesium sulphate and dexmedetomidine on managed hypotension during functional endoscopic sinus surgery, Bayoumy et al. [13] found that patients in the magnesium group needed significantly less time to reach an Aldrete score of ≥ 9 than those in the dexmedetomidine group, and that they were less sedated by the Ramsay sedation score while in the PACU.

Additionally, in order to examine the effects of two dosages of magnesium sulphate as sedatives during awake fiberoptic intubation for patients undergoing craniofacial surgery, Meena et al. [33] randomly divided 80 patients into two groups. MgSO₄ injections of 30 mg/kg and 45 mg/kg were given to Group M1 and Group M2, respectively. Ramsay Sedation was used to measure sedation, and the results indicated that Group M2 had higher sedation scores than Group M1.

According to Elgnaidy et al. [34], who looked at the effects of propofol, magnesium sulfate, and dexmedetomidine under controlled hypotensive anesthesia during endoscopic sinus surgery, the incidence of intraoperative hypotension and bradycardia did not differ between the two groups. Between the three groups, there was no appreciable variation in postoperative nausea, shivering, or vomiting, and the magnesium sulphate group experienced fewer incidences of intraoperative bradycardia and hypotension.

Our findings are supported by another study Sriram Sundar, [35], which found that the Dexmedetomidine group experienced more cases of bradycardia and significant hypotension than the propofol and magnesium sulphate groups.

About post-operative side symptoms such as bradycardia, hypotension, vomiting, shivering, and nausea, our analysis

revealed that the incidence of adverse effects did not significantly differ among the groups under investigation.

In agreement with our study Chhabra et al. [36] In their comparison of dexmedetomidine and magnesium sulphate, they included Dexmedetomidine or MgSO₄ were randomly assigned to sixty-eight patients undergoing FESS; it was discovered that there were no notable intra- or post-operative side effects in either group.

Lang et al. [37] the effectiveness and safety of dexmedetomidine and magnesium sulphate in producing controlled hypotension during surgery were examined in a meta-analysis. The results showed that magnesium sulfate treatment increased the incidence of nausea and vomiting and decreased the incidence of bradycardia compared to dexmedetomidine. The number of patients who had shivering and those who required vasoactive intervention due to hypotension did not significantly differ between the two groups.

When combined, our findings show that magnesium sulphate and phentolamine are both good choices for managed hypotension during lumbar spine fixation, with equal safety and equivalent transfusion and surgical results. Therefore, the desired hemodynamic profile may help determine which of them is best: magnesium provides better heart-rate stability both during and after surgery, while phentolamine may be linked to higher heart rates and somewhat lower early postoperative MAP. These characteristics may be important for patients who have a limited tolerance for tachycardia or for lower post-emergence pressures. Selection should also be based on cost, availability, contraindications (e.g., severe renal impairment or major conduction disease for magnesium; catecholamine-dependent physiology for α -blockade), and team familiarity.

This study has limitations since, as far as we know, it is the first to compare phentolamine with magnesium sulphate. There have also been insufficient

investigations on the use of phentolamine in hypotensive anesthesia. Results may vary with whole intravenous anesthesia, alternate opioid methods, or various titration targets. Lastly, evaluation of longer-term hemodynamic or neurological outcomes was not possible due to follow-up being restricted to the immediate postoperative period

In conclusion:

Phentolamine (0.1-2 mg/min) has similar surgical field quality, blood loss, and recovery characteristics and magnesium sulphate (40 mg/kg loading then maintenance 15 mg/kg/h) both produced dependable intraoperative hypotension appropriate for lumbar spine fixation. While phentolamine caused a lower MAP during the first postoperative hour without providing additional clinical improvements in bleeding or satisfaction, magnesium was linked to decreased heart rates both intraoperative and in the early postoperative period. Depending on the patient's comorbidities and the anesthetic team's recommended hemodynamic profile, either drug may be chosen for controlled hypotension.

Conflict of Interest: There are no conflicting interests, according to the authors.

Financial Disclosures: No specific grant from a public, private, or nonprofit funding organization was awarded for this work.

Availability of the data: Upon reasonable request, the associated author will make the datasets created and/or examined during the current work available.

