# "COMPARISON OF INTRAVENOUS MAGNESIUM SULPHATE AND INTRAVENOUS LIGNOCAINE FOR ATTENUATION OF CARDIOVASCULAR RESPONSE TO LARYNGOSCOPY AND ENDOTRACHEAL INTUBATION IN PATIENTS UNDERGOING ELECTIVE SURGERIES UNDER GENERAL ANAESTHESIA- A ONE YEAR HOSPITAL BASED DOUBLE BLINDED RANDOMISED CLINICAL TRIAL"


**By**

**REG NO: BA0121007**


# DISSERTATION

**SUBMITTED TO THE**
**KLE ACADEMY OF HIGHER EDUCATION & RESEARCH**
**(DEEMED-TO-BE-UNIVERSITY), BELAGAVI, KARNATAKA**

In Partial Fulfillment of the requirements for the degree of

**M.D.**

**In**

**ANESTHESIOLOGY**


**JAWAHARLAL NEHRU MEDICAL COLLEGE,**
**BELAGAVI, KARNATAKA**


**DEC 2024/ JAN 2025**

# ENDORSEMENT

**KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH,**

**BELAGAVI, KARNATAKA.**

## ENDORSEMENT

This is to certify that the dissertation entitled **"COMPARISON OF INTRAVENOUS MAGNESIUM SULPHATE AND INTRAVENOUS LIGNOCAINE FOR ATTENUATION OF CARDIOVASCULAR RESPONSE TO LARYNGOSCOPY AND ENDOTRACHEAL INTUBATION IN PATIENTS UNDERGOING ELECTIVE SURGERIES UNDER GENERAL ANESTHESIA – A ONE YEAR HOSPITAL BASED DOUBLE BLINDED RANDOMIZED CLINICAL TRIAL."** is a bonafide research work done by **REG NO.BA0121007.**

**Dr. RAJESH. S. MANE** M.D
Professor and Head,
Department of Anaesthesiology,
J.N. Medical college,
Nehru Nagar, Belagavi- 590010.

Date: 29-6-2024
Place: Belagavi.

KAHER BELAGAVI J.N. MEDICAL COLLEGE

**Dr. N.S. MAHANTSHETTI** M.D,(PAEDS)
Principal,
J.N. Medical college,
Nehru Nagar, Belagavi- 590010.

PRINCIPAL
J.N. Medical College,
BELAGAVI- 590 010

Date: 29-6-2024
Place: Belagavi.

# PLAGIARISM

KLE JAWAHARLAL NEHRU MEDICAL COLLEGE
(A constituent unit of KLE Academy of Higher Education & Research Deemed-to-be-University)
(Recognized by National Medical Commission, New Delhi)
Accredited 'A+' Grade by NAAC (3rd Cycle) Placed in Category 'A' by MoE (GoI)
Nehru Nagar, Belagavi- 590 010, Karnataka, INDIA
0831 - 2471350 0831 - 2470759 www.jnmc.edu rincipal@jnmc.edu

Ref No: MDC/PG/ Date: 29-06-2024

## "ACCEPTANCE LETTER"

The softcopy of thesis entitled: **"COMPARISON OF INTRAVENOUS MAGNESIUM SULPHATE AND INTRAVENOUS LIGNOCAINE FOR ATTENUATION OF CARDIOVASCULAR RESPONSE TO LARYNGOSCOPY AND ENDOTRACHEAL INTUBATION IN PATIENTS UNDERGOING ELECTIVE SURGERIES UNDER GENERAL ANAESTHESIA - A ONE YEAR HOSPITAL BASED DOUBLE BLINDED RANDOMISED CLINICAL TRIAL"** has been submitted for anti-plagiarism check through Turnitin software. The scan has been carried out and the scanned output reveals a match percentage of **10%** which is within the acceptable limits of **10%** as per the guidelines given by UGC.

Guide.

KAHER * BELAGAVI * J. N. MEDICAL COLLEGE

**Dr. (Mrs.) N.S. Mahantashetti.**
Chairperson-Antiplagiarism Committee &
Principal,
J. N. Medical College, Belagavi.

PRINCIPAL
J.N. Medical College,
BELAGAVI- 590 010

To,
**Reg. No. BA0121007**
Postgraduate Student,
2021-22 Batch,
Department of Anaesthesiology
J. N. Medical College, Belagavi.

# UNDERTAKING

UNDERTAKING

I, **(REG NO.: BA0121007)**, hereby declare that the information and data mentioned in my dissertation entitled **"COMPARISON OF INTRAVENOUS MAGNESIUM SULPHATE AND INTRAVENOUS LIGNOCAINE FOR ATTENUATION OF CARDIOVASCULAR RESPONSE TO LARYNGOSCOPY AND ENDOTRACHEAL INTUBATION IN PATIENTS UNDERGOING ELECTIVE SURGERIES UNDER GENERAL ANAESTHESIA - A ONE YEAR HOSPITAL BASED DOUBLE BLINDED RANDOMISED CLINICAL TRIAL"** belongs to me and is original. I am aware of the definition of plagiarism as detailed below:

- An act or instance of using or closely imitating the language and thoughts of another author without authorization and the representation of that author's work as one's own, as by not crediting the original author.
- A piece of writing or other work reflecting such unauthorized use or imitation.
- The deliberate or reckless representation of another's words, thoughts or ideas as one's own without attribution in connection with submission of academic work whether graded or otherwise.

I hereby declare that the dissertation prepared by me is original one and does not involve plagiarism anywhere. In case at a later stage, it is found that I have indulged in plagiarism, then I am solely responsible for the same and the institution is at liberty to take any disciplinary action against me including cancellation of dissertation or any other penalties imposed by the University.

**Date:** 1-7-2024

**Place: JNMC, Belagavi**

**REG NO. : BA0121007**

# ETHICAL CLEARANCE

K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed – to- be- University)
Accredited 'A+' Grade by NAAC in (3rd Cycle) Placed in Category 'A' by MHRD (GoI)
**JNMC INSTITUTIONAL ETHICS COMMITTEE**
**JAWAHARLAL NEHRU MEDICAL COLLEGE,**
**NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)**
Website: http//www.jnmc.edu
E-Mail : dome@jnmc.edu
Phone: (+ 91-(0)831 Office : 2472550
Principal: 2471701
Fax No. +91 (0)831 – 2470759

**Ref No.MDC/JNMCIEC/** 145 **Date: 27/09/2022**

To,
Reg No. BA0121007
PG Student in Anesthesiology,
J. N. Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"COMPARISON OF INTRAVENOUS MAGNESIUM SULPHATE AND INTRAVENOUS LIGNOCAINE FOR ATTENUATION OF CARDIOVASCULAR RESPONSE TO LARYNGOSCOPY AND ENDOTRACHEAL INTUBATION IN PATIENTS UNDERGOING ELECTIVE SURGERIES UNDER GENERAL ANAESTHESIA - A ONE YEAR HOSPITAL BASED DOUBLE BLINDED RANDOMISED CLINICAL TRIAL."** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee.

**(Dr. Smita Sonoli)**
Member Secretary
JNMC Institutional Ethics Committee
J.N.Medical College, Belagavi.

**(Dr. Harsha Hegde)**
Chairman,
JNMC Institutional Ethics Committee
J.N.Medical College, Belagavi

# LIST OF ABBREVATIONS

HR - Heart Rate

SBP – Systolic Blood Pressure

DBP – Diastolic Blood Pressure

MAP – Mean Arterial Pressure

ASA – American Society of Anesthesiologists

NS – Normal Saline

IV – Intravenous

BIS – Bispectral Index

FDA – Food and Drug Administration

ACLS – Advanced Cardiac Life Support

NMDA – N-methyl D-aspartate

ECG – Electrocardiogram

CO- Cardiac Output

PVR- Peripheral Vascular Resisstance

TPN – Total Parenteral Nutrition

BMI – Body Mass Index

PR – Pulse Rate

RR – Respiratory Rate

CBC – Complete Blood Count

RFT – Renal Function test

LFT – Liver function Test

NPO – Nil Per Oral

FBS – Fasting Blood Sugar

TLC – Total Leucocyte Count

PT – Prothrombin Time

INR – International Normalized ratio

S.D – Standard Deviation

# ABSTRACT

INTRODUCTION

The majority of surgical procedures require general anesthesia, which would require direct laryngoscopy & endo-tracheal intubation. Laryngoscopy & intubation procedures are employed both in operating rooms and for cardiopulmonary resuscitation in the emergency room. [(1)]

Direct laryngoscopy results in stimulation of autonomic nervous system due to nociceptive efferents from pharynx and larynx.[(2)] Activation of this system leads to reflex sympathetic action because of epi-pharyngeal and laryngo-pharyngeal stimulation which leads to increased sympathoadrenal activity that lead to hemodynamic variations like systemic hypertension, pulmonary hypertension, tachycardia and dysrhythmias and cerebrovascular accidents like intracranial bleed. [(3)]

Although this response is only transient and cause no harm in normotensive healthy patients, it can be detrimental in the patients having pre-existing cardiovascular diseases leading to sequelae like myocardial infarction, acute heart failure and pre-existing cerebrovascular conditions like increased intracranial pressure leading to cerebrovascular accidents. [(6)]

Various manoeuvres and techniques are recommended to reduce this sympathetic response. In this instance, we have attempted to compare the effectiveness of 50% magnesium sulphate in the dosage of 30 mg /kg IV and 2% preservative-free lignocaine at a dosage of 1.5 mg /kg IV for reducing the cardiovascular sympathetic-response to laryngoscopy & intubation.

## OBJECTIVES

To compare intravenous lignocaine with intravenous magnesium sulphate with respect to:

a) Hemodynamic variables – Heart Rate, Systolic blood pressure, Diastolic blood pressure, Mean arterial pressure.

b) Incidence of side effects and complications, if any, of the study drugs

## METHODOLOGY

Following the institutional ethical committee's clearance, 102 subjects that satisfied inclusion and exclusion criteria and were scheduled for surgical procedures under general anesthesia at KLES' Dr Prabhakar Kore Hospital at Belagavi were included in the study.

After obtaining a written consent, they were randomised by chit picking into either of the groups.

Group-M: Subjects were administered 50% Magnesium Sulphate 30 milligrams/kilogram slow IV 3-minutes prior to intubation.

Group-L: Subjects were administered 2% preservative-free-Lignocaine 1.5 milligrams/kilogram IV 3-minutes prior to intubation.

Patients were then induced under general anesthesia and hemodynamic parameters – systolic, diastolic & mean pressures and heart rate were taken at various time points: prior to intubation, each minute up-to 5th minute, at 7th minute and at 10th minute post-intubation.

RESULTS

It was observed that magnesium sulphate was better than lignocaine in controlling diastolic pressure at 2- and 3-minutes post-intubation. But there were no notable differences in heart rate, systolic pressure and mean pressure between the two groups within the first five minutes post-intubation period. And tachycardia response to intubation was better attenuated by preservative free lignocaine

CONCLUSION

Both preservative free lignocaine and magnesium sulphate are equally efficacious in attenuation of the cardiovascular sympathetic response to intubation with respect to heart rate, systolic and mean pressures. Magnesium sulphate was better in attenuation of diastolic pressure at second- and third-minutes post-intubation and tachycardia response was better attenuated by preservative free lignocaine.

KEYWORDS

Lignocaine, Magnesium Sulphate, Laryngoscopy, Response to Intubation

# TABLE OF CONTENTS


| SERIAL NO. | PARTICULARS | PAGE NO. |
|---|---|---|
| 1 | INTRODUCTION | 1 |
| 2 | OBJECTIVES | 4 |
| 3 | REVIEW OF LITERATURE | 5 |
| 4 | BASIC SCIENCES | 11 |
| 5 | METHODOLOGY | 32 |
| 6 | RESULTS | 37 |
| 7 | DISCUSSION | 70 |
| 8 | SUMMARY | 80 |
| 9 | CONCLUSION | 82 |
| 10 | BIBLIOGRAPHY | 83 |
| 11 | ANNEXURES | |
| | ANNEXURE I: Informed Consent Form | 90 |
| | ANNEXURE II: Proforma | 93 |
| | ANNEXURE III: Photographs | 98 |
| | ANNEXURE IV: Master Chart | 100 |
| | ANNEXURE V: Key to Master Chart | 102 |

# LIST OF TABLES


| TABLE NO. | PARTICULARS | PAGE NO. |
|---|---|---|
| 1 | Comparison of demographic details over groups | 37 |
| 2 | Comparison of clinical details over groups | 39 |
| 3 | Comparison of HR over time and groups | 41 |
| 4 | Comparison of SBP over time and groups | 43 |
| 5 | Comparison of DBP over time and groups | 45 |
| 6 | Comparison of MAP over time and groups | 47 |
| 7 | Comparison of HR over time and groups in males & females | 49 |
| 8 | Comparison of SBP over time and groups in males & females | 51 |
| 9 | Comparison of DBP over time and groups in males & females | 53 |
| 10 | Comparison of MAP over time and groups in males & females | 56 |
| 11 | Comparison of HR over time and groups in age groups | 58 |
| 12 | Comparison of SBP over time and groups in age groups | 61 |
| 13 | Comparison of DBP over time and groups in age groups | 64 |
| 14 | Comparison of MAP over time and groups in age groups | 67 |

# LIST OF GRAPHS


| GRAPH NO. | PARTICULARS | PAGE NO. |
|---|---|---|
| 1 | Distribution of age over groups | 38 |
| 2 | Distribution of gender over groups | 38 |
| 3 | Mean plot of age over groups | 39 |
| 4 | Mean plot of weight over groups | 40 |
| 5 | Distribution of ASA grade over groups | 41 |
| 6 | Mean plot of HR over time and group | 42 |
| 7 | Mean plot of SBP over time and group | 44 |
| 8 | Mean plot of DBP over time and group | 46 |
| 9 | Mean plot of MAP over time and group | 48 |
| 10 | Mean plot of HR over time and group in females | 50 |
| 11 | Mean plot of HR over time and group in males | 51 |
| 12 | Mean plot of SBP over time and group in females | 52 |
| 13 | Mean plot of SBP over time and group in males | 53 |
| 14 | Mean plot of DBP over time and group in females | 54 |
| 15 | Mean plot of DBP over time and group in males | 55 |
| 16 | Mean plot of MAP over time and group in females | 57 |
| 17 | Mean plot of MAP over time and group in males | 58 |
| 18 | Mean plot of HR over time and group in age group 40-50 years | 59 |
| 19 | Mean plot of HR over time and group in age group 51-60 years | 60 |

| | | |
|---|---|---|
| 20 | Mean plot of HR over time and group in age group 61-70 years | 60 |
| 21 | Mean plot of SBP over time and group in age group 40-50 years | 62 |
| 22 | Mean plot of SBP over time and group in age group 51-60 years | 63 |
| 23 | Mean plot of SBP over time and group in age group 61-70 years | 63 |
| 24 | Mean plot of DBP over time and group in age group 40-50 years | 65 |
| 25 | Mean plot of DBP over time and group in age group 51-60 years | 66 |
| 26 | Mean plot of DBP over time and group in age group 61-70 years | 66 |
| 27 | Mean plot of MAP over time and group in age group 40-50 years | 68 |
| 28 | Mean plot of MAP over time and group in age group 51-60 years | 69 |
| 29 | Mean plot of MAP over time and group in age group 61-70 years | 69 |

# LIST OF FIGURES


| FIGURE NO. | PARTICULARS | PAGE NO. |
|---|---|---|
| 1 | ANATOMY OF THE UPPER AIRWAY | 14 |
| 2 | ANATOMY OF THE LARYNX | 16 |
| 3 | FUNCTIONAL ANATOMY OF THE LARYNX | 16 |
| 4 | MALLAMPATI GRADING | 19 |
| 5 | CHEMICAL STRUCTURE OF MAGNESIUM SULPHATE | 20 |
| 6 | CHEMICAL STRUCTURE OF LIGNOCAINE | 26 |

# INTRODUCTION

The majority of surgical procedures require general anesthesia, which would require direct laryngoscopy and endo-tracheal intubation. Laryngoscopy and intubation procedures are employed both in operating rooms and for cardiopulmonary resuscitation in the emergency room. [(1)]

Direct laryngoscopy results in stimulation of autonomic nervous system due to nociceptive efferents from pharynx and larynx. [(2)] Activation of this system leads to reflex sympathetic action because of epi-pharyngeal and laryngo-pharyngeal stimulation which leads to increased sympathoadrenal activity that leads to hemodynamic variations like systemic hypertension, pulmonary hypertension, tachycardia and dysrhythmias and cerebrovascular accidents like intracranial bleed. [(3)]

The cardiovascular stressor response increases with either increase in the force or prolonged duration of laryngoscopy. [(4)] Following laryngoscopy, the blood pressures rise within 5 seconds, peak at 1 to 2-minutes only to return to base values within 5-minutes. In 1940, Reid and Bruce explained the cardiovascular response following direct laryngoscopy as a result of sympatho-adrenal stimulation. Cardiovascular pressor responses due to laryngoscopy & intubation are accompanied by an elevation in plasma catecholamine levels that directly causes hemodynamic stress. [(5)]

Although this response is only transient and cause no harm in normotensive healthy patients, it can be detrimental in the patients having pre-existing cardiovascular diseases leading to sequelae like myocardial infarction, acute heart failure and pre-existing

cerebrovascular conditions like increased intracranial pressure leading to cerebrovascular accidents. [6]

Therefore, it is essential to find out an effective method for the blunting of the sympathetic reflex to laryngoscopy and intubation and has become one of the most researched topics in the field of anesthesiology.

Various maneuvres and techniques are recommended to reduce the sympathetic response like pre-treatment with preservative-free lignocaine 1-1.5mg/kg IV, MgSO4 30-50mg/kg IV, limiting duration of laryngoscopy to <15 seconds, topical local anesthetics, vasodilators, opioids like fentanyl 1-2 µg/kg, [7,8,9] morphine, beta blockers like esmolol 0.5mg/kg IV, [10] labetolol 0.25mg/kg IV, [10] metoprolol, inhalational gases like isoflurane/ sevoflurane, calcium channel blockers like nifedipine IV, alpha 2 agonists like clonidine 1-2 µg/kg IV [9] and dexmedetomidine IV 0.5-1 µg/kg. [8,11]

Lignocaine was introduced in the year 1948. It is an amino-ethyl-amide and is the cheapest and extensively used local anesthetic even today. [12] It has membrane stabilizing property and hence commonly used as an anti-arrhythmic agent. Bromage showed that intravenous administration of lignocaine before intubation diminished the stressor response to intubation in 1961. Lignocaine was advocated widely and was a standard agent for attenuating the stress response at various health centres.

It has been demonstrated that administering 1.5 mg/kg of preservative-free lignocaine intravenously 3-minutes prior to intubation could reduce stress reaction to laryngoscopy& and intubation.

