ORIGINAL ARTICLE

EFFECT OF MAGNESIUM SULFATE WITH PROPOFOL ON HEMODYNAMIC STABILITY DURING TRACHEAL INTUBATION IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFTING: A SINGLE-CENTER STUDY

Iftekhar Shah[1], Amin M. Khuwaja[1], Aftab Ahmed[1], Haris Tariq Chohan[1], Rabia Iqtdar[1], Maaida Muzaffar[1], Kashif Zia[1], Maria Faraz[1]

[1]**National Institute of Cardiovascular Disease Karachi, Pakistan**

Objectives: This study aimed to assess the hemodynamic response of magnesium sulfate (MGS) with propofol during tracheal intubation in patients undergoing coronary artery bypass grafting (CABG).

Methodology: A cross-sectional study was conducted at a tertiary cardiac center in Pakistan, involving 100 patients undergoing elective CABG. Hemodynamic parameters were recorded before and after intubation, following the administration of MGS with propofol.

Results: The mean systolic blood pressure was 114.9±9.4 mmHg, 120.3±3.4 mmHg and 111.1±6.4 mmHg before intubation, after 2 minutes and 5minutes respectively, with p-value of <0.001. The mean diastolic blood pressure was 66.2±10.3 mmHg, 67.8±6.1 mmHg, and 62±7.2 mmHg before intubation, after 2 minutes and 5minutes respectively, with p-value of <0.001. The mean arterial blood pressure was 82.5±9.2 mmHg, 85.3±4.5, mmHg and 78.4±6.4 mmHg before intubation, after 2 minutes and 5minutes respectively, with p-value of <0.001. The mean heart rate was 65.1±8.8 bpm, 69.7±5.2 bpm and 71.3±4.6 bpm before intubation, after 2 minutes and 5minutes respectively, with p-value of <0.001.

Conclusion: The study concludes that the addition of MGS to propofol contributes to hemodynamic stability during tracheal intubation in patients undergoing CABG. Further research is needed to validate these findings and explore optimal dosing regimens.

Keywords: Magnesium sulphate, propofol, tracheal intubation, hemodynamic stability, coronary artery bypass grafting

Citation: Shah I, Khuwaja AM, Ahmed A, Chohan HT, Iqtdar R, Muzaffar M, Zia K, Faraz M. Effect of Magnesium Sulfate with Propofol on Hemodynamic Stability during Tracheal Intubation in Patients Undergoing Coronary Artery Bypass Grafting: A Single-Center Study. Pak Heart J. 2024;57(02):136-141. DOI: https://doi.org/10.47144/phj.v57i2.2710

INTRODUCTION

The induction of general anesthesia, particularly through laryngoscopy and intubation, is known to trigger a surge in plasma catecholamine concentrations.[1-3] This physiological response, often referred to as the stress response, can lead to adverse hemodynamic effects, including hypertension and arrhythmias, with potentially severe consequences such as myocardial arrest or cerebrovascular accidents.[4,5] Managing hemodynamic instability during and after intubation poses a significant challenge for anesthesiologists, particularly in patients scheduled for cardiac surgeries.

Various pharmacological agents have been explored to mitigate the hemodynamic stress response associated with intubation. Among these, dexmedetomidine has gained attention for its ability to modulate sympathetic activity by acting on α-2 adrenergic receptors, thereby reducing norepinephrine release and dampening airway and circulatory reflexes.[6,7] However, dexmedetomidine administration may also lead to undesirable side effects such as bradycardia and hypotension.[8,9]

An alternative approach involves the use of magnesium sulfate (MGS) in conjunction with anesthetic drugs to optimize hemodynamics. MGS acts by inhibiting the release of catecholamines from the adrenal medulla and peripheral nerve endings, as well as by blocking catecholamine receptors, ultimately leading to sympathetic blockade and vasodilation.[10-12] This multifaceted action of magnesium makes it a promising therapeutic agent for maintaining hemodynamic stability in various clinical settings.[11-12]

Propofol, a commonly used intravenous anesthetic agent, is often administered during induction of anesthesia. Additional bolus doses of propofol, such as 0.5 mg/kg at the time of intubation, have been proposed to improve intubation conditions without posing a significant risk of hypotension.[13] However, investigations into the combined use of magnesium and propofol to attenuate the stress response during tracheal intubation in patients undergoing coronary artery bypass grafting (CABG) remain limited.