Author contribution: In addition to writing and getting the paper ready for publication, the writers were in charge of gathering and analyzing the data. The final version was examined and approved by all authors

REFERENCES

1. Degoute CS. Controlled hypotension: a guide to drug choice. *Drugs*. 2007;1053–76.
2. Ward CF, Alfery DD, Saidman LJ. Deliberate hypotension in head and neck surgery. *Head Neck Surg*. 1980; 2(3):185–95.
3. Dragan S, Kulej M, Krawczyk A, Wall A, Plocieniak K, Ubanski W. Methods of reducing allogeneic blood demand in orthopedic surgery. *Ortop Traumatol Rehabil*. 2012;14(3):199–214.
4. Tagarakis GL, Whitlock RP, Gutsche JT, Diegeler A, Patel PA, Daskalopoulos ME, et al. New frontiers in aortic therapy: focus on deliberate hypotension during thoracic aortic endovascular interventions. *J Cardiothorac Vasc Anesth*. 2014;28(3):843–7.
5. Gupta KK, Kumari V, Kaur S, Singh A. Comparative evaluation of propofol versus dexmedetomidine infusion for hypotensive anesthesia during functional endoscopic sinus surgery: a prospective randomized trial. *Anesth Pain Med*. 2022;17(3):271–9.
6. Ahmed OH, Nour-Eldin TM, Ali WM, Abd El Zaher MA. Comparison of the effect of nitroglycerin, magnesium sulphate and dexmedetomidine as hypotensive agents in lumbar spine surgery. *Egypt J Hosp Med*. 2019;76(7):4628–38.
7. Mohamed HS, Asida SM, Salman OH. Dexmedetomidine versus nimodipine for controlled hypotension during spine surgery. *Egypt J Anaesth*. 2013;29(4):325–31.
8. David LL, James KS, David MC, John KJ. The Cleveland Clinic internal medicine case reviews. Hagerstown, MD: Lippincott Williams & Wilkins; 2003. 6(3):32–5.
9. Chan GM, Sharma R, Price D, Hoffman RS, Nelson LS. Phentolamine therapy for cocaine-associated acute coronary syndrome (CAACS). *J Med Toxicol*. 2006;2(3):108–11.
10. Elsharnouby NM, Elsharnouby MM. Magnesium sulphate as a technique of hypotensive anaesthesia. *Br J Anaesth*. 2006;96(6):727–31.
11. Granry JC, Rod B, Monrigal JP. The analgesic efficacy of an injectable pro drug of acetaminophen in children after orthopedic surgery. *Pediatr Anesth*. 2003;7:445–9.
12. Fakhry DM, Mahmoud HE, Ahmed AG. Comparison between phentolamine and nitroglycerin for controlled hypotension during functional endoscopic sinus

- surgery. *J Anesth Pain Med.* 2019;4(1):1–6.
13. Bayoumy AA, Abo Zeid GS, El Deek AM, Elbeialy MA. Comparative study between magnesium sulphate and dexmedetomidine in controlled hypotension during functional endoscopic sinus surgery: a prospective randomized study. *Ain-Shams J Anesthesiol.* 2020;12(1):1–9.
14. Aldrete JA. The post-anesthesia recovery score revisited. *J Clin Anesth.* 1995;7(1):89–91.
15. Fromme GA, MacKenzie RA, Gould AB, Lund BA, Offord KP. Controlled hypotension for orthognathic surgery. *Anesth Analg.* 1986;65(6):683–6.
16. Ramsay MA, Savege TM, Simpson BR, Goodwin R. Controlled sedation with alphaxolone-alphadalone. *BMJ.* 1974;2:656–9.
17. Fathy W, Hussein M, Magdy R, Soliman HH, Elmoutaz H, Meshref AA, et al. Comparative effect of deliberate hypotensive anesthesia using nitroglycerine vs. phentolamine on event related potentials and cognitive functions in patients undergoing septoplasty: a randomized controlled trial. *BMC Anesthesiol.* 2023; 23(1):150.
18. McMillian WD, Trombley BJ, Charash WE, Christian RC. Phentolamine continuous infusion in a patient with pheochromocytoma. *Am J Health Syst Pharm.* 2011;68(2):130–4.
19. Ghodraty MR, Homaee MM, Farazmehr K, Nikzad-Jamnani AR, Soleymani-Dodaran M, Pournajafian AR, et al. Comparative induction of controlled circulation by magnesium and remifentanil in spine surgery. *World J Orthop.* 2014;5(1):51–6.
20. Yosry M, Othman IS. Controlled hypotension in adults undergoing choroidal melanoma resection: comparison between the efficacy of nitroprusside and magnesium sulphate. *Eur J Anaesthesiol.* 2008; 25:891–6.
21. Shoukry RA, Mahmoud AE. Controlled hypotension for functional endoscopic sinus surgery: a comparative study between magnesium sulfate and nitroglycerin. *Ain-Shams J Anaesthesiol.* 2018;10:91–6.
22. Ali AMY, Abd-Eldayem OT, Ahmed MAE, Elsayed MAA. Effect of magnesium sulphate on perioperative hemodynamic responses in hypertensive patients undergoing laparoscopic cholecystectomy. A randomized controlled double blinded trial. *MJCU.* 2022; 90:647–56.
23. Ryu JH, Kang MH, Park KS, Do SH. Effects of magnesium sulphate on intraoperative anaesthetic requirements and postoperative analgesia in gynaecology patients receiving total intravenous anaesthesia. *Br J Anaesth.* 2008;100(3): 397–403.
24. Noor El-Din TM, Madian MF, Salem EA, Hamed AH. Magnesium sulfate versus nitroglycerin in controlled hypotensive anesthesia in middle ear surgeries. *Int J Med Arts.* 2020;2(3):661–7.
25. Nooraei N, Dabbagh A, Niazi F, Mohammadi S, Mohajerani SA, Radmand G, et al. The impact of reverse trendelenburg versus head-up position on intraoperative bleeding of elective rhinoplasty. *Int J Prev Med.* 2013;4(12):1438–40.
26. Moawad HE, Ezzat ME, Mageed NA, AboZeid M. Controlled hypotension during endoscopic sinus surgery: a comparison of propofol and magnesium sulphate. *Anaest Sur Open Access J.* 2020;2(3):26–8.
27. Awad AA, Mohamed NA. A comparative study between nitroglycerin and magnesium sulfate during shoulder arthroscopic surgery in the beach chair position. *Med J Cairo Univ.* 2019;87:4449–55.
28. Modanlou Juibari H, Eftekharian HR, Arabion HR. Intravenous magnesium sulfate to deliberate hypotension and bleeding after bimaxillary orthognathic surgery; a randomized double-blind controlled trial. *J Dent (Shiraz).* 2016;17(3 Suppl):276–82.
29. Hamed MA. Comparative study between magnesium sulfate and lidocaine for controlled hypotension during functional endoscopic sinus surgery: a randomized controlled study. *Anesth Essays Res.* 2018;12(3):715–8.
30. Faranak R, Soudabeh DM, Mohamadreza G, Alireza P, Mojtaba MD, Arash TB, et al. Controlled hypotension during rhinoplasty. A comparison of dexmedetomidine with magnesium sulfate. *Anesth Pain Med.* 2017;7(6):32–64.