Magnesium is the second most extensively present intra-cellular ion. Magnesium sulphate is a magnesium salt which has sulphate as the counter ion. It also has anti-convulsant and

calcium channel blocking property. It also has tocolytic, antiarrhythmic and analgesic properties. It assists in reducing the sympathetic reflex to laryngoscopy and intubation and inhibits catecholamine-release from the adrenal-medulla and nerve endings of adrenergic system. It also causes excitation and contraction uncoupling in myometrial cells of the heart which exerts a negative inotropic action. It also has NMDA receptor blocking property and thus acts as an analgesic too. **(13)**

Several authors have investigated magnesium sulphate dosages in an effort to prevent the sympathetic reaction that occurs during laryngoscopy & intubation. The effects of prior treatment with magnesium sulphate at 60 mg/kg IV and its subsequent cardiovascular response and the release of catecholamines in response to tracheal intubation were studied by James et al. and they concluded that magnesium sulphate was helpful in attenuating the catecholamine-mediated response after endotracheal intubation.**(12)** Puri et al demonstrated that Magnesium sulphate was a better alternative to lignocaine when given at 50 mg/kg prior to laryngoscopy and could diminish the sympathetic reaction to intubation.**(1)**

In this instance, we have attempted to compare the effectiveness of 50% magnesium sulphate in the dosage of 30 mg/kg IV and 2% preservative-free lignocaine at a dosage of 1.5 mg/kg IV for reducing the cardiovascular sympathetic-response to laryngoscopy and intubation.

Anesthesiologists are still hesitant to use magnesium sulphate in their routine use even though there is data supporting its efficacy. This study was carried out in order to provide for a comprehensive understanding of the clinical significance of magnesium sulphate for reducing the sympathetic cardiovascular reflex to laryngoscopy & intubation during procedures under general anesthesia. This study sought to determine how effectively magnesium sulphate and preservative-free lignocaine could maintain hemodynamic stability in patients during laryngoscopy in a tertiary hospital setting.

# OBJECTIVES

Primary objective:

To evaluate the relative effectiveness of magnesium-sulphate and preservative-free lignocaine in diminishing the sympathetic cardiovascular reflex to laryngoscopy & intubation in relation to the hemodynamic variables –heart-rate, systolic-blood pressure, diastolic-blood pressure, mean-arterial pressure.

Secondary objective:

To ascertain any potential adverse effects and complications of the drugs under evaluation.

# REVIEW OF THE LITERATURE

Misganaw Abebaw et al.[1] conducted a trial in 2020 on 112 patients in the ages 18 to 60 years. There were 37 subjects in nonexposed group, 37 in the preservative-free-lignocaine group and 38 in magnesium sulphate group. One group was given 2% preservative-free lignocaine at 1.5 mg/kg IV 5-minutes prior to intubation, another group was given 30 mg/kg magnesium sulphate slow IV 5-minutes prior to intubation, and nonexposed patients were administered NS and hemodynamic parameters were noted. They found that prophylactic magnesium sulphate in the dosage of 30 mg/kg and lignocaine in the dosage of 1.5 mg/kg were efficacious in diminishing the hemodynamic reflex to laryngoscopy and intubation; however, prophylactic magnesium sulphate in the dosage of 30 mg/kg was linked to a more favorable outcome than lignocaine.

Madhu Kumar B S et al.[6] conducted a randomized control trial on 70 patients in 2020 with 35 patients in group-A receiving preservative-free lignocaine at 1.5 mg/kg IV & 35 patients in group-B receiving magnesium sulphate at 30 mg/kg IV both 90-seconds prior to laryngoscopy & intubation. According to this study, the cardiovascular reflex to laryngoscopy and intubation was blunted by both lignocaine at 1.5 mg/kg IV and magnesium sulphate at 30 mg/kg IV; however, the sympathetic reflex was more effectively controlled by magnesium sulphate than by lignocaine. They inferred that magnesium sulphate was a superior substitute for lignocaine for minimizing the reaction to laryngoscopy & intubation.

Sachin Padmawar et al.[13] undertook a study in 2016 on one hundred ASA-grade-1 and grade-2 patients, aged 17-50 years, with 50 patients in group-1 receiving 2% preservative-free lignocaine at 1.5mg/kg IV and 50 patients in group-2 receiving magnesium sulphate 40mg/kg IV prior to laryngoscopy & intubation. They discovered that, in the post-intubation phase, the lignocaine-group saw a considerable elevation in blood pressure& heart rate & rate-pressure product, which did not recover to pre-intubation levels five minutes post-intubation. and the rate-pressure product exceeded the angina-limit of 12,000 in >50% patients. But, in the magnesium-group, blood pressure & heart-rate & rate-pressure product was significantly elevated only at 1-minute post-intubation and returned to pre-intubation values within 5 minutes post-intubation and the rate-pressure product never exceeded the angina limit of 12,000. This study concluded that magnesium sulphate 40 mg/kg IV was better alternative to preservative-free lignocaine 1.5mg/kg IV in reducing stressor reflex to laryngoscopy and intubation.

Bulle S et al.[3] undertook a comparative study involving 60 ASA-grade-1 patients, ranging in 15-45 years, posted for surgeries with general anesthesia. These patients were assigned at random into two groups each consisting of 30 subjects, with no discernible variations between groups. Group-L patients were given preservative-free lignocaine at dosage of 1.5 mg/kg IV 3-minutes prior to intubation, while Group-M patients were given magnesium sulphate at dosage of 40 mg/kg slow IV over a minute just prior to inducing. Both cohorts demonstrated a significant elevation in heart rate, but it was notably greater in lignocaine-group than the magnesium sulphate-group. Furthermore, there was an elevation in systolic blood pressure immediately following drug administration in both sets. This elevation was significant at 1st

minute post-intubation and reverted to base values at 3rd minute, dropping below base values at 5-minutes post-intubation in Group-M. Conversely, Group-L demonstrated a surge in systolic-blood pressure at 1- & 3-minutes, which returned to pre-intubation values at 5-minutes post-intubation. Moreover, the elevation in systolic-blood pressure was remarkably more in lignocaine-group than magnesium sulphate-group. In contrast to lignocaine, the study found that magnesium sulphate offered efficient in the management of the elevation in SBP, DBP & HR during laryngoscopy and intubation.

Valia Khalid and colleagues.**(14)** carried out a research involving 100 patients classified as ASA grade-2, grade-3, grade-4, aged 18-65 years, who were taken up for cardiac surgeries. They were split into two groups. Group-A were given 1.5 mg/kg of preservative-free lignocaine, while Group-B was given 50 mg/kg of magnesium sulphate both prior to intubation. BP and HR in both groups were assessed before intubation and at 5th minute post-intubation. The results showed that during laryngoscopy & intubation, there was an elevation in BP and HR in both groups. Both groups exhibited stability in hemodynamics following laryngoscopy & intubation. The study came to the conclusion that magnesium sulphate concentrations were sufficient to reduce the hemodynamic reaction after intubation, with results that were similar to those of lignocaine.

Archana P Vaghela et al.**(15)** undertook a study of2% preservative-free-lignocaine versus 50% magnesium sulphate in preventing sympathetic reaction associated with laryngoscopy & intubation amongst 42 ASA grade-1 and grade-2 patients, aged 15-65 years, with 21 patients of group-A receiving magnesium sulphate at a dosage of 50 mg/kg IV added in 100 mL NS given over 30-minutes prior to intubation and another 21 patients of group-B receiving 2% preservative-free-lignocaine at a dosage of 1.5 mg/ kg 90-seconds prior to laryngoscopy. They

discovered that magnesium sulphate, as opposed to lignocaine, offered more effective control over hemodynamics after laryngoscopy & intubation. They inferred that, in terms of avoiding the hemodynamic response associated with laryngoscopy & intubation, magnesium sulphate was a superior substitute for lignocaine.

Prajakta N Kasar et al.[16] undertook a study inducting sixty ASA-1 patients, with ages between 18-60, posted for procedures with general anesthesia. Patients were grouped randomly into two with Group-1 consisting of 30 patients receiving magnesium sulphate 30mg/kg given IV 90-seconds prior intubation and Group-2 consisting of 30 patients receiving lignocaine 2 mg/kg given IV 90-seconds prior to intubation. The sympathetic reflex to laryngoscopy & intubation in both groups were assessed by noting down blood pressures and heart rate prior to inducing and after injecting the study drugs, at laryngoscopy, 1-min, 3-min, 5-min post-intubation. This study found out that Group-1 patients had significant reductions in MAP and HR until 5mins post-intubation. They also concluded that magnesium sulphate possesses vasodilator property and inhibits catecholamine release and thus diminishes the stress reflex to laryngoscopy & intubation better than lignocaine.

Megha Tajne and colleagues[17] conducted a study involving 150 ASA grade-1 patients, grouped into three with 50 patients each. Group-1 was considered to be the control, while groups 2 and 3 were administered the drugs under study. In group-1, 10 mL of NS was administered one minute before intubation. Group-2 received 50% magnesium sulphate at50mg/kg, administered one minute before intubation over a one-minute period. Group-3 received 2% preservative-free lignocaine at 1.5mg/kg given 90-seconds prior to intubation. Variations in hemodynamics were noted in all three groups at various intervals. This study

revealed that both drugs induced tachycardia & fall in BP. The elevation in heart rate in the magnesium sulphate-group was 20.44%, significantly higher than the 7.55% in the lignocaine-group. Moreover, the reduction in systolic-blood pressure in the lignocaine-group (13.23%) was more profound than the decrease observed in the magnesium sulphate-group (5.25%). The fall in the rate-pressure-product in the magnesium sulphate-group was attributed solely to prevention of reflex hypertension, whereas in the lignocaine-group, it was due to the prevention of both hypertensive and tachycardia responses. The study concluded that magnesium sulphate effectively protected only against the hypertensive response, but lignocaine was efficacious in preventing both hypertension and tachycardia responses accompanied with intubation.

Fabricio Tavares Mendonc and colleagues[18] conducted a study with 56 patients falling under ASAgrade-1 and grade-2, aged between 18-65 years, taken up for procedures under general anesthesia. They were put into two groups at random before inducing anesthesia: Group-M was given magnesium sulphate at a dosage of 30 mg/kg, and Group-L was given 2 mg/kg of preservative-free-lignocaine. At pre-intubation and 3-min, 6-min postintubation, BP, HR, BIS values were taken in both groups after the study medications were administered. Following laryngoscopy and intubation, the BP and HR of both groups were higher than their pre-intubation values. Following intubation, Group-M showed a considerable elevation in both DBP and SBP levels, however this increase was not clinically meaningful. There was no discernible variation in the bi-spectral indices among the groups. With no significant variation among the groups, one patient (4%) in the lignocaine-group and in three patients (12%) that were given magnesium sulphate had high blood pressure. The study inferred that both magnesium sulphate & lignocaine were efficacious and safe for managing hemodynamics during laryngoscopy & intubation.

NavidNooraei et al.[19] carried out a research that compared magnesium sulphate & preservative-free lignocaine over control of hemodynamics following direct laryngoscopy & intubation on sixty patients of ASA grade-1 and grade-2 where magnesium sulphate-group received 60 mg/kg of the drug and lignocaine-group was administered 1.5 mg/kg of the drug both 3-minutes prior to intubation. They compared the MAP, SBP, DBP, HR among the two groups for a 5-minutes period after administering the study drugs, and compared them with baseline values. They observed that magnesium sulphate was better than preservative-free-lignocaine in lowering MAP and SBP in the first 2-minutes post-intubation. The heart rate was higher at 2-, 3- and 4-minutes post-intubation in the magnesium sulphate-group. But at 1$^{st}$ minute when maximum cardiovascular response occurred post-intubation, the rise in both groups was not different significantly and there was only a decrease in HR in magnesium sulphate-group compared to lignocaine-group.

# BASIC SCIENCES

## APPLIED ANATOMY OF THE UPPER AIRWAY [20]

A detailed understanding of the airway anatomy is essential for the anesthesiologist. Various aspects of airway management depend on a working knowledge of the anatomy involved, including airway assessment, preparation of the airway for awake intubation, and the proper use of airway devices.

Knowledge of normal anatomy and anatomic variations that may render airway management more difficult helps with the formulation of an airway management plan. Because some critical anatomic structures may be obscured during airway management, the anesthesiologist must be familiar with the interrelationship between different airway structures.

The airway can be divided into the upper airway, which includes the nasal cavity, the oral cavity, the pharynx, and the larynx; and the lower airway, which consists of the tracheobronchial tree.

### UPPER AIRWAY:

#### Nasal Cavity:

The airway begins functionally at the nares, the external opening of the nasal passages. The nasal cavity is divided into the right and left nasal passages by the nasal septum, which forms the medial wall of each passage.

The septum is formed by the septal cartilage anteriorly and by two bones posteriorly the ethmoid superiorly and the vomer inferiorly. The lateral wall of the nasal passages is characterized by the presence of three turbinates that divide the nasal passage into three scroll-shaped meatuses. The roof of the nasal cavity is formed by the cribriform plate, part of the ethmoid bone. The posterior openings of the nasal passages are the choanae, which lead into the nasopharynx.

Oral Cavity:

Because of the relatively small size of the nasal passages and the significant risk of trauma, the mouth is often used as a conduit for airway devices. Many airway procedures require adequate mouth opening, which is accomplished by rotation within the temporo-mandibular joint and subsequent opening by sliding known as protrusion of the condyles of the mandible within the joint.

The oral cavity leads to the oropharynx and is inferiorly bounded by the tongue and superiorly by the hard and soft palates. The hard palate, formed by parts of the maxilla and the palatine bone, makes up the anterior two thirds of the roof of the mouth; the soft palate, a fibromuscular fold of tissue attached to the hard palate, forms the posterior one third of the roof of the mouth.

The tongue is anchored to various structures by its extrinsic musculature; of these, the most clinically relevant to the anesthesiologist is the genioglossus, which connects the tongue to the mandible. The jaw-thrust maneuver uses the sliding component of the Temporo-mandibular

joint to move the mandible and the attached tongue anteriorly, thereby relieving airway obstruction caused by the posterior displacement of the tongue into the oropharynx.

Beneath the tongue, the mylohyoid muscles separate the floor of the mouth into the sublingual space superiorly and the submental space inferiorly.

Pharynx:

The pharynx is a muscular tube that extends from the base of the skull down to the level of the cricoid cartilage and connects the nasal and oral cavities with the larynx and esophagus. It is subdivided as follows:

1. Nasopharynx, also known as the rhino-pharynx, is the muscular tube from the nares, including the posterior nasal cavity, divide from the oropharynx by the palate and lining the skull base superiorly.
2. The oro-pharynx connects the nasopharynx and hypopharynx. It is the region between the palate and the hyoid bone, anteriorly divided from the oral cavity by the tonsillar arch.
3. The hypopharynx connects the oropharynx to the esophagus and the larynx, the region of pharynx below the hyoid bone.

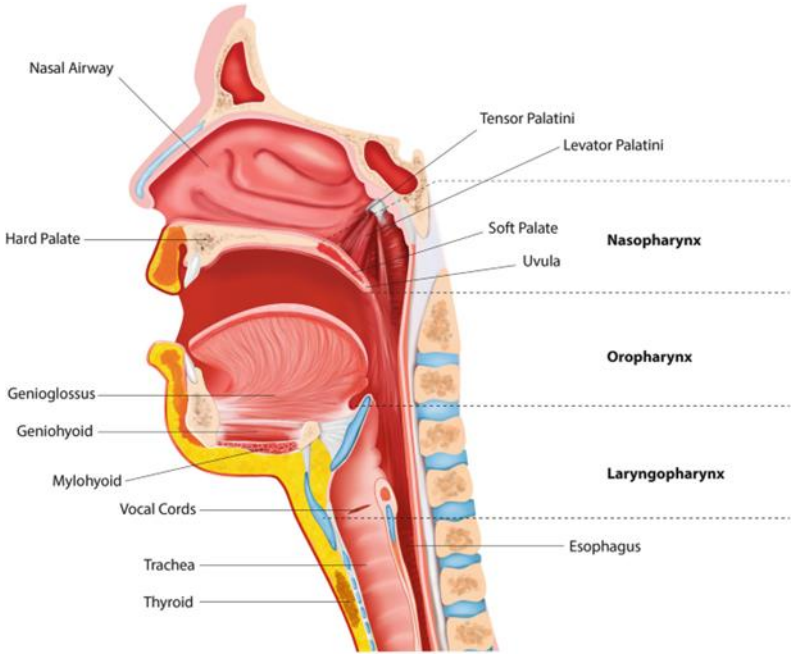



FIGURE 1: ANATOMY OF UPPER AIRWAY

Larynx:

The larynx is a complex structure of cartilage, muscles, and ligaments that serves as the inlet to the trachea and performs various functions like phonation and airway protection. The cartilaginous framework of the larynx is made up of nine separate cartilages: the epiglottis, thyroid and cricoid cartilages (unpaired); arytenoid, corniculate, and cuneiform cartilages (paired). They are joined by ligaments, membranes, and synovial joints, and are suspended by the hyoid bone via the thyrohyoid ligaments and membrane.

The thyroid cartilage is the largest of these cartilages and supports most of the soft tissues of the larynx. The superior thyroid notch and the associated laryngeal prominence are appreciable from the anterior neck and serve as important landmarks for percutaneous airway techniques and laryngeal nerve blocks.

The cricoid cartilage, at the level of the sixth cervical vertebra, is the inferior limit of the larynx and is anteriorly connected to the thyroid cartilage by the cricothyroid membrane. It is the only complete cartilaginous ring in the airway.

The arytenoid cartilages articulate with the posterior cricoid and are the posterior attachments for the vocal cords.

When viewed from the pharynx, as during direct laryngoscopy, the larynx begins at the epiglottis, which is a cartilaginous flap that serves as the anterior border of the laryngeal inlet. It functions to divert food away from the larynx during the act of swallowing.

The anterior surface of the epiglottis is attached to the upper border of the hyoid bone by the hyo-epiglottic ligament. The laryngeal inlet is bound laterally by the aryepiglottic folds, and posteriorly by the corniculate cartilages and the inter-arytenoid notch. The space inferior to the laryngeal inlet down to the inferior border of the cricoid cartilage is the laryngeal cavity.

The vestibular folds are the most superior structure within the laryngeal cavity. Beneath these are the true vocal cords, which attach to the arytenoids posteriorly and the thyroid cartilage anteriorly, where they join together to form the anterior commissure.

The space between the vocal cords is termed the glottis; the portion of the laryngeal cavity above the glottis is known as the vestibule, and the portion inferior to the vocal cords is known as the subglottis.