This study aims to evaluate the hemodynamic response of magnesium sulfate when used in conjunction with propofol during tracheal intubation in patients undergoing CABG at a tertiary cardiac center in Pakistan. By assessing the impact of this combination on hemodynamic stability, this research seeks to contribute to the optimization of anesthesia management in cardiac surgery, ultimately enhancing patient outcomes and safety.

METHODOLOGY

Study Design: This cross-sectional study aimed to investigate the hemodynamic response during tracheal intubation in patients undergoing cardiac surgery, specifically focusing on the effects of magnesium sulfate in conjunction with propofol.

Setting: Conducted within the Department of Anesthesia & Surgical Intensive Care Unit (SICU) at the National Institute of Cardiovascular Diseases (NICVD) in Karachi. The study spanned a period of six months, from May 5th, 2023, to November 4th, 2023, ensuring a comprehensive sampling of patients undergoing cardiac surgery within the specified timeframe.

Ethics: Ethical considerations were paramount throughout the conduct of this study. Approval was obtained from the Ethical Review Committee (ERC) prior to the commencement of the research, ensuring adherence to ethical guidelines and principles. Informed consent was obtained from all participants before their inclusion in the study, with a clear explanation provided regarding the purpose, procedures, and potential risks involved. Patient confidentiality was strictly maintained, and measures were implemented to protect participants' privacy and sensitive information. The study was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki and other relevant regulatory guidelines to uphold the welfare and rights of the participants.

Participants: Participants comprised patients aged 18 to 75 years undergoing elective coronary artery bypass grafting (CABG) with an American Society of Anesthesiologists (ASA) classification of III or IV. Exclusion criteria encompassed patients with known hypersensitivity to the study medications, those at risk of complicated intubation, obese patients, and individuals requiring multiple attempts for endotracheal tube intubation, among others.

Variables: The primary independent variable was the administration of magnesium sulfate and propofol during tracheal intubation, while dependent variables included hemodynamic parameters such as systolic and diastolic blood pressure, mean arterial pressure, and heart rate.

Data Sources/Measurement: Data collection involved recording hemodynamic parameters before intubation, 2 minutes post-intubation, and 5 minutes post-intubation. This comprehensive assessment allowed for the evaluation of hemodynamic stability following laryngoscopy and anesthesia induction. Tablet alprazolam was administered to patients 12 hours prior to surgery, and anesthesia management was standardized across all participants.

Bias: To mitigate potential biases, a non-probability consecutive sampling technique was employed, ensuring all eligible patients meeting the inclusion criteria were included. Additionally, intubations were performed by experienced anesthesiologists with a minimum of 5 years of experience, reducing the risk of operator-related bias.

Study Size: A judgmental sample of 100 patients was deemed adequate based on a previous study's findings, which reported significant reductions in blood pressure and heart rate following tracheal intubation with magnesium sulfate. This sample size facilitated robust statistical analysis while ensuring feasibility within the study duration.

Quantitative Variables: Quantitative variables, including systolic and diastolic blood pressure, mean arterial pressure, and heart rate, were analyzed using means ± standard deviations. Paired sample t-tests or Wilcoxon signed-rank tests were employed to compare baseline hemodynamic parameters with subsequent values, maintaining a significance level of 5%.

Statistical Methods: Data analysis was conducted using SPSS software (version 21.0), facilitating rigorous statistical assessment of the study variables. This included comparisons of hemodynamic parameters at different time points and the determination of hemodynamic stability following laryngoscopy and anesthesia induction.

RESULTS

Participants: The study encompassed 100 participants, predominantly male (88%) with a mean age of 56.4 years. The majority of patients had comorbid hypertension (95%) and diabetes (69%), with a significant proportion diagnosed with three-vessel disease (80%).