31. Bayram A, Ulgey A, Güneş I, Ketenci I, Capar A, Esmaoglu A, et al. Comparison between magnesium sulfate and dexmedetomidine in controlled hypotension during functional endoscopic sinus surgery. *Rev Bras Anesthesiol.* 2015;65(1):61–7.
32. Rokhtabnak F, Motlagh SD, Ghodrati M, Pournajafian A, Delarestaghi MM, Banihashemi AT, et al. Controlled hypotension during rhinoplasty: a comparison of dexmedetomidine with magnesium sulfate. *Anesth Pain Med.* 2017;7(6): e64032.
33. Meena K, Singh A, Meena RK, Singh DK. Comparison of two doses of magnesium sulphate as sedative during awake fiberoptic intubation for patients undergoing maxillofacial surgery: a prospective RCT. *Anaesth Pain Intensive Care.* 2020;24(2):175–82.
34. Elgnaidy EA, Elshehdawy SR, Elbably ME, Dowidar AM, Elbadawy AH. Comparative study between dexmedetomidine, magnesium sulfate and propofol in controlled hypotensive anesthesia during endoscopic sinus surgery. *Int J Med Anaesthesiol.* 2023;6(3):123–33.
35. Sriram Sundar M. Comparison between magnesium sulfate and dexmedetomidine in controlled hypotension during functional endoscopic sinus surgery. *Curr Top Med Chem.* 2020;6:52–93.
36. Chhabra A, Saini P, Sharma K, Chaudhary N, Singh A, Gupta S. Controlled hypotension for FESS: a randomised double-blinded comparison of magnesium sulphate and dexmedetomidine. *Indian J Anaesth.* 2020;64(1):24–30.
37. Lang B, Zhang L, Lin Y, Zhang W, Li FS, Chen S. Comparison of effects and safety in providing controlled hypotension during surgery between dexmedetomidine and magnesium sulphate: a meta-analysis of randomized controlled trials. *PLoS One.* 2020;15(1):23–7.

Table (S1): Quality of the surgical field, number of patients needed blood transfusion and intraoperative total blood loss in the two studied groups:

	Group P n=31	Group M n=31	χ^2	p-value
The quality of surgical field N (%)				
GI: Slight bleeding without suction	1(3.2)	1(3.2)	2.32	0.677
G II: Slight bleeding with suction	6(19.4)	3(9.7)		
G III: light bleeding	11(35.5)	13(41.9)		
G IV: moderate bleeding	12(38.7)	14(45.2)		
G V: severe bleeding	1(3.2)	0.0		
Number of patients who needed blood Transfusion n (%)	2(6.5%)	5(16.1%)	f	0.425
			t	p-value
Total blood loss (ml) Median (Range)	600 (500-700)	650 (500-800)	0.162	0.871

χ^2 : Chi-square test; t: Student's t-test; $p \geq 0.05$ was considered not significant. Data are expressed as median, range, number and percentage. Group P: phentolamine group; Group M: magnesium sulphate group.