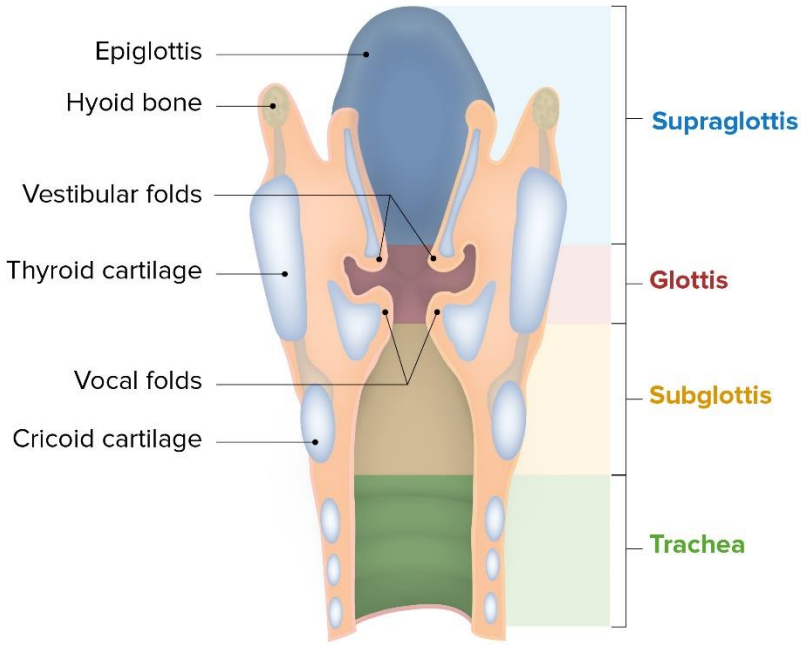



FIGURE 2: ANATOMY OF THE LARYNX

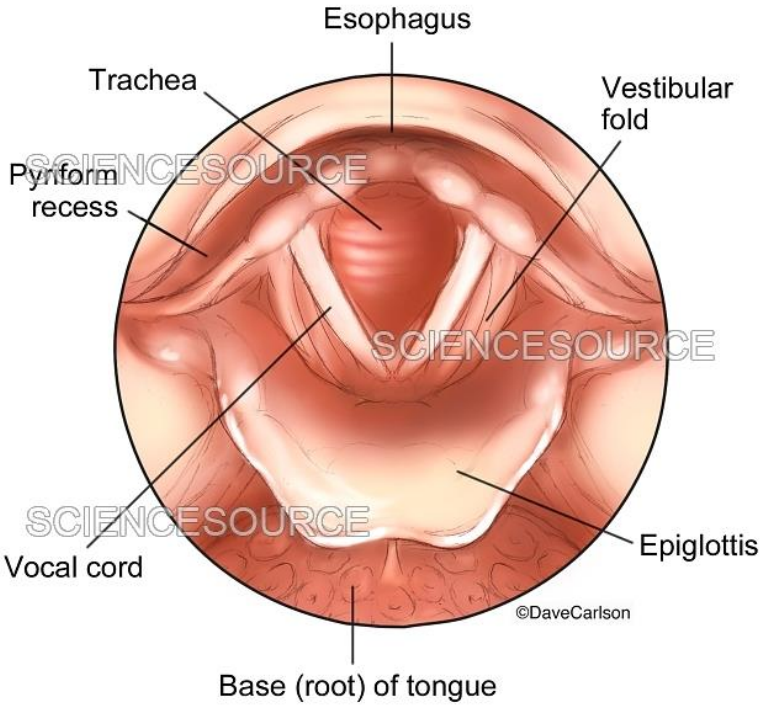



FIGURE 3: FUNCTIONAL ANTOMY OF THE LARYNX

## STRUCTURE AND FUNCTION: [21,22]

Airways allow airflow in ventilation from the external environment to the respiratory surfaces where gas exchange for respiratory processes can occur.

To allow this and to maintain homeostasis and adequate protection from the external environment they must also perform other barrier functions.

Moisture barrier is the mucous lining of the airway that provides a barrier to prevent loss of excessive moisture during ventilation by increasing the humidity of the air in the upper airway

Temperature barrier is relative to body temperature as the external environment is nearly always colder, and the increased vasculature and structures such as nasal turbinates warm air as it enters the airways

They also form a barrier to infection as the airways are lined with a rich lymphatic system including mucosa-associated lymphoid tissue (MALT) that prevents early access to any invading pathogens. Macrophages also patrol the respiratory surfaces providing an important component of the air-blood barrier.

## EMBRYOLOGY: [23]

The upper airways develop from the pharyngeal arches as part of the embryological development of the head and neck structures.

At around four weeks, the larynx and lower airways develop from the longitudinal laryngotracheal groove which forms a medial, groove-like structure becoming a tubular, blind-

ended structure called the laryngotracheal diverticulum. This eventually separates from the developing foregut by the formation of the tracheo-oesophageal folds.

The laryngeal cartilages and musculature develop from the four and six pharyngeal arches, and the glottic opening forms connecting this region to the trachea.

NERVE SUPPLY: [23]

Innervation of the pharynx is via cranial nerves VII, IX, X, and XII.

The larynx is supplied by the vagus - by the superior laryngeal branch directly and the recurrent laryngeal branch.

CLINICAL SIGNIFICANCE: [24]

The importance of the upper airway assessment is paramount in both emergency and anesthetic scenarios.

The upper airway assessment can be performed and enhanced by the following assessment tools:

1. The Mallampati score which describes the visible airway:

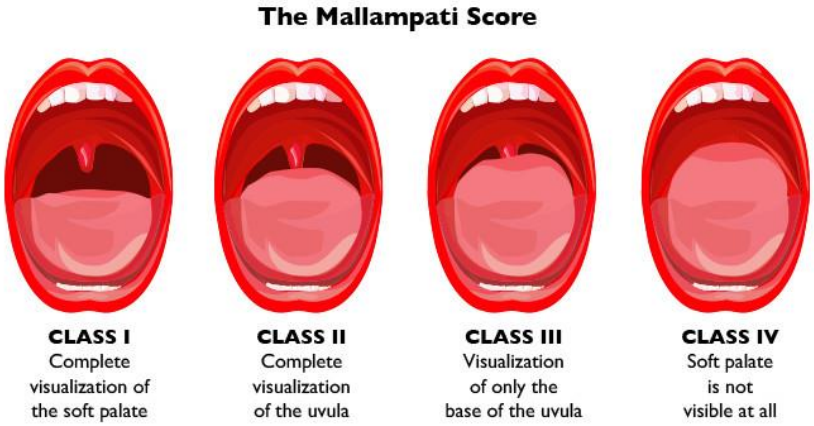



FIGURE 4: MALLAMPATI GRADING

2. The "3, 3, 2" rule in which three estimated measurements of the inter incisor distance, the hyoid-mental distance, hyoid-thyroid cartilage distance is measured, and if these are shortened, it implies a difficult airway.

The cricoid cartilage is important both as a clinical landmark and also as the only complete cartilage ring within the upper airway used during cricoid pressure manoeuvres.

## MAGNESIUM SULPHATE

Magnesium sulphate is a magnesium salt having sulphate as the counterion. It has a role as an anticonvulsant, a cardiovascular drug, a calcium channel blocker, an anaesthetic, a tocolytic agent, an anti-arrhythmia drug, an analgesic. [25]

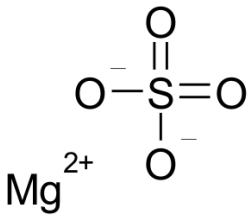


FIGURE 5: CHEMICAL STRUCTURE OF MAGNESIUM SULPHATE

INDICATIONS:

FDA-approved Indications: [26,27]

Constipation

Hypomagnesemia

Prevention of seizures in eclampsia/preeclampsia

Acute nephritis in pediatric patients

Cardiac arrhythmias secondary to hypomagnesemia

Soaking minor cuts or bruises

Non-FDA-approved Indications: [28,29]

Acute asthma exacerbations

Torsades de pointes during ACLS

Tocolytic to prevent preterm labor

PHARMACOLOGY: [25,30]

Magnesium is a positively charged divalent cation that is absorbed in the gastrointestinal tract from our diets. Regulation of magnesium concentration in the serum occurs mostly through renal reabsorption and excretion. Parathyroid hormone causes magnesium reabsorption in the cortical thick ascending limb, but hypercalcemia and hypermagnesemia will cause magnesium excretion. Serum magnesium levels should remain within a range of 0.7 to 1 mmol/L (1.4 to 2.0mEq/L) concentration, but almost half of the total body magnesium is taken up by the bone. [30]

Magnesium is a vasodilator in both the systemic and pulmonary circulations. The mechanism of action of magnesium effects on vasodilation is through its effects on membrane channels involved in calcium flux and through its action in the synthesis of cAMP. It is an important cofactor for endothelial-dependent pulmonary vasodilation. It also has analgesic properties, primarily related to the regulation of calcium influx into cells and antagonism of NMDA receptors in the CNS. [31]

PHYSIOLOGICAL ROLE OF MAGNESIUM:

Magnesium helps ion transport and maintain balance across the cellular membrane. Magnesium also acts as cofactors for enzymatic activation in multiple biochemical pathways such as glycolysis and the Krebs cycle. Intracellular magnesium is vital for neurochemical transmission and muscular contractions by working indirectly at the neuromuscular junction. More specifically, $Mg^{++}$ ions compete on voltage-gated calcium channels, affecting the distribution of calcium uptake and release. Magnesium also affects calcium metabolism by stimulation or suppression of Parathyroid Hormone. **(25)**

HYPERMAGNESEMIA:

It is a state of elevated magnesium levels with serum concentrations higher than 2 mmol/L. It rarely presents unless renal insufficiency is present or the patient is exposed to high levels of exogenous magnesium. Clinical signs of hypermagnesemia result in neuromuscular blockade or vasodilation—high levels of circulating magnesium lead to inhibition of calcium influx through the voltage-gated channels. Without calcium influx into the cell at the neuromuscular junction, no acetylcholine is released, leading to muscle contraction slowing. Clinical symptoms of hypermagnesemia include weakness, decreased respiratory drive, hyporeflexia, hypotension, or electrocardiogram (ECG) changes. The most notable ECG changes are P-R interval prolongation, an increase in the Q-T interval, or an increase in QRS duration leading to heart block. **(25)**

HYPOMAGNESEMIA:

It is a state of elevated magnesium levels with serum concentrations are less than 0.7 mmol/L. Typically due to intestinal malabsorption or renal disease leading to failed reabsorption. Low levels of magnesium can result in the loss of competitive inhibition at the neuromuscular junction, allowing for increased acetylcholine release, resulting in

neuromuscular irritability. Without competitive inhibition, the threshold of motor nerve excitation diminished, leading to enhanced myofiber contraction. Clinical symptoms of hypomagnesemia include muscle spasms, hyperreflexia, or ECG changes. Most notable changes seen on ECG include the widening of the P-R interval, widening of the QRS complex, and peaking of the T waves. [25]

ADMINISTRATION:

Magnesium sulphate can administration can be oral (PO), intramuscular (IM), intraosseous (IO), or intravenous (IV). For every 1 gram of magnesium sulphate, it contains 98.6 mg or 8.12Eq of elemental magnesium. Magnesium sulphate can be combined with dextrose 5% or water to make intravenous solutions.

Oral: It is available as a capsule or powder (Epsom salt), which can be combined with water to form an oral solution.

Intramuscular: It can be administered IM after dilution

Intraosseous: It can be administered through an adequately placed IO if no other access is available.

Intravenous: It can be administered as an IV push, infusion, or additive to TPN.

Magnesium given orally leads to osmotic shifts of fluid, which can help alleviate constipation. If given parenterally, it will be broken down into elemental magnesium and used to replete and maintain circulating magnesium stores, thus changing the serum concentration of magnesium. [25]

ADVERSE EFFECTS:

When giving magnesium sulphate, there are minimal side effects with standard therapeutic doses, but it has a broad therapeutic index. Patients most commonly complain of minor facial flushing and warmth with the administration; however, symptoms typically resolve spontaneously. In patients with neuromuscular disease, such as in myasthenia gravis, the neuromuscular function may worsen at lower concentrations of medication. If given rapidly or in high doses, patients may experience transient hypotension due to smooth muscle inhibition causing a vasodilatory effect that will resolve. If the patient is on a continuous magnesium sulphate infusion, serum levels must be accounted for as symptoms related to hypermagnesemia may become clinically evident. At supratherapeutic serum concentrations, absent reflexes, abnormal cardiac conduction, and muscle weakness may occur. [25]

CONTRAINDICATIONS:

If any known hypersensitivity reaction to magnesium sulphate has occurred in the past, it should not be administered. If a patient is in a known heart block, it should not be given as it can exacerbate the already slowed cardiac conduction. It is also recommend withholding magnesium sulphate infusions in patients with preeclampsia/eclampsia two hours before fetal delivery due to possible interaction with neuromuscular blocking agents given intraoperatively; however, it should not be stopped due to the possibility of precipitating seizure activity. [25]

MONITORING:

Magnesium levels must be monitored frequently by checking serum levels every 6 to 8 hours or clinically by checking patellar reflexes or urinary output. [25]

Normal Serum Levels: 0.7 to 1.0 mmol/L (1.4 to 2.0 meq/L)

Therapeutic level in preeclampsia/eclampsia: 2.0 to 3.5 mmol/L (4 to 7 meq/L)

Patellar reflexes lost: 4.0 to 5.0 mmol/L (8 to 10 meq/L)

Respiratory depression: 5.0 to 7.5 mmol/L (10 to 15 meq/L)

Respiratory paralysis: 6.0 to 7.5 mmol/L (12 to 15 meq/L)

Cardiac arrest: 12.5 to 15.0 mmol/L (25 to 30 meq/L)

TOXICITY:

If patients exhibit signs and symptoms of hypermagnesemia, the recommendation is to discontinue magnesium sulphate products immediately. If the patient consumed magnesium sulphate orally, then the use of magnesium-free enemas or cathartics can be useful in removing excess magnesium from the GI tract. Patients should receive parenteral doses of calcium gluconate to help alleviate symptoms, but continued doses may be necessary as the calcium provides temporary improvement. IV hydration should also occur if clinically appropriate. In patients with severe renal disease, then hemodialysis should be considered. [25]

# LIGNOCAINE

Lidocaine, formerly also referred to as lignocaine, is an amide local anesthetic agent. First synthesized between 1943 and 1946 by Nils Löfgren and Bengt Lundquist, it is a tertiary amine derived from xylidine, and its use rapidly became widespread given its superior safety profile compared to older local anesthetic agents. [32] It is the cheapest and extensively used local anesthetic. It also has antiarrhythmic and analgesic uses and can be used as an adjunct to tracheal intubation. It is a tertiary amine and is a class I-b antiarrhythmic agent on the Vaughan-Williams classification. [31]

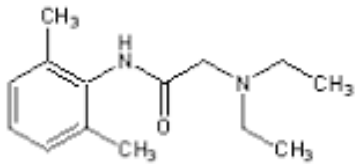



FIGURE 6: CHEMICAL STRUCTURE OF LIGNOCAINE

The drug is commonly used for local anesthesia, often combined with epinephrine that which acts as a vasopressor and extends its duration of action at a site by opposing the local vasodilatory effects of lidocaine.

It can be used intravenously during advanced airway management as an adjuvant to tracheal intubation, obtunding the hypertensive response to laryngoscopy and potentially reducing the incidence of myalgia and hyperkalemia when succinylcholine is given. It is indicated in the

management of acute ventricular tachydysrhythmias. It also has roles as an adjuvant analgesic in managing acute and chronic pain.

MECHANISM OF ACTION:

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 ionizing 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.

As lidocaine is a weak base with a dissociation constant (pKa) of 7.7, approximately 25% of molecules will be un-ionized at a physiological pH of 7.4 and will be available to translocate inside the nerve cells, meaning that lidocaine has a more rapid onset of action than other local anesthetics with higher pKa values. **(33)**

Efficacy decreases in the presence of inflammation; this can be due to acidosis decreasing the proportion of un-ionized lidocaine molecules, a faster decrease in lidocaine concentration due to increased blood flow, and potentially also through increased production of inflammatory mediators like peroxy-nitrite, which act directly on sodium channels. **(34)**

In cardiac myocytes, lidocaine slows the rise of the cardiac action potential during phase 0, thereby increasing the effective threshold potential.

Lidocaine is 65% protein-bound to albumin and alpha1-acid glycoprotein in the plasma, giving it a medium duration of action compared to other local anesthetic agents. It is less lipid-soluble than other agents, limiting its overall potency. Its volume of distribution is 0.7 to 1.5 L/kg, and it is metabolized by hepatic enzymes to active and inactive metabolites.

ADMINISTRATION:

Various routes of administration utilize different preparations of lidocaine: [35]

Dilute concentrations, in the order of 0.05 to 0.1%, can be infiltrated subcutaneously in large volumes to provide tumescent local anesthesia, resulting in swelling and firmness of the site, which may be beneficial for certain surgical procedures.

Dilute solutions of 0.25 to 0.5% are used for intravenous regional anesthesia (Bier's block) or infiltration into subcutaneous tissue.

1 to 2% solutions are used for regional nerve block and epidural anesthesia.

It is also available in intravenous preparations for antiarrhythmic use.

1 to 2% aqueous gels, typically including an antiseptic such as chlorhexidine, are used to topicalize and lubricate the urethra prior to procedures like Foley catheterization.

4% solution is used for topical anesthesia of the mucous membranes of the airway, including the mouth, pharynx, and respiratory tract, either by gargling, spraying, or using an atomizer.

5% ointment, typically mixed with hydrocortisone, is employed topically on other mucous membranes such as the skin or in the rectum.

10% solution is also used topically for airway anesthesia, typically by spraying from a metered-dose atomizer.

The aqueous preparations from 0.5 to 2% are available in either plain forms or with 1 per 200000 and are available with or without preservatives. It is also available as medicated plasters impregnated with lidocaine, intended to treat chronic postherpetic neuralgia. Lidocaine and

prilocaine are available premixed in a eutectic 5% cream (containing 2.5%) which is often used to anesthetize small areas of skin prior to procedures.

Doses used for infiltrative or regional anesthesia will depend on the specific block. When lidocaine is used to obtund airway reflexes, the dose is 1 to 2 mg/kg given 2 to 5 minutes before intubation. For cardiac dysrhythmias, the initial dose is 1 to 1.5 mg/kg given intravenously, optionally followed with an infusion.

ADVERSE EFFECTS:

Side effects occur when plasma concentrations rise to toxic levels. The drug reaches the intravascular compartment most rapidly when administered into the intercostal space, followed by the caudal, epidural, brachial plexus, femoral and subcutaneous spaces. The maximum safe dose by body weight may be taken to be 3 mg/kg, or 7 mg/kg when using preparations with epinephrine.

Lidocaine is more neurotoxic than other local anesthetics, especially when high concentrations are applied directly to nervous tissue. Use of highly concentrated lidocaine (2.5 to 5%) for spinal anesthesia correlates with a greater incidence of transient radicular irritation syndrome, which is a self-limiting painful condition affecting the calves, thighs, and buttocks. **(36)**

CONTRAINDICATIONS:

The drug is contraindicated in patients with a known severe adverse reaction. Anaphylactic reactions to lidocaine are possible but are rare.