Descriptive Data: The administration of magnesium sulfate (2 grams) and propofol (ranging from 30 to 60 mg) during tracheal intubation was standardized across all participants. Preoperative characteristics such as mean ejection fraction (48.3%) and type of surgery (isolated CABG) were consistent among the cohort. Notably, no complications such as toxicity, hypotension, or electrolyte imbalance were reported during the study period.

Outcome Data: Hemodynamic parameters, including systolic and diastolic blood pressure, heart rate, and mean arterial pressure, were recorded at various time points: before intubation, 2 minutes after intubation, and 5 minutes after intubation. These readings were compared to baseline values to assess the impact of magnesium sulfate and propofol on hemodynamic stability during anesthesia induction.

Main Results: The results demonstrate significant changes in hemodynamic parameters following the administration of magnesium sulfate and propofol. Systolic blood pressure decreased significantly from a mean of 173.3 mmHg at baseline to 114.9 mmHg before intubation, with further reductions to 120.3 mmHg at 2 minutes and 111.1 mmHg at 5 minutes post-intubation. Similarly, diastolic blood pressure decreased from a mean of 101 mmHg at baseline to 66.2 mmHg before intubation, with fluctuations observed at subsequent time points.

Heart rate exhibited a slight increase post-intubation, with a mean of 65.1 bpm before intubation, rising to 69.7 bpm at 2 minutes and 71.3 bpm at 5 minutes. Mean arterial pressure followed a similar trend, showing a decrease from baseline to pre-intubation values and subsequent stabilization post-intubation.

Graphical representation (Figure-1) further elucidates the effect of magnesium sulfate when added to propofol on hemodynamics at the time of intubation, illustrating the favorable impact of this combination on maintaining hemodynamic stability during anesthesia induction.

Table 1: Descriptive Statistics

Characteristics	Summary
Total (N)	**100**
Sex	
Male	88 (88%)
Female	12 (12%)
Mean age (years)	56.4 ± 4
Dose of MgSO4 at Intubation	
2 grams	100 (100%)
Dose of Propofol at Intubation	
30 mg	12 (12%)
40 mg	1 (1%)
50 mg	86 (86%)
60 mg	1 (1%)
Co-morbid conditions	
Hypertension	95 (95%)
Diabetes	69 (69%)
Valvular heart disease	3 (3%)
Chronic kidney disease	0 (0%)
Cerebrovascular accident	0 (0%)
Number of vessels involved	
2 vessel disease	20 (20%)
3 vessel disease	80 (80%)
Left main involved	33 (33%)
Mean ejection fraction (%)	48.3 ± 5.6
Type of Surgery	
Isolated CABG	100 (100%)
Complications	
Toxicity	0 (0%)
Hypotension	0 (0%)
Hypertension	0 (0%)
Bradycardia	0 (0%)
Tachycardia	0 (0%)
Prolonged muscle relaxant effect	0 (0%)
Electrolyte imbalance	0 (0%)

DISCUSSION

Magnesium sulfate (MGS) emerges as a promising agent for attenuating the stress response induced by laryngoscopy and intubation, as evidenced by previous research.[14] In our study, we sought to explore the impact of magnesium in combination with propofol on heart rate and blood pressure responses to laryngoscopy during anesthesia induction. Our results clearly demonstrate the significant role of magnesium in blunting these responses, as indicated by the observed p-values.

Our findings align with previous studies, such as that of Sachin Padmawar et al. (2016), which reported significantly lower systolic blood pressure (SBP) values following intubation in patients receiving magnesium sulfate.[15] Similarly, our study corroborates the findings of Nooraei N et al. (2013), highlighting significant differences in hemodynamics between magnesium sulfate and control groups.[16]