Table (S2): Pre and post-operative hemoglobin (HB) and Hematocrit (HCT) in the two studied groups:

	Group P n=31	Group M n=31	t	p-value
Hemoglobin (HB)				
Pre-operative HB(gm/dl) Mean $\pm$ SD Range	12.43 $\pm$ 1.41 10-15	12.32 $\pm$ 1.67 10-15.2	0.263	0.794
Post-operative HB			0.616	0.540

	Group P n=31	Group M n=31	t	p-value
Mean $\pm$ SD	11.19 $\pm$ 1.35	10.98 $\pm$ 1.33		
Range	9-13.3	9-13.5		
Paired t	13.3	8.6		
P	<0.001	<0.001		
% of decrease in HB	10%	10.9%		
Hematocrit (HCT)				
Pre-operative HCT				
Mean $\pm$ SD	37.28 $\pm$ 4.27	36.997 $\pm$ 4.99	0.244	0.808
Range	30-45	30-45.6		
Post-operative HCT				
Mean $\pm$ SD	33.7 $\pm$ 4.03	33.003 $\pm$ 4.01	0.683	0.497
Range	27-41	27-40		
Paired t	12.9	8.6		
P	<0.001*	<0.001*		
%	9.6%	10.8%		

t: student' t test, * $p \leq 0.05$ was considered significant, data was expressed as Mean $\pm$ standard deviation (SD) and range or (percentage), group P (phentolamine group), group M (magnesium sulphate group).

Table (S3): Surgeon satisfaction in both studied groups:

	Group P n.31	Group M n.31	χ^2	p- value
	n (%)	n (%)		
Surgeon satisfaction				
Excellent	9(29.0)	7(22.6)		
Good	22(71.0)	24(77.4)		
Satisfactory	0	0	0.337	0.562
Poor	0	0		
Very poor	0	0		

χ^2 Chisquare test, $p \geq 0.05$ was considered no significant data was expressed as number (percentage), group P (phentolamine group), group M (magnesium sulphate group).

Table (S4): Time of discharge from PACU according to modified aldrete score and Ramsay sedation score in the two studied groups:

	Group P n=31	Group M n=31	T	p-value
Time of discharge(min)				
Mean $\pm$ SD	12.0 $\pm$ 0.86	11.94 $\pm$ 0.81	0.304	0.762
Range	11-14	12(11-13)		
			χ^2	p- value
Ramsay sedation score				
1	13(41.9)	11(35.5)		
2	17(54.8)	14(45.2)	1.96	0.161
3	1(3.2)	4(12.9)		
4	0.0	2(6.5)		
Patient's sedation n (%)				
No	31(100)	29(93.5)	f	0.492
Yes	0.0	2(6.5)		

t: student' t test, $p \geq 0.05$ was considered no significant, data was expressed as Mean $\pm$ standard deviation (SD), range and number (percentage) group P (phentolamine group), group M (magnesium sulphate group).

Table (S11): Incidence of intra and post-operative side effects in the two studied groups:

	Group P n=31		Group M n=31		p- value
	n.	%	n.	%	
Intra- operative side effect					
Incidence of hypotension	3	9.7	1	3.2	0.612
Incidence of bradycardia	2	6.5	3	9.7	0.99
Incidence of patients took fentanyl to manage tachycardia	1	3.2	0	0.0	0.99
Incidence of patients took propofol to manage hypertension	1	3.2	3	9.7	0.612
Post-operative side effect					
Hypotension	0	0.0	0	0.0	-
Hypertension	1	3.2	3	9.7	0.612
Tachycardia	3	9.7	1	3.2	0.612
Bradycardia	0	0.0	2	6.5	0.492
Nausea	3	9.7	2	6.5	0.99
Vomiting	3	9.7	2	6.5	0.99
Shivering	4	12.9	2	6.5	0.612

f: fisher exact test, $p \geq 0.05$ was considered no significant, data was expressed as number (percentage), group P (phentolamine group), and group M (magnesium sulphate group).

Citation

Ali Mohamed Abdelkareem, N., Elattar, H., Fathi, H., Shahin, M., Nazmy, H. Phentolamine versus Magnesium Sulphate for Controlled Hypotension in Patients During Lumbar Spine Fixation Surgery under General Anesthesia. *Zagazig University Medical Journal*, 2025; (5780-5797): -. doi: 10.21608/zumj.2025.426711.4215