Methemoglobinemia can occur due to lidocaine metabolism to O-toluidine.[49] This metabolite is more likely to be present when very high doses are given, but it may also occur with lower doses where the patient is taking other medications that can precipitate methemoglobinemia or where the patient has a hemoglobinopathy or another cause of anemia.

Lidocaine should not be used as an antiarrhythmic if the dysrhythmia may be secondary to local anesthetic toxicity.

Lidocaine preparations containing epinephrine cause demonstrable cardiovascular effects even if only given in small amounts, and it is prudent for essential hemodynamic monitoring to be carried out before and during use solutions containing vasopressors, particularly if there is any specific concern over the patient's cardiovascular status. **(37)**

MONITORING:

Lidocaine has a narrow therapeutic index, and plasma level monitoring may be necessary for patients with hepatic impairment who are on prolonged infusions. Ideal body weight should be used instead of actual body weight for dose calculations to avoid excessively high plasma concentrations with an absolute upper limit of 120 mg/h for lidocaine infusions. **(35)**

TOXICITY:

Signs and symptoms of mild toxicity become apparent at plasma levels greater than 5 mcg/mL, beginning with slurred speech, tinnitus, circumoral paresthesia. Above 10 mcg/mL, the patient may experience seizures or loss of consciousness. The myocardium and central nervous system are further depressed at 15 mcg/mL, progressing to cardiac arrhythmias, respiratory arrest, and cardiac arrest above 20 mcg/mL. **(37)** In the event of toxic dosing in the conscious patient, lidocaine may be less likely than other local anesthetics to progress rapidly

from neurological effects through to full cardiovascular collapse. By contrast, neurological signs and symptoms can often be masked if the patient is under the concurrent effects of sedation or general anesthesia, meaning that cardiovascular instability or arrhythmias may be the first manifestations. [38]

Administration of the drug should immediately cease if toxicity is suspected. In the case of cardiorespiratory collapse, there should be airway support and breathing assistance to prevent the development of respiratory acidosis, which may exacerbate toxicity and potentiate lidocaine's negative chronotropic and inotropic effects. [39] Vital function support, including oxygen, IV fluids, and inotropes, should be instituted if required. Intravenous lipid emulsion is indicated as rescue therapy, especially in cases of refractory cardiovascular collapse. [40]

# MATERIALS AND METHODS

DATA SOURCE

Patients in 40-70 year age-range, of either gender, coming under ASA grades 1 & 2, posted for surgeries on an elective basis under general anesthesia with endotracheal intubation at KLES' Dr Prabhakar Kore Hospital at Belagavi

DESIGN OF THE STUDY: Double-blinded-randomised clinical trial

PERIOD OF THE STUDY: March 2023 to April 2024 – a one year study period

SAMPLE SIZE: 102

SAMPLE-SIZE FORMULA: The mean and SD based minimum sample-size-formula:

$$n = \frac{(z_\alpha + z_\beta)^2 (s_1^2 + s_2^2)}{(\bar{X}_1 - \bar{X}_2)^2}$$

Zα– level-of-significance, Zβ– power-of -test

Zα =1.96, for 5-percent level of significance

Zβ =0.84, for 80-percent power of test

REFERENCE: "Comparison of intravenous magnesium sulphate and lidocaine for attenuation of cardiovascular response to laryngoscopy and endotracheal intubation in elective surgical patients" by Abebaw Misganaw et al [(1)]

The parameter considered in the calculation is DBP 5-minutes post-intubation

$\bar{X}_1$-Group-1 mean (72.87), $\bar{X}_2$- Group-2 mean (77.11)

S1– S.D Group-1 (7.44), S2 - is the S.D Group-2 (7.79)

With this, the size of the sample obtained was 51

So, there were two-groups, consisting of 51 subjects in each group

SAMPLING TECHNIQUE: Randomization was achieved by chit-picking method.

CRITERIA FOR INCLUSION:

1. Subjects that provided voluntary consent
2. Subjects that belonged to either ASA grades-1and-2
3. Age between 40-70 years
4. Patients that were posted for surgeries on an elective basis under general anesthesia with intubation

CRITERIA FOR EXCLUSION:

1. Subjects that refused provide consent
2. Subjects that were allergic to the study-drugs
3. Subjects that underwent emergency surgeries
4. Subjects that had significant cardiac or respiratory disease
5. Subjects with difficult airway
6. Pregnant patients

STUDY PROTOCOL:

Following the institutional ethical committee's clearance, 102 subjects that were scheduled for surgical procedures under general anesthesia were included.

After selecting subjects as per inclusive and exclusive criteria and obtaining a written consent, they were randomised by chit picking into either of the groups.

Group-M: Subjects were administered 50% Magnesium Sulphate 30milligrams/kilogram slow IV 3-minutesprior to intubation.

Group-L: Subjects were administered 2% preservative-free-Lignocaine 1.5 milligrams/kilogram IV 3-minutes prior to intubation.

After loading the calculated doses as per individual body weight in a syringe, the volume of both the drugs was made up to 5ml each by adding NS to ensure blinding.

DATA COLLECTION PROCEDURE:

Detailed preanesthetic examination and all necessary investigations like CBC, RFT, LFT, ECG, coagulation profile and serology were done for the subjects. All study participants were kept NPO for 6-8 hours and were given Tablet-ranitidine 150 milligram per oral and Tablet-alprazolam 0.5milligramper oral the night prior to the procedure.

On the day of the surgical procedure, all participants were transferred to pre-operative area. NPO status was confirmed and written informed consents were obtained for anesthesia as well as for the study participation voluntarily. Standard monitors - SpO2, NIBP and ECG were attached, and baseline values were noted. RL was started IV as maintenance fluid through a wide bore peripheral cannula.

After shifting the patients into the OT, standard-monitors were connected and base-line readings were noted. Premedication was administered with Injection Glycopyrrolate 0.005

mg/kg IV, Injection-Midazolam 0.05 mg/kg IV, Injection-Fentanyl 1-2 µg/kg IV and simultaneous pre-oxygenation was done with 100% of Oxygen for a minimum of 3-minutes.

Group-M subjects were administered with 50% Magnesium Sulphate at 30 mg/kg slow IV 3-minutes prior to laryngoscopy and intubation.

Group-L subjects were administered with 2% preservative-free-lignocaine at 1.5 mg/kg IV 3-minutes prior to laryngoscopy and intubation.

Patients were later induced using Injection Propofol at 2mg/kg IV and Injection-Succinylcholine at 2mg/kg IV was administered to aid laryngoscopy& intubation. A Macintosh-laryngoscope was used for laryngoscopy, and an adequately sized cuffed endo-tracheal tube was used for endo-tracheal intubation. The cuff was inflated, and the ET tube was secured once it was confirmed that bilateral air admission was equal.

Hemodynamic parameters –systolic, diastolic & mean pressures and heart rate were taken at time-points prior to intubation, each minute up-to $5^{th}$ minute, at $7^{th}$ minute and at $10^{th}$ minute post-intubation. Anesthesia was maintained with 50% $O_2$ and $N_2O$ mixture, Isoflurane/Sevoflurane, bolus of Injection-Vecuronium at 0.1mg/kg IV or Injection-Atracurium at 0.5mg/kg IV. After the surgery, antagonizing the neuro-muscular block was achieved with Injection-Neostigmine at 0.05mg/kg IV and Injection Glycopyrrolate at 0.01mg/kg IV. Extubation was performed once extubation criteria was satisfied and patients were transferred to post-operative room.

DATA PROCESSING AND STATISTICAL ANALYSIS:

Statistical software R version 4.4.0. and Microsoft-Excel were utilized for data analysis.

Categorical-variables are expressed as frequency-tables.

Continuous-variables are expressed as Mean +/- SD / Median (Min, Max)

To check the association of categorical-variables with groups, Chi-square test was utilized.

Shapiro-Wilk test and QQ plot were used to check normality of variables.

Parametric-tests were utilized if data followed normal-distribution. Otherwise, nonparametric tests were utilized.

For comparing the means of variables-over-groups, the Two-sample-t-test was utilized.

For comparing the distribution of variables-over-groups, the Mann-Whitney-U-test was utilized.

For comparing the distribution of variables-over-time, Friedman's-test was utilized.

p-value</= 0.05 was considered to be statistically-significant.

# RESULTS:

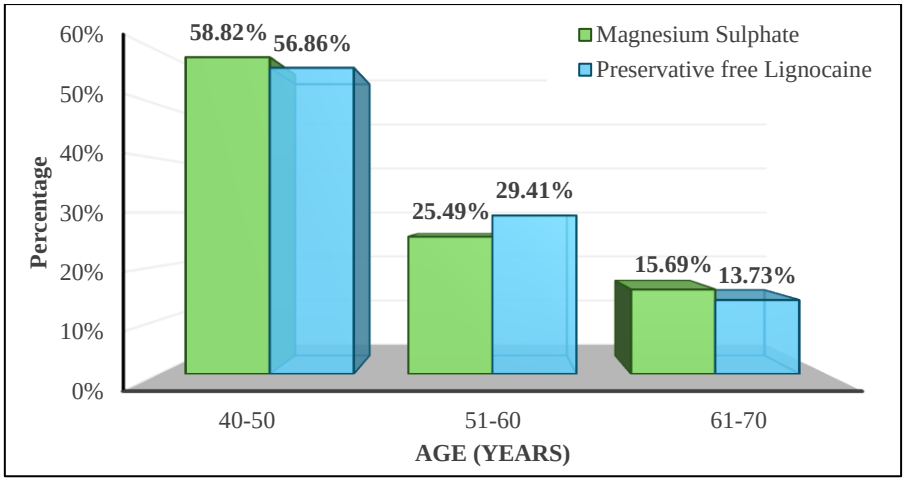
Data contains measurements on 102 subjects that are divided into 2 groups of 51 subjects each. The following table gives the comparison of group-level demographic information.

Table 1: Comparison of demographic details over groups.

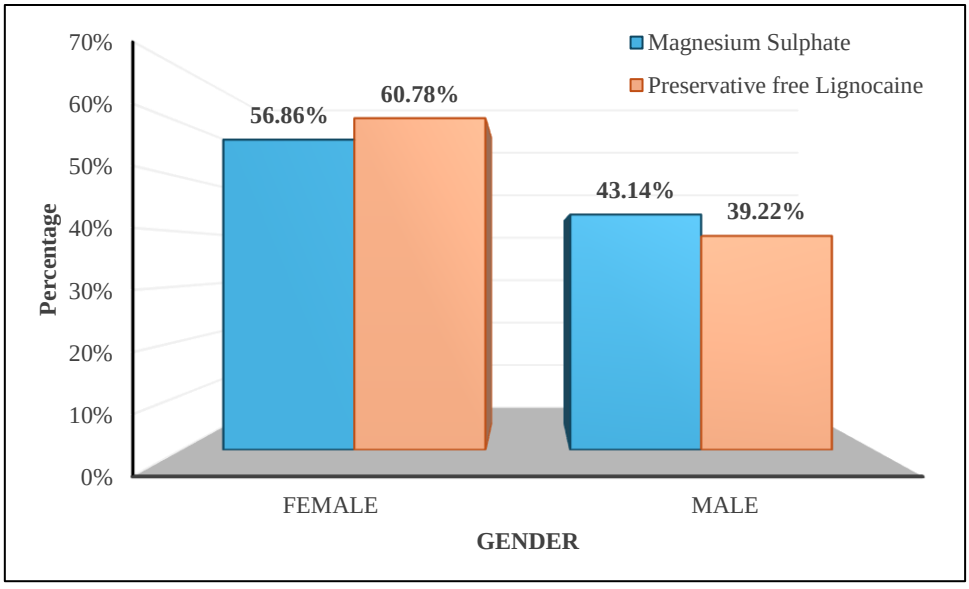
| Variables | Sub Category | Magnesium Sulphate | Preservative free Lignocaine | Total | p-value |
|---|---|---|---|---|---|
| Age (years) | 40-50 | 30 (58.82%) | 29 (56.86%) | 59 (57.84%) | 0.8929[C] |
| | 51-60 | 13 (25.49%) | 15 (29.41%) | 28 (27.45%) | |
| | 61-70 | 8 (15.69%) | 7 (13.73%) | 15 (14.71%) | |
| | Mean ± SD<br>Median (Min, Max) | 49.90 ± 9.59<br>46 (40, 70) | 50.63 ± 9.13<br>48 (40, 68) | 50.26 ± 9.32<br>47 (40, 70) | 0.6386[MW] |
| Gender | Female | 29 (56.86%) | 31 (60.78%) | 60 (58.82%) | 0.6874[C] |
| | Male | 22 (43.14%) | 20 (39.22%) | 42 (41.18%) | |

The mean age of subjects receiving Magnesium Sulphate was 49.90 ± 9.59 years, while the median age was 46 years, ranging from 40 to 70 years. Conversely, for those receiving Preservative-free Lignocaine, the mean-age was 50.63 ± 9.13 years, and median-age was 48 years, also ranging from 40 to 68 years. From MW-U test, no significant difference in the age-distribution was observed over groups. (p-value = 0.6386).

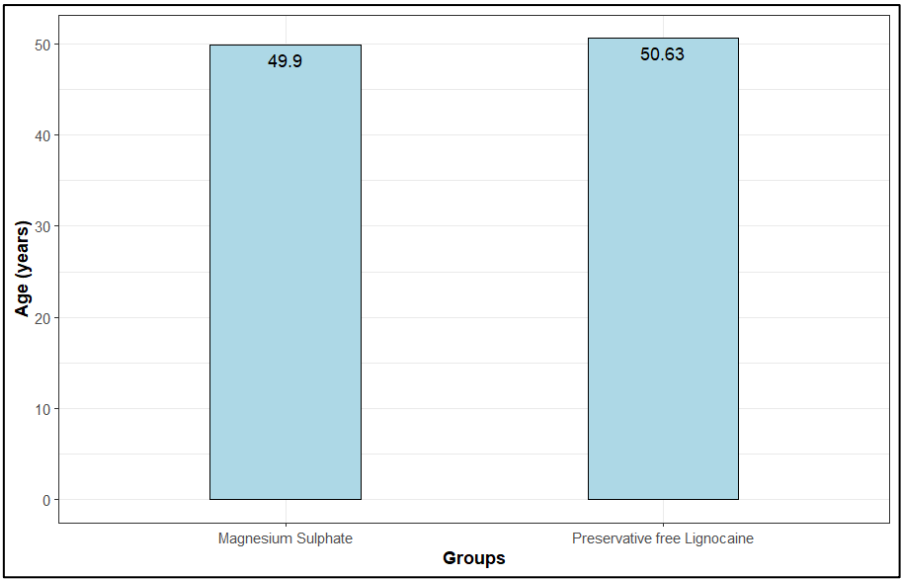
In the Magnesium Sulphate group, there are 29 (56.86%) females and 22 (43.14%) males, while in the Preservative-free Lignocaine group, there are 31 (60.78%) females and 20 (39.22%) males. From Chi-square test, no significant difference was noted in the gender-distribution over groups. (p-value = 0.6874).




Graph 1: Distribution of age over groups.




Graph 2: Distribution of gender over groups.




Graph 3: Mean plot of age over groups.

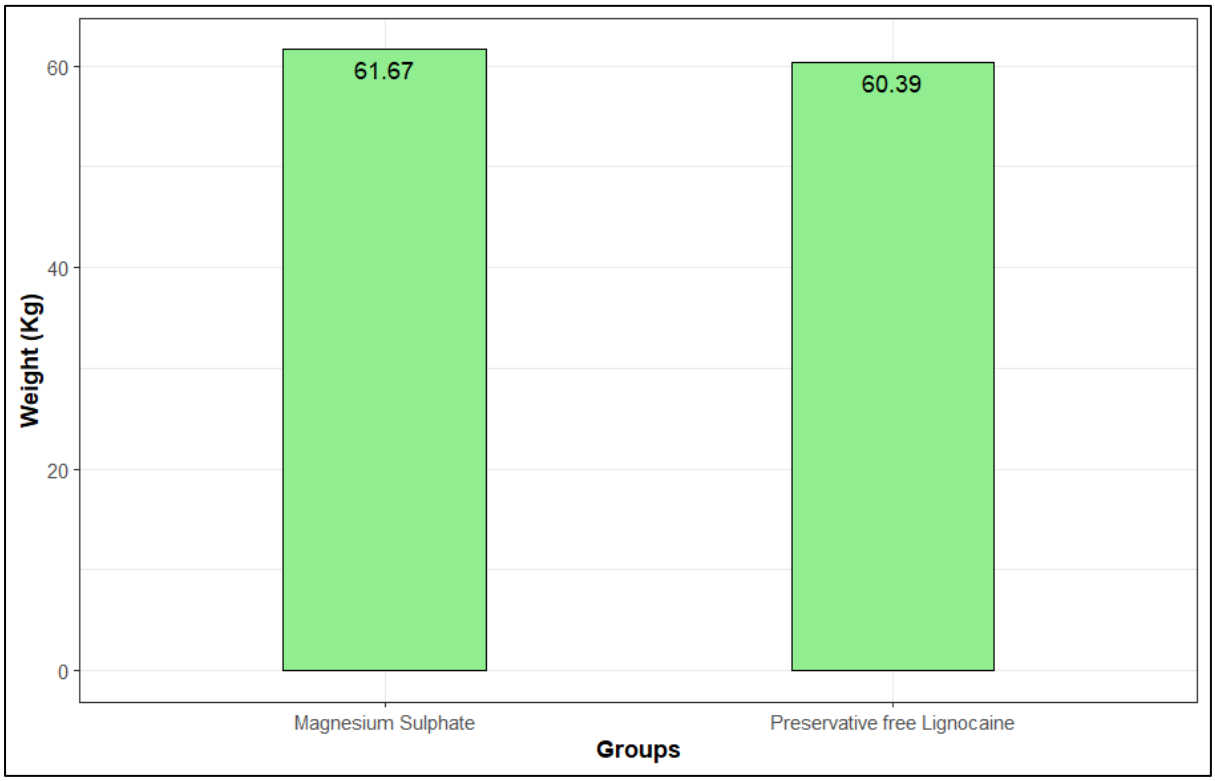
The following table gives the comparison of clinical details over groups.

Table 2: Comparison of clinical details over groups.