Table 2: Hemodynamic Stability during anesthesia induction

	Basal	Before intubation	2 minutes after intubation	5 minutes after intubation
Systolic blood pressure (mmHg)				
Mean ± SD	173.3 ± 17	114.9 ± 9.4	120.3 ± 3.4	111.1 ± 6.4
P-value (vs. preceding)	-	<0.001	<0.001	<0.001
Diastolic blood pressure (mmHg)				
Mean ± SD	101 ± 14.3	66.2 ± 10.3	67.8 ± 6.1	62 ± 7.2
P-value (vs. preceding)	-	<0.001	0.091	<0.001
Heart rate (bpm)				
Mean ± SD	65.9 ± 13.6	65.1 ± 8.8	69.7 ± 5.2	71.3 ± 4.6
P-value (vs. preceding)	-	0.329	<0.001	<0.001
Mean atrial pressure (mmHg)				
Mean ± SD	125.2 ± 13.5	82.5 ± 9.2	85.3 ± 4.5	78.4 ± 6.4
P-value (vs. preceding)	-	<0.001	0.003	<0.001

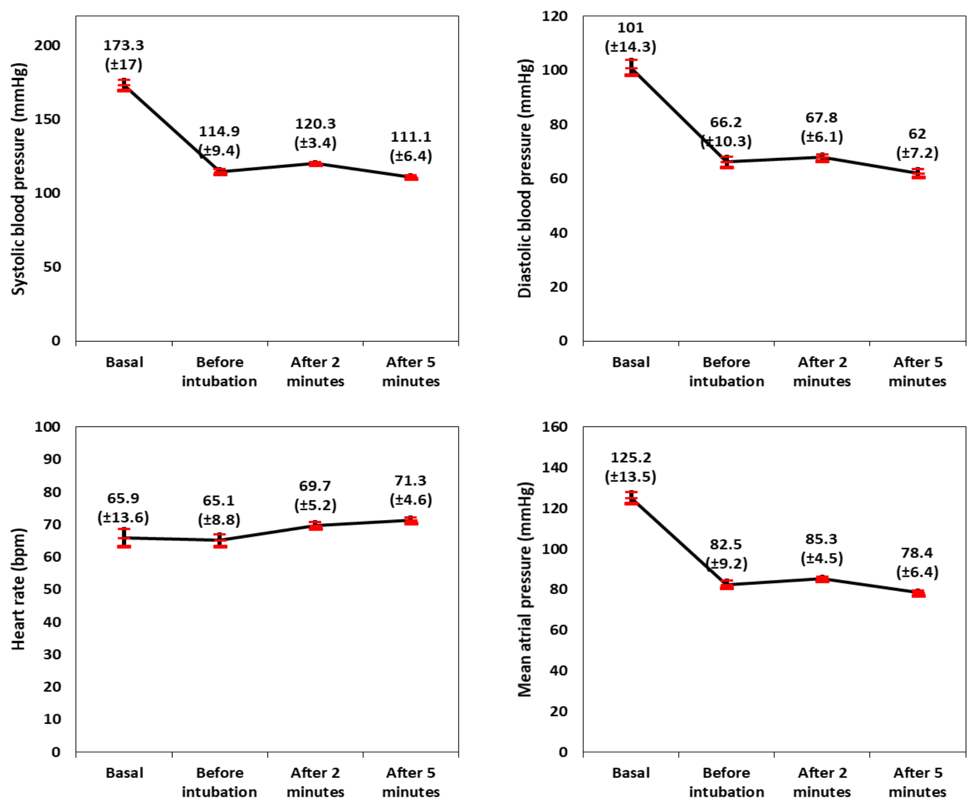

Figure 1: Graphical representation of effect of Propofol plus MgSO4 on Haemodynamics

Moreover, research by Vallabha et al. and Batata et al. further supports the efficacy of magnesium sulfate in improving mean arterial pressure and reducing the pressor response to lidocaine, respectively.[17,18]

However, our results diverge from some prior studies, such as that of G Kiraci et al. (2014), which did not find significant differences in mean arterial pressure at various time points post-intubation when magnesium was added to standard settings.[19] Similarly, Aissaoui et al.'s study failed to demonstrate significant differences in heart rate and mean arterial pressure.[20] The discrepancies between our findings and these studies may be attributed to variations in induction drugs, doses of magnesium sulfate pretreatment, or the absence of muscle relaxant induction, as suggested by Hassan-Ali Soltani et al.[21]

Despite the valuable insights gained from our study, several limitations warrant consideration. Confounding factors such as hypertension, diabetes, and valvular heart disease may have influenced our results. Additionally, we did not measure serum magnesium levels post-administration, which could have provided further insights into the pharmacokinetics of magnesium sulfate. Furthermore, using magnesium as a sole drug rather than comparing it with alternative agents like lidocaine limits the comprehensive evaluation of its benefits during induction. Future research could overcome these limitations by expanding the study to multiple centers or exploring comparative drug interventions.