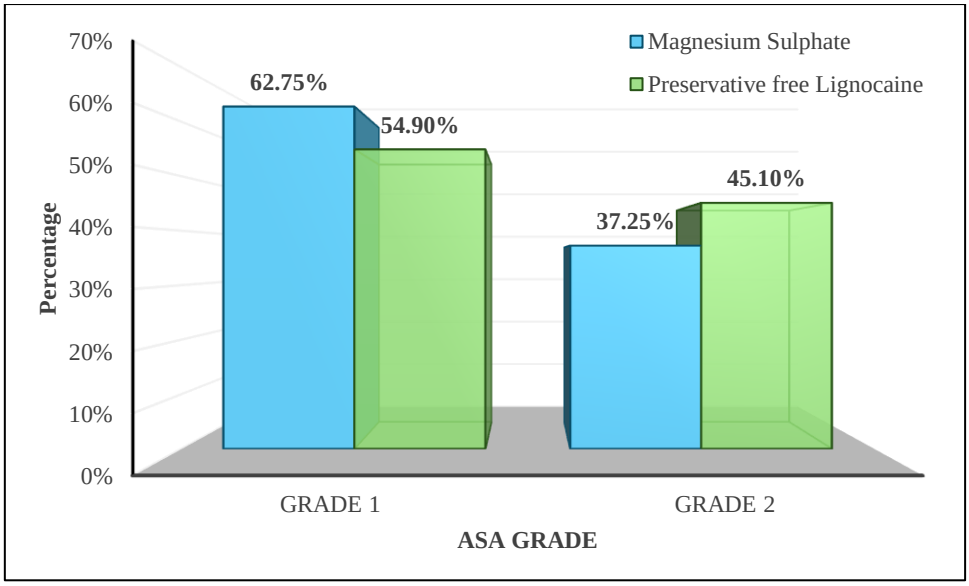
| Variables | Sub Category | Magnesium Sulphate | Preservative free Lignocaine | Total | p-value |
|---|---|---|---|---|---|
| Weight (Kg) | Mean ± SD<br>Median (Min, Max) | 61.67 ± 9.32<br>61 (45, 84) | 60.39 ± 9.77<br>61 (40, 82) | 61.03 ± 9.52<br>61 (40, 84) | 0.5018[t] |
| ASA grade | Grade 1 | 32 (62.75%) | 28 (54.9%) | 60 (58.82%) | 0.4210[C] |
| | Grade 2 | 19 (37.25%) | 23 (45.1%) | 42 (41.18%) | |

The mean weight of patients administered Magnesium Sulphate was 61.67 ± 9.32 kg, and a median weight of 61 kg, ranging from 45 to 84 kg. Conversely, for those receiving Preservative-free Lignocaine, the mean weight was 60.39 ± 9.77 kg, and a median weight of 61 kg, ranging from 40 to 82 kg. From two sample t test, no significant variation was noted in weight-distribution among the two groups. (p-value = 0.5018).

In terms of ASA grade distribution, the Magnesium Sulphate group consisted of 32 (62.75%) patients classified as Grade 1 and 19 (37.25%) patients as Grade 2, while the Preservative-free Lignocaine group included 28 (54.9%) patients classified as Grade 1 and 23 (45.1%) patients as Grade 2. From Chi-square-test, no significant difference was noted in ASA grade-distribution in the two groups. (p-value = 0.4210).




Graph 4: Mean plot of weight over groups.



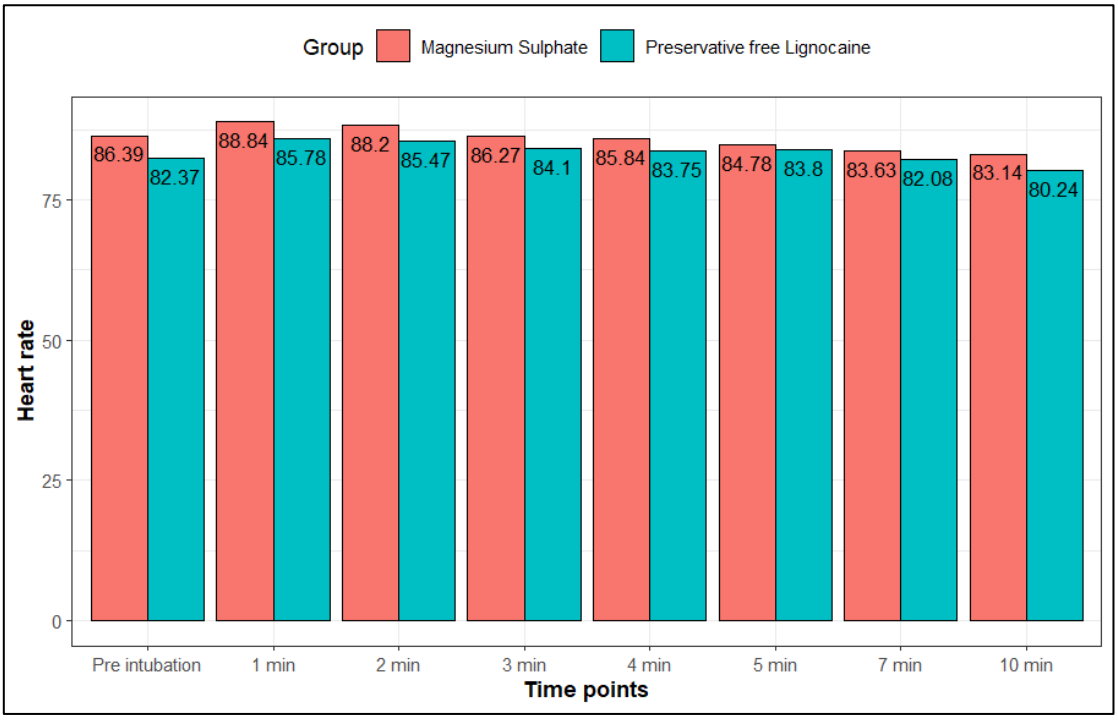

Graph 5: Distribution of ASA grade over groups.

The following table gives the of heart-rate comparison over time and groups.

Table 3: Heart-rate comparison over time and groups.

| HR | Magnesium Sulphate | Preservative free Lignocaine | Total | p-value |
|---|---|---|---|---|
| Pre-intubation | 86.39 ± 13.32<br>85 (64, 131) | 82.37 ± 14.72<br>84 (50, 111) | 84.38 ± 14.12<br>84 (50, 131) | 0.2677$^{MW}$ |
| 1 min | 88.84 ± 13.86<br>86 (68, 138) | 85.78 ± 15.04<br>86 (56, 120) | 87.31 ± 14.47<br>86 (56, 138) | 0.5760$^{MW}$ |
| 2 min | 88.2 ± 13.25<br>86 (65, 139) | 85.47 ± 14.44<br>85 (51, 107) | 86.83 ± 13.85<br>86 (51, 139) | 0.6609$^{MW}$ |
| 3 min | 86.27 ± 12.63<br>86 (65, 123) | 84.1 ± 13.47<br>85 (51, 103) | 85.19 ± 13.04<br>86 (51, 123) | 0.8434$^{MW}$ |
| 4 min | 85.84 ± 12.2<br>83 (65, 125) | 83.75 ± 13.27<br>86 (50, 103) | 84.79 ± 12.73<br>85 (50, 125) | 0.9733$^{MW}$ |
| 5 min | 84.78 ± 12.13<br>84 (68, 121) | 83.8 ± 12.8<br>84 (50, 110) | 84.29 ± 12.42<br>84 (50, 121) | 0.9067$^{MW}$ |
| 7 min | 83.63 ± 12.09<br>82 (65, 117) | 82.08 ± 13.16<br>83 (52, 107) | 82.85 ± 12.6<br>82.5 (52, 117) | 0.8802$^{MW}$ |
| 10 min | 83.14 ± 11.01<br>82 (65, 115) | 80.24 ± 12.94<br>78 (48, 107) | 81.69 ± 12.05<br>81 (48, 115) | 0.2255$^{t}$ |
| p-value | **< 0.001$^{F}$*** | **< 0.001$^{F}$*** | - | - |

At none of the time points did significant differences in heart rate distribution exist between the groups. Additionally, the Friedman test revealed significant variations in heart rate over time within both the Magnesium Sulphate and Preservative-free Lignocaine groups (p-values < 0.001).




Graph 6: Mean plot of HR over time and group.

The following table gives the comparison of SBP over time and groups.

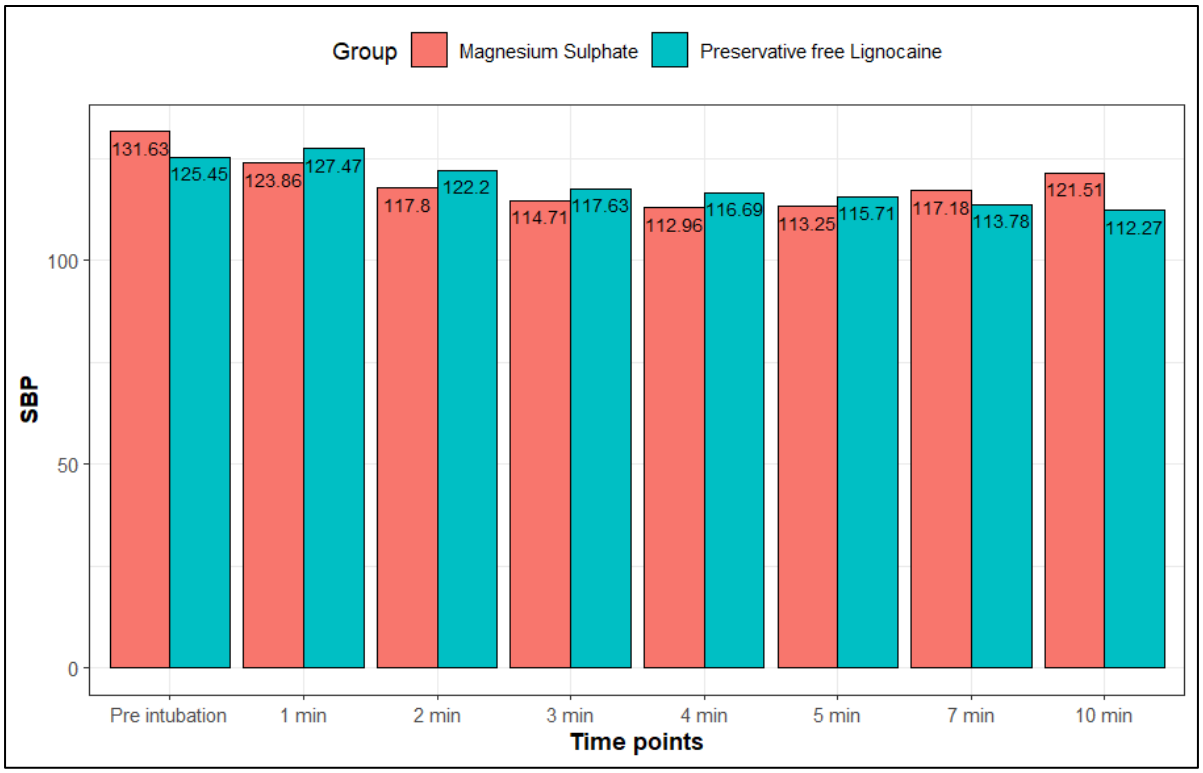
Table 4: Comparison of SBP over time and groups.

| SBP | Magnesium Sulphate | Preservative free Lignocaine | Total | p-value |
|---|---|---|---|---|
| Pre-intubation | 131.63 ± 14.75<br>130 (100, 166) | 125.45 ± 13.72<br>124 (101, 152) | 128.54 ± 14.51<br>129.5 (100, 166) | **0.0309$^{t*}$** |
| 1 min | 123.86 ± 16.58<br>122 (88, 157) | 127.47 ± 19.86<br>131 (80, 173) | 125.67 ± 18.29<br>124 (80, 173) | 0.3217$^{t}$ |
| 2 min | 117.8 ± 16.55<br>116 (85, 161) | 122.2 ± 19.65<br>125 (84, 168) | 120 ± 18.21<br>117.5 (84, 168) | 0.2249$^{t}$ |
| 3 min | 114.71 ± 15.89<br>113 (88, 153) | 117.63 ± 18.88<br>116 (83, 155) | 116.17 ± 17.43<br>114 (83, 155) | 0.3999$^{t}$ |
| 4 min | 112.96 ± 14.31<br>109 (86, 142) | 116.69 ± 19.34<br>115 (75, 159) | 114.82 ± 17.03<br>112.5 (75, 159) | 0.2205$^{MW}$ |
| 5 min | 113.25 ± 13.53<br>112 (80, 139) | 115.71 ± 17.21<br>113 (79, 141) | 114.48 ± 15.45<br>113 (79, 141) | 0.3503$^{MW}$ |
| 7 min | 117.18 ± 13.19<br>118 (92, 145) | 113.78 ± 16.22<br>114 (76, 146) | 115.48 ± 14.81<br>115.5 (76, 146) | 0.2493$^{MW}$ |
| 10 min | 121.51 ± 10.14<br>120 (102, 143) | 112.27 ± 14.99<br>115 (73, 141) | 116.89 ± 13.56<br>117.5 (73, 143) | **0.0004$^{t*}$** |
| p-value | **< 0.001$^{F*}$** | **< 0.001$^{F*}$** | - | - |

Pre-intubation, the mean SBP was 131.63 ± 14.75 mmHg in the Magnesium Sulphate group and 125.45 ± 13.72 mmHg in the Preservative free Lignocaine group. A significant variation was noted among the groups. (p-value = 0.0309). However, at subsequent time points, no significant variations were noted in SBP distribution between groups.

At 10$^{th}$ minute after intubation, a significant difference was noted in SBP distribution among the groups. (p-value = 0.0004).

Additionally, the Friedman test revealed significant variations in SBP over time within both the Magnesium Sulphate and Preservative-free Lignocaine groups (p-values < 0.001).




Graph 7: Mean plot of SBP over time and group.

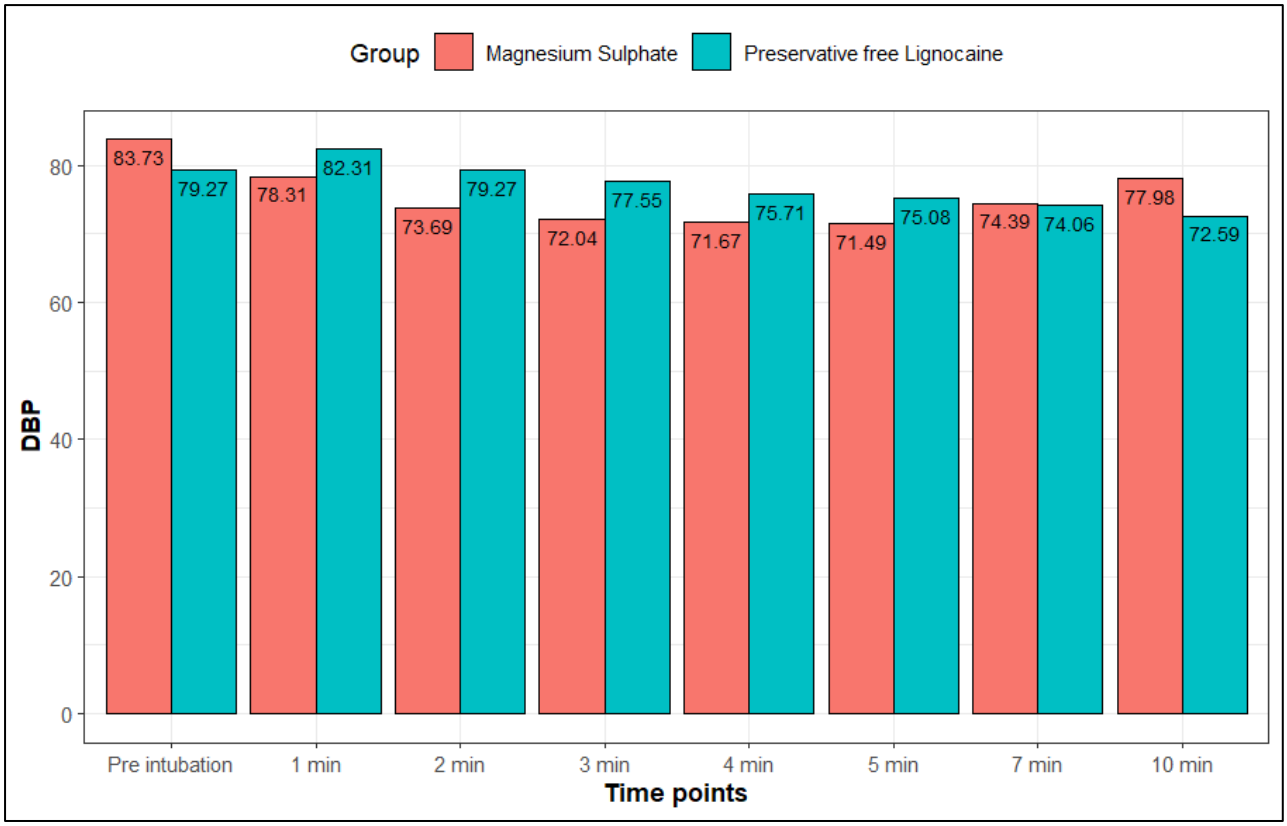
The following table gives the comparison of DBP over time and groups.

Table 5: Comparison of DBP over time and groups.

| DBP | Magnesium Sulphate | Preservative free Lignocaine | Total | p-value |
|---|---|---|---|---|
| Pre-intubation | 83.73 ± 9.82<br>84 (63, 101) | 79.27 ± 11.2<br>78 (48, 100) | 81.5 ± 10.72<br>82 (48, 101) | **0.0353$^{t*}$** |
| 1 min | 78.31 ± 11.64<br>79 (54, 100) | 82.31 ± 13.34<br>84 (50, 108) | 80.31 ± 12.62<br>80 (50, 108) | 0.1098$^{t}$ |
| 2 min | 73.69 ± 11.48<br>73 (53, 102) | 79.27 ± 14.23<br>80 (50, 119) | 76.48 ± 13.16<br>76 (50, 119) | **0.0314$^{t*}$** |
| 3 min | 72.04 ± 12.37<br>70 (47, 98) | 77.55 ± 12.87<br>78 (47, 104) | 74.79 ± 12.86<br>74 (47, 104) | **0.0298$^{t*}$** |
| 4 min | 71.67 ± 11.86<br>69 (51, 99) | 75.71 ± 13.95<br>77 (45, 105) | 73.69 ± 13.04<br>71 (45, 105) | 0.1140$^{MW}$ |
| 5 min | 71.49 ± 10.64<br>71 (48, 94) | 75.08 ± 12.06<br>75 (43, 97) | 73.28 ± 11.46<br>72 (43, 97) | 0.1143$^{t}$ |
| 7 min | 74.39 ± 9.63<br>74 (55, 98) | 74.06 ± 11.78<br>73 (48, 105) | 74.23 ± 10.7<br>74 (48, 105) | 0.8760$^{t}$ |
| 10 min | 77.98 ± 8.69<br>78 (63, 94) | 72.59 ± 11.2<br>72 (45, 96) | 75.28 ± 10.34<br>74.5 (45, 96) | **0.0078$^{t*}$** |
| p-value | **< 0.001$^{F*}$** | **< 0.001$^{F*}$** | - | - |

The results indicated significant DBP differences among the groups at pre-intubation, 2-minutes, 3-minutes, and 10-minutes (p-values < 0.05). However, at the other time points, there were no significant disparities.

Additionally, the Friedman test revealed significant variations in DBP over time within both the Magnesium Sulphate and Preservative-free Lignocaine groups (p-values < 0.001).




Graph 8: Mean plot of DBP over time and group.

The below table gives the MAP comparison over time and groups.

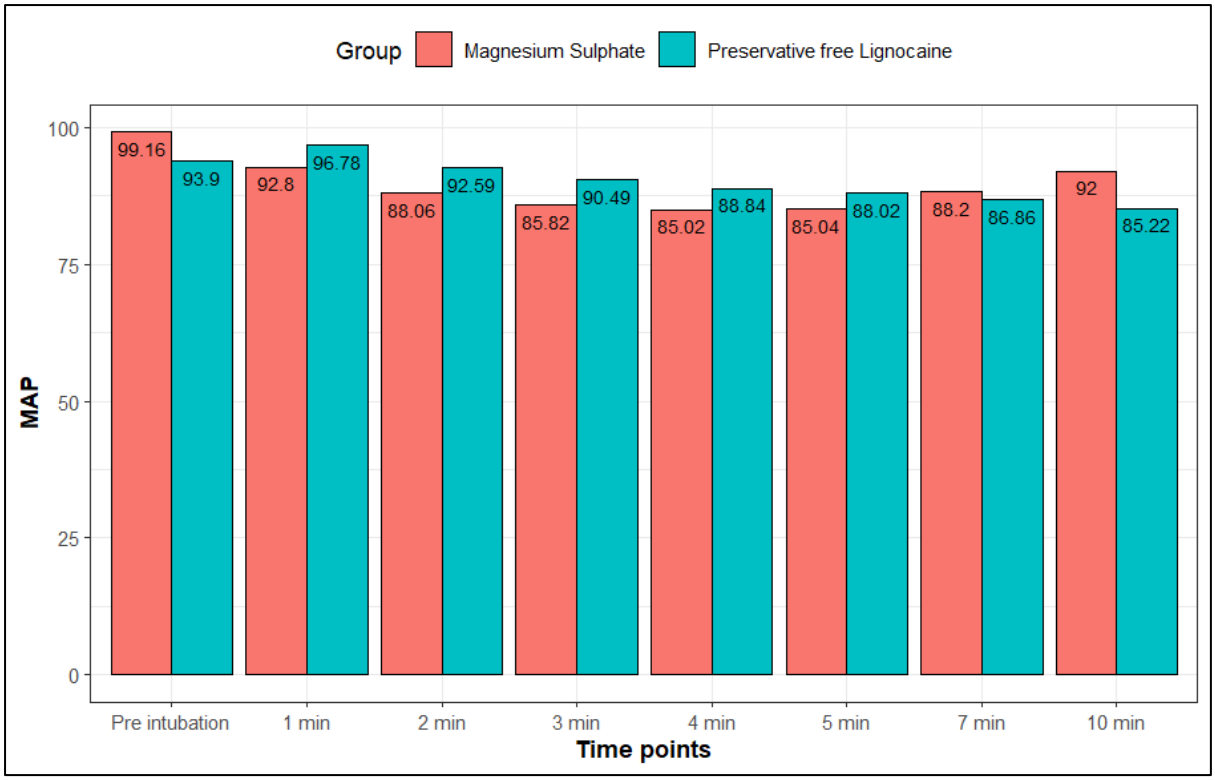
Table 6: MAP comparison over time and groups.

| MAP | Magnesium Sulphate | Preservative free Lignocaine | Total | p-value |
|---|---|---|---|---|
| Pre-intubation | 99.16 ± 10.94<br>100 (79, 119) | 93.9 ± 12.21<br>94 (66, 117) | 96.53 ± 11.83<br>96.5 (66, 119) | **0.0242$^{t*}$** |
| 1 min | 92.8 ± 12.94<br>92 (65, 118) | 96.78 ± 15.83<br>100 (56, 125) | 94.79 ± 14.52<br>96 (56, 125) | 0.1674$^{t}$ |
| 2 min | 88.06 ± 12.95<br>86 (64, 119) | 92.59 ± 16.33<br>94 (59, 130) | 90.32 ± 14.84<br>89.5 (59, 130) | 0.1238$^{t}$ |
| 3 min | 85.82 ± 13.36<br>84 (64, 118) | 90.49 ± 14.94<br>90 (54, 117) | 88.16 ± 14.3<br>86 (54, 118) | 0.0995$^{t}$ |
| 4 min | 85.02 ± 12.39<br>81 (62, 109) | 88.84 ± 15.98<br>88 (54, 123) | 86.93 ± 14.35<br>84 (54, 123) | 0.1666$^{MW}$ |
| 5 min | 85.04 ± 11.45<br>85 (61, 108) | 88.02 ± 13.96<br>88 (53, 109) | 86.53 ± 12.79<br>85 (53, 109) | 0.2413$^{t}$ |
| 7 min | 88.2 ± 10.78<br>88 (68, 114) | 86.86 ± 13.51<br>87 (54, 119) | 87.53 ± 12.18<br>87 (54, 119) | 0.5828$^{t}$ |
| 10 min | 92 ± 9.1<br>91 (75, 110) | 85.22 ± 12.86<br>84 (51, 109) | 88.61 ± 11.6<br>89 (51, 110) | **0.0027$^{t*}$** |
| p-value | **< 0.001$^{F*}$** | **< 0.001$^{F*}$** | - | - |

Pre-intubation, the mean MAP was 99.16 ± 10.94 mmHg in the Magnesium Sulphate group and 93.9 ± 12.21 mmHg in the Preservative-free Lignocaine-group and this was significant among the groups. (p-value = 0.0242). However, at the subsequent time points, no significant variations were noted in MAP distribution among the groups.

At 10$^{th}$ minute after intubation, there was a significant variation in MAP distribution among groups. (p-value = 0.0027).

Additionally, the Friedman test revealed significant variations in MAP over time within both the Magnesium Sulphate and Preservative-free Lignocaine groups (p-values < 0.001).




Graph 9: Mean plot of MAP over time and group

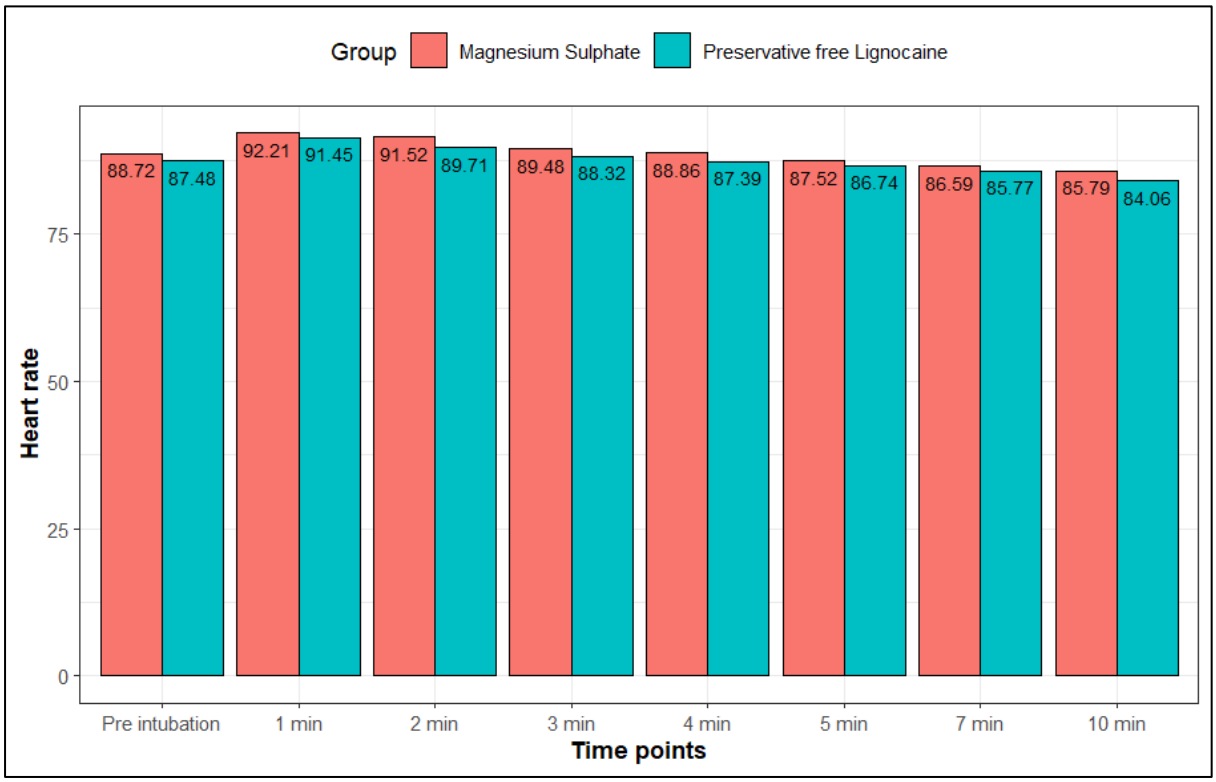
The following table gives the heart-rate comparison over time and groups in males and females.

Table 7: Heart-rate comparison over time and groups in males and females.

| HR | Females | | | Male | | |
|---|---|---|---|---|---|---|
| | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** |
| Pre-intubation | 88.72 ± 14.28<br>86 (64, 131) | 87.48 ± 12.96<br>88 (60, 111) | $0.9116^{MW}$ | 83.32 ± 11.55<br>84 (64, 104) | 74.45 ± 14.02<br>71 (50, 103) | **$0.0303^{t*}$** |
| 1 min | 92.21 ± 15.18<br>86 (70, 138) | 91.45 ± 12.11<br>92 (70, 120) | $0.6838^{MW}$ | 84.41 ± 10.69<br>84.5 (68, 105) | 77 ± 15.16<br>75 (56, 108) | $0.0727^{t}$ |
| 2 min | 91.52 ± 15.12<br>88 (72, 139) | 89.71 ± 12.49<br>91 (64, 107) | $0.9116^{MW}$ | 83.82 ± 8.8<br>85 (65, 99) | 78.9 ± 15.08<br>77.5 (51, 103) | $0.1992^{t}$ |
| 3 min | 89.48 ± 13.96<br>88 (66, 123) | 88.32 ± 10.65<br>90 (65, 103) | $0.8881^{MW}$ | 82.05 ± 9.34<br>83 (65, 96) | 77.55 ± 14.97<br>75.5 (51, 102) | $0.2412^{MW}$ |
| 4 min | 88.86 ± 13.38<br>86 (65, 125) | 87.39 ± 10.84<br>90 (62, 103) | $0.8128^{MW}$ | 81.86 ± 9.31<br>82.5 (65, 97) | 78.1 ± 14.92<br>77 (50, 101) | $0.4199^{MW}$ |
| 5 min | 87.52 ± 12.82<br>87 (68, 121) | 86.74 ± 10.26<br>88 (63, 103) | $0.7962^{t}$ | 81.18 ± 10.36<br>83 (68, 99) | 79.25 ± 15.14<br>77.5 (50, 110) | $0.4568^{MW}$ |
| 7 min | 86.59 ± 13.46<br>86 (65, 117) | 85.77 ± 9.86<br>88 (63, 100) | $0.7898^{t}$ | 79.73 ± 8.87<br>80 (66, 94) | 76.35 ± 15.66<br>76 (52, 107) | $0.3892^{t}$ |
| 10 min | 85.79 ± 11.68<br>84 (65, 115) | 84.06 ± 9.76<br>83 (61, 97) | $0.5354^{t}$ | 79.64 ± 9.19<br>79 (68, 98) | 74.3 ± 15.14<br>70.5 (48, 107) | $0.1706^{t}$ |
| p-value | **$< 0.001^{F*}$** | **$< 0.001^{F*}$** | - | **$< 0.001^{F*}$** | $0.1946^{F}$ | - |

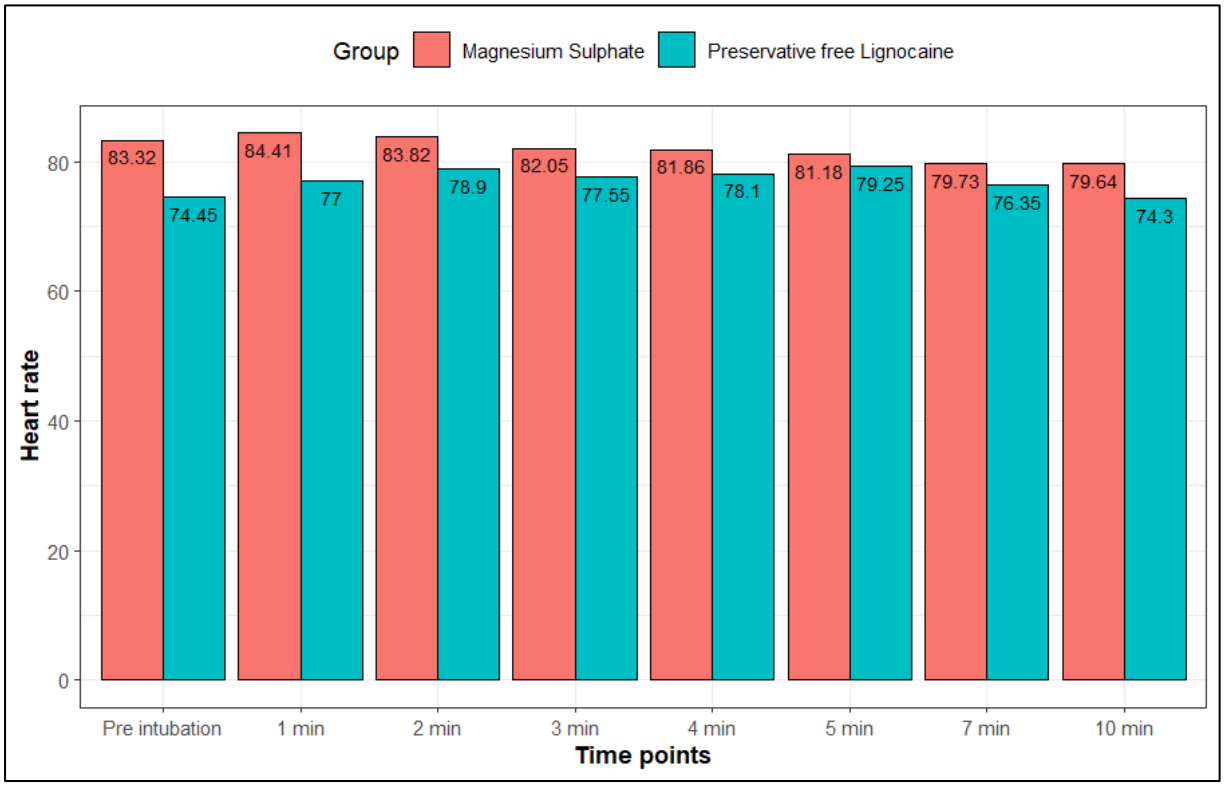
In females, no significant heart-rate differences were noted between the two groups during all time-points. However, from Friedman's test, there is significant difference in heart-rates over-time within each group. (p-value < 0.001 for both groups).

In males, a significant difference is observed pre-intubation (p-value=0.0303), with the Magnesium Sulphate-group having a higher heart rate. No significant differences are seen at subsequent time points. Over time, the Magnesium Sulphate group showed a significant variation in heart-rate. (p-value < 0.001), while Preservative free Lignocaine-group does not (p-value = 0.1946).




Graph 10: Mean plot of HR over time and group in females.

.




Graph 11: Mean plot of HR over time and group in males.

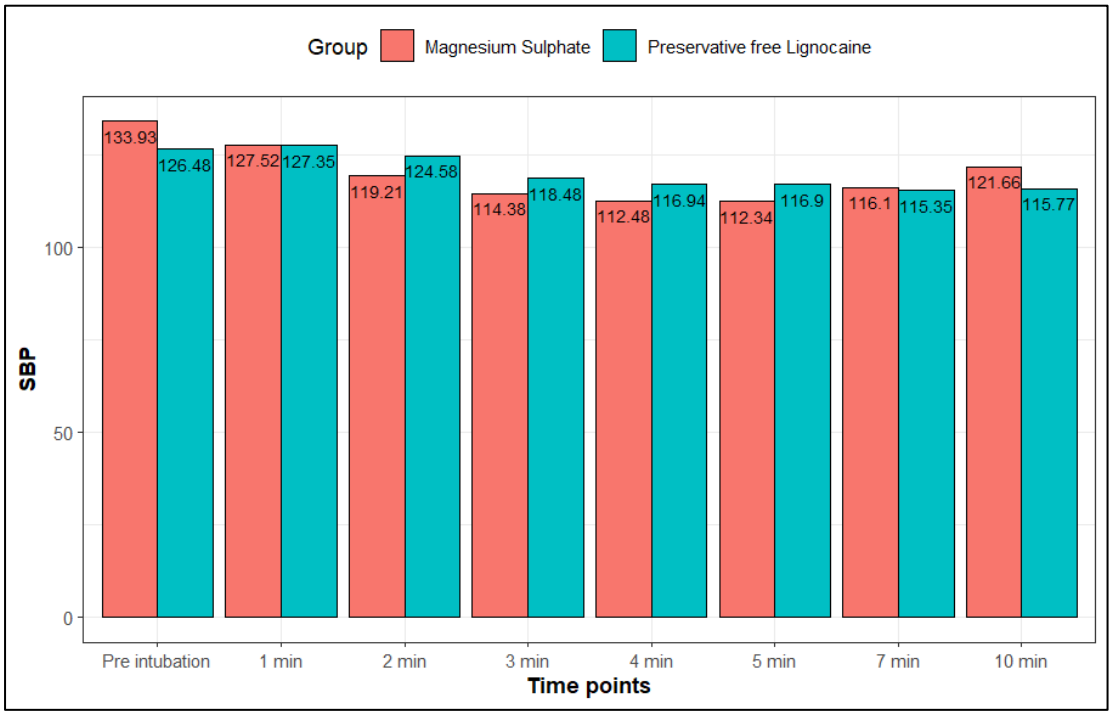
The following table gives the SBP comparison over time and groups in males and females.

Table 8: SBP comparison over time and groups in males and females.