LIMITATION

One limitation of our study is the potential influence of confounding factors such as hypertension, diabetes, and other comorbidities on the observed hemodynamic responses. Additionally, the absence of post-administration serum magnesium level measurements restricts our ability to fully elucidate the pharmacokinetics of magnesium sulfate. Furthermore, the study's single-center design may limit the generalizability of our findings, warranting future multicenter studies to validate our results across diverse patient populations and clinical settings.

CONCLUSION

Our study demonstrates the significant efficacy of magnesium sulfate in conjunction with propofol for attenuating the hemodynamic response to laryngoscopy during anesthesia induction in patients undergoing CABG. Through meticulous observation of heart rate and blood pressure responses, we have corroborated previous research findings, reaffirming magnesium sulfate's role in blunting these responses. Despite certain limitations, including confounding factors and the absence of post-administration serum magnesium level measurements, our findings underscore the potential of magnesium sulfate as a valuable adjunctive therapy in anesthesia practice, with the capacity to enhance patient safety and optimize outcomes in cardiac surgery. Further research is warranted to refine dosing strategies and explore its broader clinical applications, ensuring its effective integration into anesthesia management protocols.

AUTHORS' CONTRIBUTION

IS and AMK: Concept and design, data acquisition, interpretation, drafting, final approval, and agree to be accountable for all aspects of the work HTC, AA, MM, RI, KZ, and MF: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

Disclaimer: None.

Conflict of interest: Authors declared no conflict of interest.

Source of funding: None.

Double blinded peer review history:
Submission complete: January 05, 2024
Review began: January 13, 2024
Revision received: March 4, 2024
Revision accepted: March 27, 2024