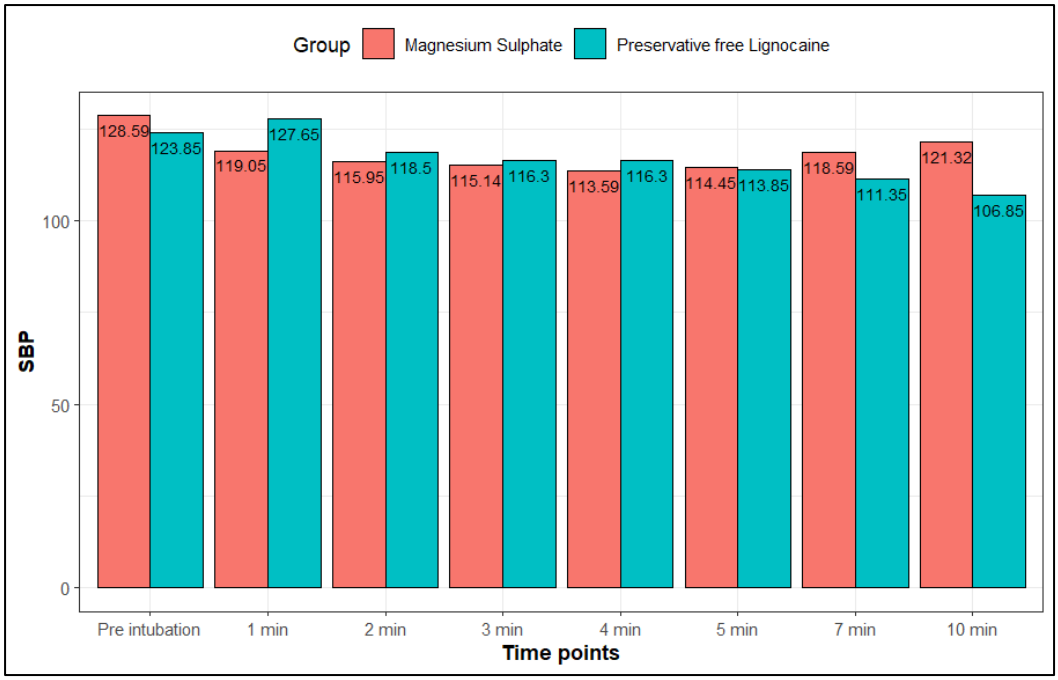
| SBP | Females | | | Males | | |
|---|---|---|---|---|---|---|
| | Magnesium Sulphate | Preservative free Lignocaine | p-value | Magnesium Sulphate | Preservative free Lignocaine | p-value |
| Pre-intubation | 133.93 ± 16.17<br>130 (100, 166) | 126.48 ± 13.99<br>124 (107, 152) | 0.0610[t] | 128.59 ± 12.34<br>128.5 (100, 158) | 123.85 ± 13.48<br>125.5 (101, 149) | 0.2410[t] |
| 1 min | 127.52 ± 18.28<br>127 (92, 157) | 127.35 ± 18.4<br>132 (92, 158) | 0.9728[t] | 119.05 ± 12.89<br>119 (88, 146) | 127.65 ± 22.42<br>126.5 (80, 173) | 0.1309[t] |
| 2 min | 119.21 ± 16.82<br>116 (90, 161) | 124.58 ± 18.78<br>128 (84, 156) | 0.2489[t] | 115.95 ± 16.39<br>114.5 (85, 154) | 118.5 ± 20.87<br>120.5 (84, 168) | 0.6611[t] |
| 3 min | 114.38 ± 15.67<br>113 (88, 146) | 118.48 ± 19.54<br>118 (83, 152) | 0.3752[t] | 115.14 ± 16.54<br>114 (88, 153) | 116.3 ± 18.23<br>114.5 (84, 155) | 0.8294[t] |
| 4 min | 112.48 ± 15.75<br>108 (86, 142) | 116.94 ± 18.68<br>118 (81, 146) | 0.3241[t] | 113.59 ± 12.49<br>112 (93, 140) | 116.3 ± 20.8<br>110.5 (75, 159) | 0.6078[t] |
| 5 min | 112.34 ± 14.44<br>112 (80, 139) | 116.9 ± 17.4<br>118 (81, 140) | 0.2757[t] | 114.45 ± 12.47<br>114 (90, 137) | 113.85 ± 17.19<br>109 (79, 141) | 0.8962[t] |
| 7 min | 116.1 ± 14.32<br>118 (92, 145) | 115.35 ± 15.71<br>116 (81, 138) | 0.8480[t] | 118.59 ± 11.71<br>118 (96, 138) | 111.35 ± 17.09<br>106.5 (76, 146) | 0.1143[t] |
| 10 min | 121.66 ± 10.68<br>119 (103, 143) | 115.77 ± 14.63<br>116 (80, 141) | 0.0824[t] | 121.32 ± 9.63<br>122.5 (102, 141) | 106.85 ± 14.23<br>103.5 (73, 133) | **0.0004[t]*** |
| p-value | **< 0.001[F]*** | **< 0.001[F]*** | - | **< 0.001[F]*** | **< 0.001[F]*** | - |

In females, no significant SBP variations were noted among the groups at all time-points. However, from Friedman's test, there is a significant difference in SBP over time within each group (p-value < 0.001 for both groups).

In males, no significant SBP variations were noted between the groups at pre-intubation, 1- , 2-, 3- , 4- , 5- and 7-minutes. However, at 10-minutes, a significant SBP difference was noted among the groups, with the Magnesium Sulphate group having a higher SBP compared to the Preservative free Lignocaine group (p-value=0.0004). Friedman's test also shows significant changes in SBP over time within each group (p-value < 0.001).




Graph 12: Mean plot of SBP over time and group in females.




Graph 13: Mean plot of SBP over time and group in males

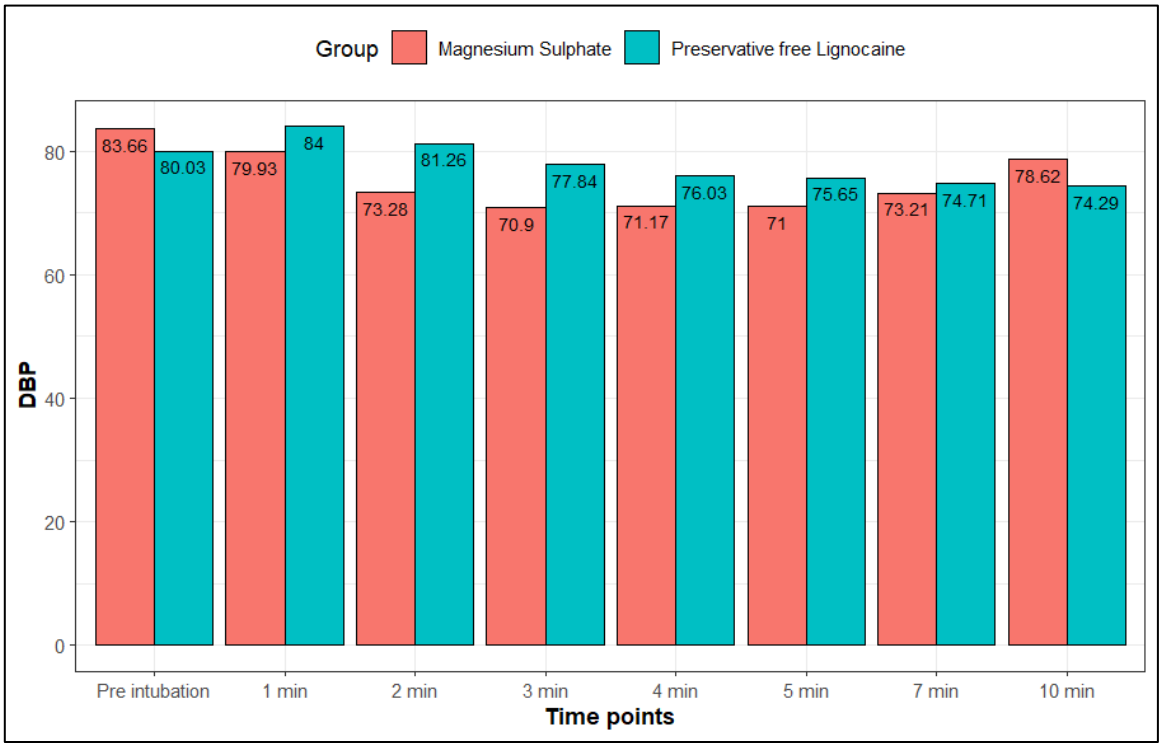
The following table gives the DBP comparison over time and groups in males and females.

Table 9: DBP comparison over time and groups in males and females.

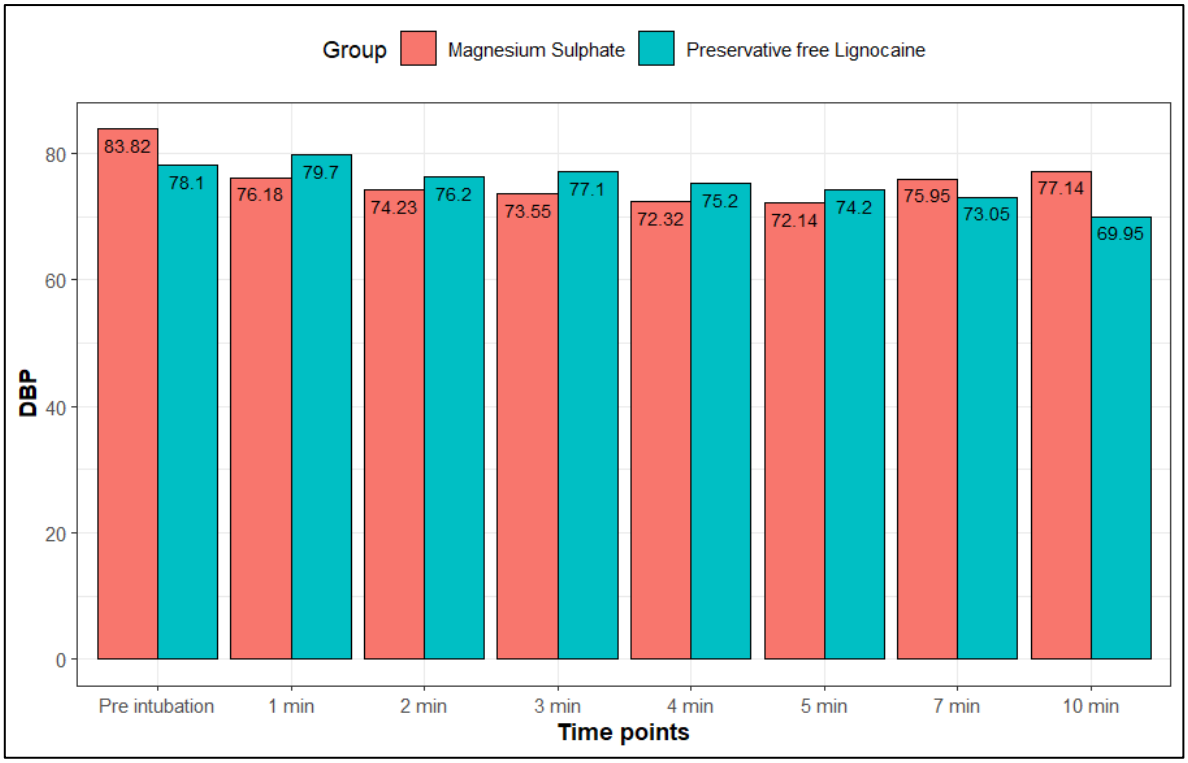
| DBP | Females | | | Males | | |
|---|---|---|---|---|---|---|
| | Magnesium Sulphate | Preservative free Lignocaine | p-value | Magnesium Sulphate | Preservative free Lignocaine | p-value |
| Pre-intubation | 83.66 ± 10.12<br>84 (63, 101) | 80.03 ± 12.4<br>79 (48, 100) | 0.2219$^{t}$ | 83.82 ± 9.65<br>85 (68, 101) | 78.1 ± 9.2<br>77 (64, 97) | 0.0569$^{t}$ |
| 1 min | 79.93 ± 11.81<br>81 (60, 100) | 84 ± 14.25<br>86 (52, 108) | 0.2351$^{t}$ | 76.18 ± 11.32<br>75.5 (54, 99) | 79.7 ± 11.66<br>78 (50, 97) | 0.3274$^{t}$ |
| 2 min | 73.28 ± 11.27<br>72 (57, 101) | 81.26 ± 13.79<br>82 (50, 103) | **0.0175$^{t}$*** | 74.23 ± 11.99<br>73.5 (53, 102) | 76.2 ± 14.69<br>74.5 (57, 119) | 0.6349$^{t}$ |
| 3 min | 70.9 ± 11.64<br>70 (47, 92) | 77.84 ± 13.31<br>79 (47, 100) | **0.0361$^{t}$*** | 73.55 ± 13.39<br>70.5 (57, 98) | 77.1 ± 12.48<br>74.5 (56, 104) | 0.2618$^{MW}$ |
| 4 min | 71.17 ± 11.42<br>69 (51, 93) | 76.03 ± 13.63<br>77 (45, 98) | 0.1413$^{t}$ | 72.32 ± 12.67<br>69.5 (56, 99) | 75.2 ± 14.77<br>74 (51, 105) | 0.5001$^{t}$ |
| 5 min | 71 ± 11.16<br>71 (48, 94) | 75.65 ± 11.95<br>76 (43, 94) | 0.1258$^{t}$ | 72.14 ± 10.13<br>71.5 (55, 89) | 74.2 ± 12.49<br>71.5 (54, 97) | 0.5583$^{t}$ |
| 7 min | 73.21 ± 10.07<br>74 (55, 98) | 74.71 ± 10.87<br>73 (50, 95) | 0.5815$^{t}$ | 75.95 ± 8.99<br>76 (61, 89) | 73.05 ± 13.29<br>70 (48, 105) | 0.4079$^{t}$ |
| 10 min | 78.62 ± 8.77<br>78 (64, 94) | 74.29 ± 10.86<br>74 (49, 96) | 0.0960$^{t}$ | 77.14 ± 8.72<br>76 (63, 93) | 69.95 ± 11.47<br>68 (45, 94) | **0.0268$^{t}$*** |
| p-value | **< 0.001$^{F}$*** | **< 0.001$^{F}$*** | - | **< 0.001$^{F}$*** | **< 0.001$^{F}$*** | - |

In females, at pre-intubation and 1-min, no significant variation in DBP was observed among the groups. However, at 2-minutes and 3-minutes post-intubation, significant differences are observed, with the Preservative free Lignocaine group having higher DBP. (p-values = 0.0175 and 0.0361 respectively). At other time points (1, 4, 5, 7 and 10 minutes), no significant differences are noted. Friedman's test indicates significant changes in DBP over time within each group. (p-value < 0.001).

In males, no significant variation in DBP was noted among the two groups at pre-intubation, 1-, 2-, 3-, 4-, 5- and 7-minutes. However, at 10-minutes, there was a difference that is significant between the groups, with the Magnesium Sulphate-group having higher DBP compared to the Preservative-free Lignocaine group (p-value = 0.0268). Friedman's test also shows significant changes in DBP over time within each group. (p-value < 0.001).




Graph 14: Mean plot of DBP over time and group in females




Graph 15: Mean plot of DBP over time and group in males

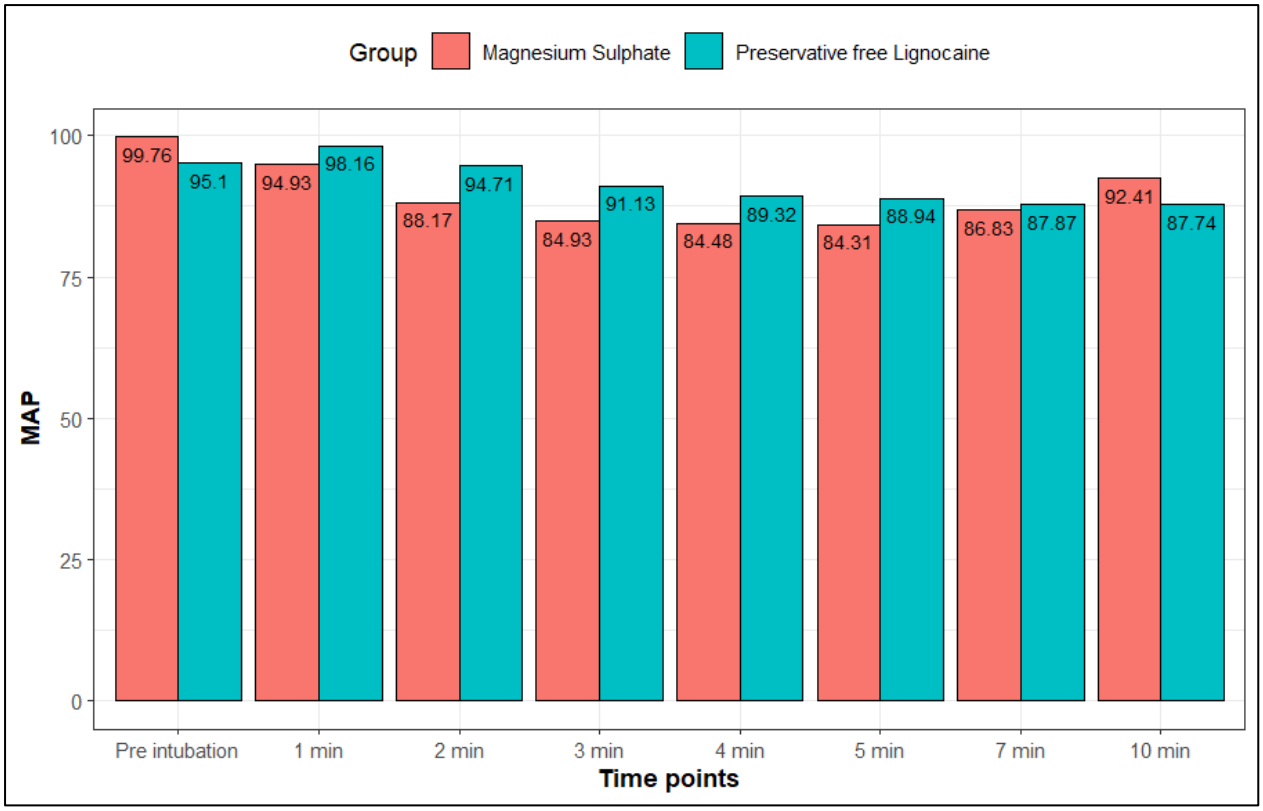
The following table gives the MAP comparison over time and groups in males and females.