REFERENCES

1. Shribman AJ, Smith G, Achola KJ. Cardiovascular and catecholamine responses to laryngoscopy with and without tracheal intubation. Br J Anaesth. 1987;59(3):295-9.
2. Derbyshire DR, Chmielewski A, Fell D, Vater M, Achola K, Smith G. Plasma catecholamine responses to tracheal intubation. Br J Anaesth. 1983;55:855-60.
3. King BD, Harris LC, Greifenstein FE, Elder JD, Dripps RD. Reflex circulatory responses to direct laryngoscopy and tracheal intubation performed during general anesthesia. Anesthesiology. 1951;12(5):556-66.
4. Fox EJ, Sklar GS, Hill CH, Villanueva R, King BD. Complications related to the pressor response to endotracheal intubation. Anesthesiology. 1977;47(6):524-5.
5. Gunalan S, Venkatraman R, Sivarajan G, Sunder P. Comparative evaluation of bolus administration of dexmedetomidine and fentanyl for stress attenuation during laryngoscopy and endotracheal intubation. J Clin Diagn Res. 2015;9(9):Uc06-9.
6. Gulabani M, Gurha P, Dass P, Kulshreshtha N. Comparative analysis of efficacy of lignocaine 1.5 mg/kg and two different doses of dexmedetomidine (0.5 mug/kg and 1 mug/kg) in attenuating the hemodynamic pressure response to laryngoscopy and intubation. Anesth Essays Res. 2015;9(1):5-14.
7. Kunisawa T, Nagata O, Nagashima M, Mitamura S, Ueno M, Suzuki A, et al. Dexmedetomidine suppresses the decrease in blood pressure during anesthetic induction and blunts the cardiovascular response to tracheal intubation. J Clin Anesth. 2009;21:194-9.
8. Reddy SV, Balaji D, Ahmed SN. Dexmedetomidine versus esmolol to attenuate the hemodynamic response to laryngoscopy and tracheal intubation: a randomized double-blind clinical study. Int J Appl Basic Med Res. 2014;4(2):95-100.
9. Yildiz M, Tavlan A, Tuncer S, Reisli R, Yosunkaya A, Otelcioglu S. Effect of dexmedetomidine on haemodynamic responses to laryngoscopy and intubation: perioperative haemodynamics and anaesthetic requirements. Drugs R&D. 2006;7(1):43-52.
10. Puri GD, Marudhachalam KS, Chari P, Suri RK. The effect of magnesium sulphate on hemodynamics and its efficacy in attenuating the response to endotracheal intubation in patients with coronary artery disease. Anesth Analg. 1998;87(4):808-11.
11. Mendonça FT, Queiroz LM, Guimarães CC, Xavier AC. Effects of lidocaine and magnesium sulfate in attenuating hemodynamic response to tracheal intubation: single-center, prospective, double-blind, randomized study. Rev Bras Anestesiol. 2017;67(1):50-6.
12. Khalid V, Khuwaja MA, Ahmed A, Kumar K, Iqtdar R, Hussain SA. Magnesium sulphate versus lignocaine at induction for hemodynamic response in patients undergoing cardiac surgery. Pak Armed Forces Med J. 2021;71(Suppl-2):S338-42.
13. Dashti M, Amini S, Azarfarin R, Totonchi Z, Hatami M. Hemodynamic changes following endotracheal intubation with glidescope® video-laryngoscope in patients with untreated hypertension. Res Cardiovasc Med. 2014;3:e17598.
14. Feroze R, Hussain A, Naseer M. Blunting Stress Response During Intubation in Hypertensive Patients; A Comparison Between Lidocaine and Magnesium Sulphate. Pak Armed Forces Med J 2022; 72(6):1916-9.
15. Padmawar Sachin, Patil Manish. A comparative study of 2% lignocaine vs 50% magnesium sulphate for attenuation of stress

responses to laryngoscopy and endotracheal intubation. Int J Contemp Med Res. 2016;3(8):2317-21.

16. Nooraei N, Dehkordi ME, Radpay B, Teimoorian H, Mohajerani SA. Effects of Intravenous Magnesium Sulfate and Lidocaine on Hemodynamic Variables Following Direct Laryngoscopy and Intubation in Elective Surgery Patients. Tanaffos 2013;12(1):57-63.
17. Vallabha R, Muthayala VK. Attenuating the haemodynamic stress to laryngoscopy and intubation with IV magnesium sulphate and lignocaine-comparative study. IOSR J Dent Med Sci. 2018;17(4):1-5.
18. Balata AA, Latif HK, Waly SH, Mohamed AB. Dexmedetomidine versus Magnesium Sulphate or Lidocaine for blunting stress response to direct laryngoscopy and endotracheal intubation in abdominal surgeries. Zagazig Uni Med J. 2018;24(6):492-500.
19. Kiraci G, Demirhan A, Tekelioglu UY, Akkaya A, Bilgi M, Erdem A, et al. A comparison of the effects of lidocaine or magnesium sulfate on hemodynamic response and QT dispersion related with intubation in patients with hypertension. Acta Anæsthesiologica Belgica. 2014;65(3):81-6.
20. Aissaoui Y, Qamous Y, Serghini I, Zoubir M, Salim JL, Boughalem M. Magnesium sulphate: An adjuvant to tracheal intubation without muscle relaxation – A randomised study. Eur J Anaesthesiol. 2012;29:391-7.
21. Soltani HA, Hashemi SJ, Montazeri K, Dehghani A, Nematbakhsh M. The role of magnesium sulfate in tracheal intubation without muscle relaxation in patients undergoing ophthalmic surgery. J Res Med Sci. 2016;21:96.

Address for Correspondence:

Dr. Iftekhar Shah, Senior Registrar Cardiac Anesthesia at National Institute of Cardiovascular Diseases, Karachi, Pakistan.

Email: iftekharshahdr@gmail.com