Table 10: MAP comparison over time and groups in males and females

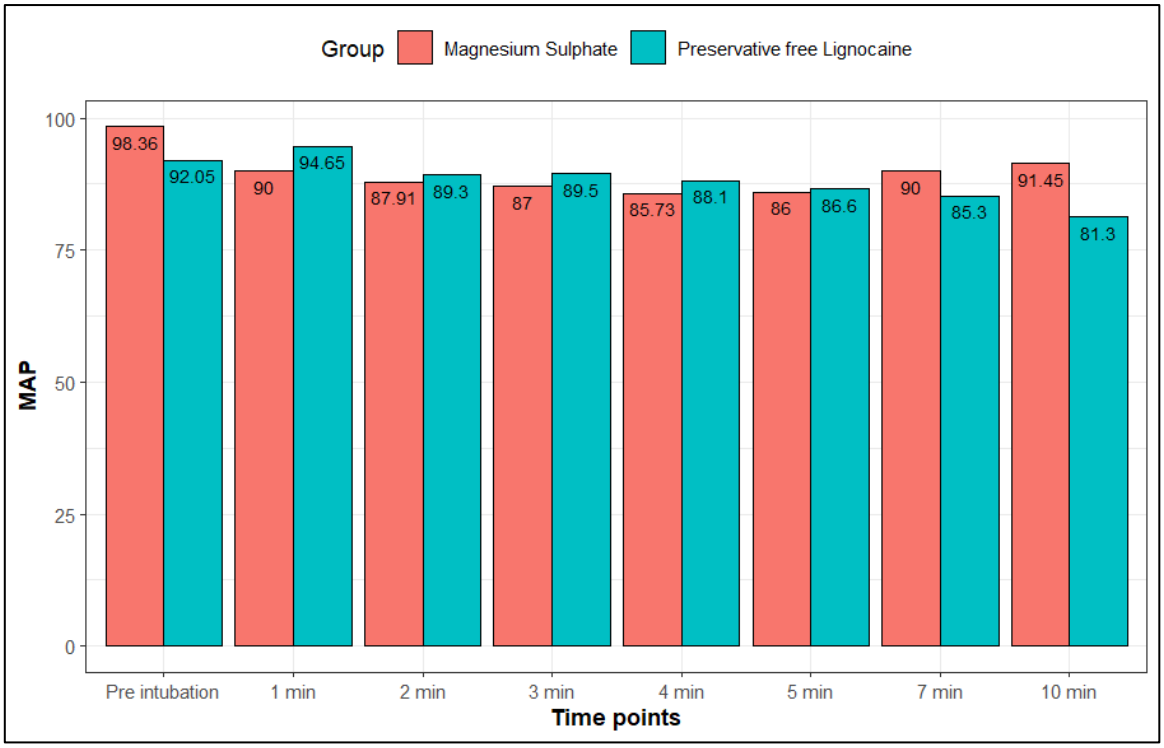
| MAP | Females | | | Males | | |
|---|---|---|---|---|---|---|
| | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** |
| Pre-intubation | 99.76 ± 11.55<br>101 (79, 119) | 95.1 ± 13.04<br>94 (66, 117) | 0.1491[t] | 98.36 ± 10.3<br>97.5 (79, 117) | 92.05 ± 10.86<br>94 (77, 112) | 0.0603[t] |
| 1 min | 94.93 ± 13.22<br>96 (71, 118) | 98.16 ± 15.99<br>102 (63, 125) | 0.3990[t] | 90 ± 12.29<br>87.5 (65, 116) | 94.65 ± 15.74<br>95.5 (56, 120) | 0.2899[t] |
| 2 min | 88.17 ± 12.7<br>86 (69, 116) | 94.71 ± 15.81<br>99 (59, 120) | 0.0840[t] | 87.91 ± 13.56<br>86.5 (64, 119) | 89.3 ± 16.98<br>88 (64, 130) | 0.7698[t] |
| 3 min | 84.93 ± 12.89<br>84 (64, 110) | 91.13 ± 15.45<br>94 (54, 117) | 0.0981[t] | 87 ± 14.17<br>85 (68, 118) | 89.5 ± 14.46<br>85 (66, 116) | 0.5748[t] |
| 4 min | 84.48 ± 12.73<br>81 (62, 109) | 89.32 ± 15.64<br>93 (54, 114) | 0.1956[t] | 85.73 ± 12.18<br>82.5 (69, 107) | 88.1 ± 16.87<br>83 (56, 123) | 0.7334[MW] |
| 5 min | 84.31 ± 12.03<br>83 (61, 108) | 88.94 ± 13.91<br>91 (53, 109) | 0.1748[t] | 86 ± 10.85<br>85 (68, 106) | 86.6 ± 14.29<br>82 (60, 109) | 0.8783[t] |
| 7 min | 86.83 ± 11.62<br>87 (68, 114) | 87.87 ± 12.64<br>87 (57, 105) | 0.7409[t] | 90 ± 9.52<br>91 (75, 106) | 85.3 ± 14.96<br>82 (54, 119) | 0.2271[t] |
| 10 min | 92.41 ± 9.34<br>91 (76, 110) | 87.74 ± 12.44<br>88 (56, 109) | 0.1072[t] | 91.45 ± 8.96<br>91.5 (75, 106) | 81.3 ± 12.84<br>79.5 (51, 107) | **0.0047[t]*** |
| p-value | **< 0.001[F]*** | **< 0.001[F]*** | - | **< 0.001[F]*** | **< 0.001[F]*** | - |

In females, no significant MAP variation was noted among the groups at all time-points. However, from Friedman's test, a significant variation in MAP was noted over time within each group.

In males, there was no significant variation in MAP between the groups at pre-intubation, 1, 2, 3, 4, 5 and 7 minutes. However, at 10 minutes, there is a difference that is significant between the groups, with the Magnesium Sulphate-group having higher MAP compared to the Preservative free Lignocaine-group (p-value = 0.0047). Friedman's test indicates significant changes in MAP -over time within each group. (p-value < 0.001).




Graph 16: Mean plot of MAP over time and group in females.




Graph 17: Mean plot of MAP over time and group in males

The following table gives the heart rate comparison over time and groups in different age groups.

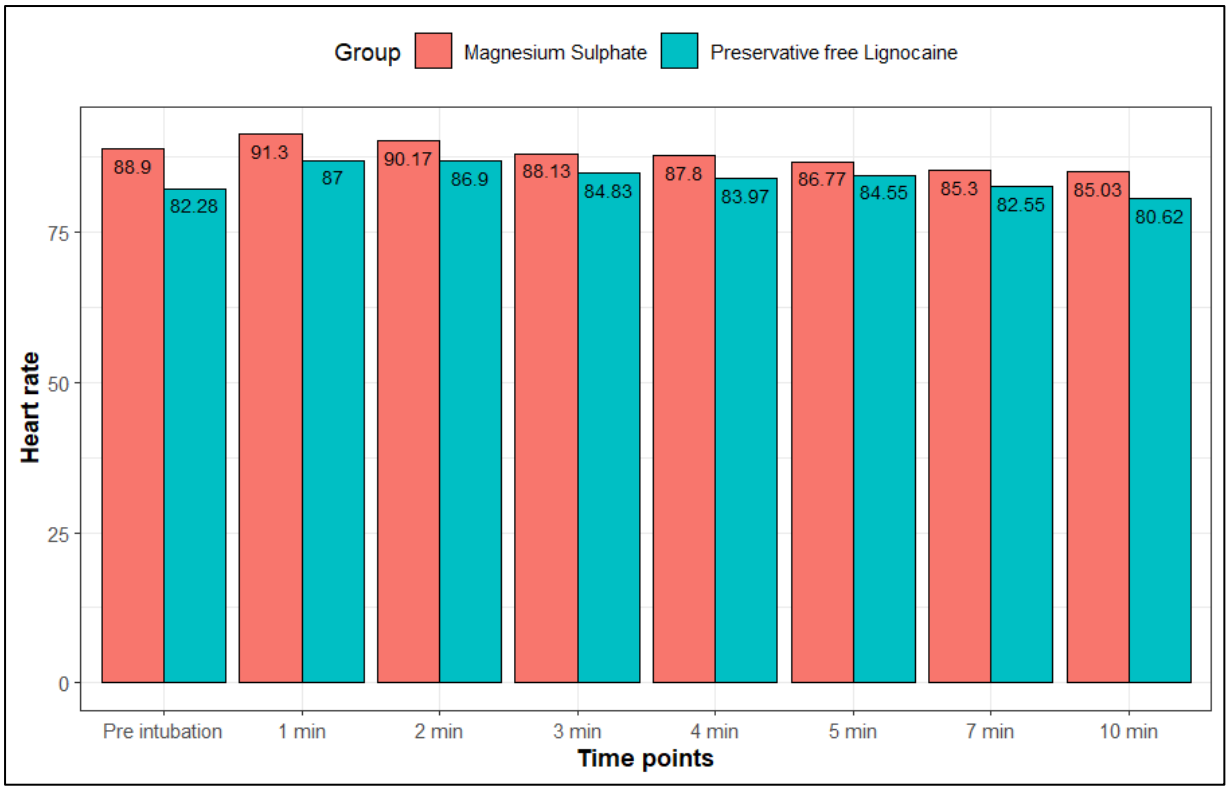
Table 11: Heart rate comparison over time and groups in different age groups.

| HR | 40-50 | | | 51-60 | | | 61-70 | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** |
| Pre-intubation | 88.9 ± 14.45<br>86.5 (64, 131) | 82.28 ± 13.01<br>82 (60, 104) | 0.0697$^{t}$ | 85.23 ± 12<br>86 (67, 107) | 85.4 ± 16.18<br>90 (56, 111) | 0.9755$^{t}$ | 78.88 ± 7.88<br>79.5 (64, 88) | 76.29 ± 18.43<br>72 (50, 102) | 0.7226$^{t}$ |
| 1 min | 91.3 ± 15.38<br>87 (70, 138) | 87 ± 15.34<br>89 (57, 120) | 0.5746 $^{MW}$ | 87.92 ± 11.29<br>85 (70, 112) | 85.73 ± 14.69<br>85 (61, 107) | 0.6659$^{t}$ | 81.12 ± 8.89<br>82 (68, 93) | 80.86 ± 15.73<br>82 (56, 101) | 0.9677$^{t}$ |
| 2 min | 90.17 ± 14.58<br>87 (69, 139) | 86.9 ± 13.69<br>88 (56, 107) | 0.8259 $^{MW}$ | 87.85 ± 11.18<br>86 (75, 112) | 85.6 ± 14.57<br>85 (60, 106) | 0.5336 $^{MW}$ | 81.38 ± 9.4<br>82.5 (65, 93) | 79.29 ± 17.67<br>78 (51, 101) | 0.7752$^{t}$ |
| 3 min | 88.13 ± 13.32<br>87 (66, 123) | 84.83 ± 13.2<br>86 (61, 102) | 0.82$^{MW}$ | 85.31 ± 12.26<br>86 (69, 108) | 85.33 ± 12.21<br>83 (63, 103) | 0.9956$^{t}$ | 80.88 ± 9.86<br>80.5 (65, 94) | 78.43 ± 17.53<br>75 (51, 102) | 0.7399$^{t}$ |
| 4 min | 87.8 ± 12.75<br>84.5 (69, 125) | 83.97 ± 12.71<br>87 (57, 101) | 0.6654 $^{MW}$ | 84.77 ± 12.13<br>85 (65, 108) | 86.13 ± 12.32<br>86 (63, 103) | 0.7709$^{t}$ | 80.25 ± 9.15<br>83 (65, 89) | 77.71 ± 17.37<br>79 (50, 100) | 0.6422 $^{MW}$ |
| 5 min | 86.77 ± 13.07<br>85.5 (68, 121) | 84.55 ± 12.58<br>87 (61, 110) | 0.5101$^{t}$ | 83.38 ± 11.51<br>84 (69, 104) | 85.47 ± 11.13<br>86 (70, 103) | 0.6311$^{t}$ | 79.62 ± 8.03<br>80 (68, 91) | 77.14 ± 16.66<br>78 (50, 98) | 0.7131$^{t}$ |
| 7 min | 85.3 ± 12.43<br>85 (65, 117) | 82.55 ± 13.33<br>84 (56, 107) | 0.416$^{t}$ | 83 ± 13.01<br>82 (66, 114) | 84.67 ± 11.32<br>84 (69, 100) | 0.7199$^{t}$ | 78.38 ± 8.37<br>77.5 (66, 89) | 74.57 ± 15.16<br>75 (52, 94) | 0.5506$^{t}$ |
| 10 min | 85.03 ± 11.74<br>83.5 (68, 115) | 80.62 ± 13.07<br>82 (56, 107) | 0.1775$^{t}$ | 81.92 ± 10.81<br>82 (65, 102) | 82.87 ± 9.8<br>81 (69, 97) | 0.8105$^{t}$ | 78 ± 6.85<br>77.5 (68, 87) | 73 ± 17.19<br>70 (48, 96) | 0.4610$^{t}$ |
| p-value | **< 0.001$^{F*}$** | **< 0.001$^{F*}$** | - | **< 0.001$^{F*}$** | 0.5531$^{F}$ | - | **0.0451$^{F*}$** | **0.0492$^{F*}$** | - |

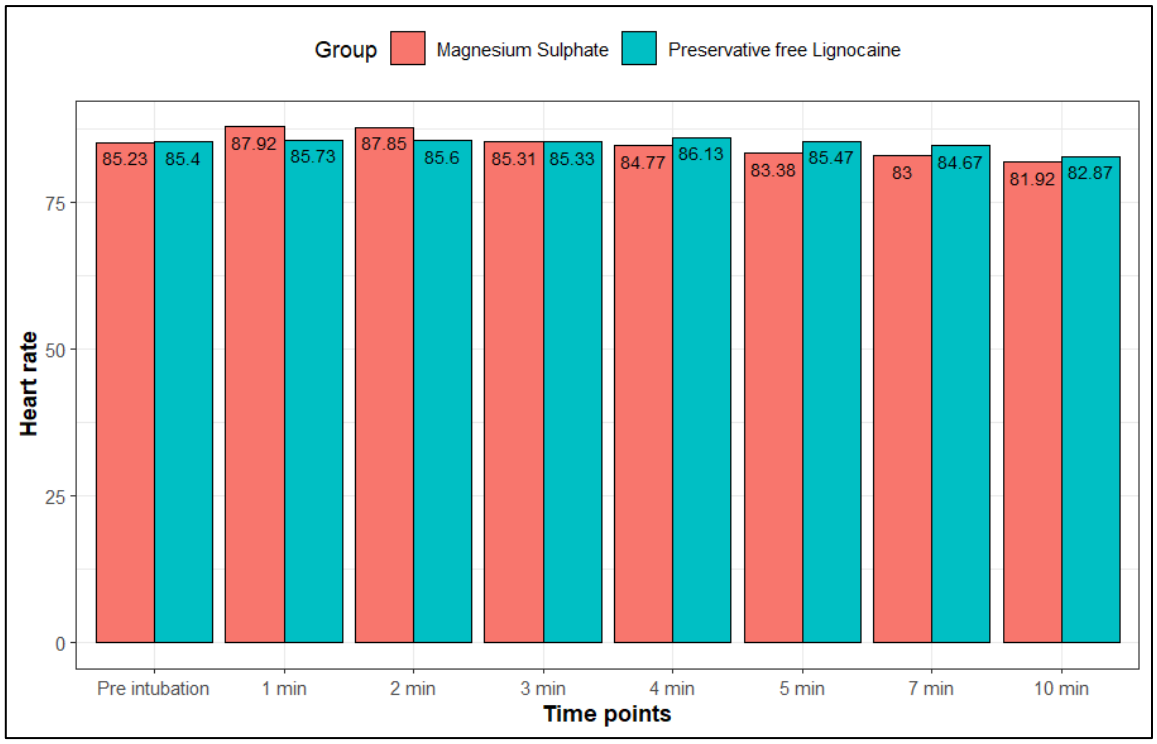
For the 40-50 age group, the heart rate didn't show significant difference between the groups at all time-points. However, the changes in HR were significant over time within each group as indicated by Friedman's-test. (p-value < 0.001).

For the 51-60 age group, no significant variation in HR was noted among the groups at all time-points. Friedman's test indicates significant changes in HR over time within the Magnesium Sulphate group (p-value < 0.001), but not within the Preservative free Lignocaine group (p-value = 0.5531).

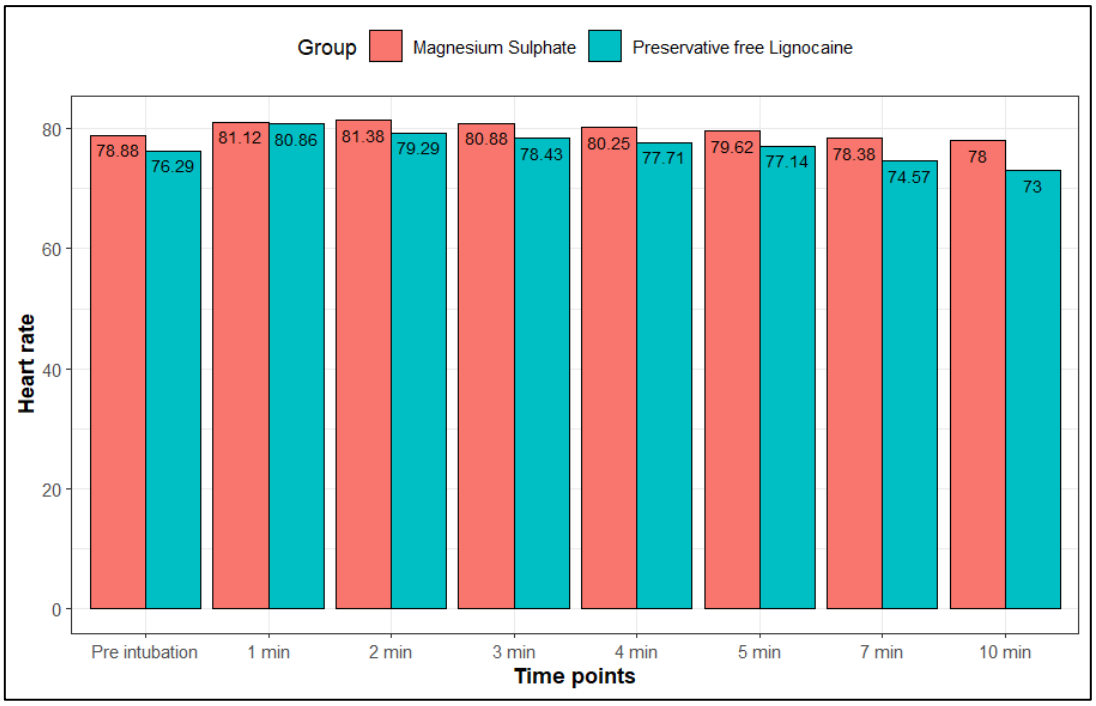
For the 61-70 age group, no significant variation in HR was noted among the groups at all time-points. Friedman's test shows significant heart rate changes over time within both groups. (p-value = 0.0451 for Magnesium Sulphate, p-value = 0.0492 for Preservative-free Lignocaine).




Graph 18: Mean plot of HR over time and group in age group 40-50 years.




Graph 19: Mean plot of HR over time and group in age group 51-60 years.




Graph 20: Mean plot of HR over time and group in age group 61-70 years

The following table gives the comparison of SBP over time and groups.

Table 12: Comparison of SBP over time and groups.

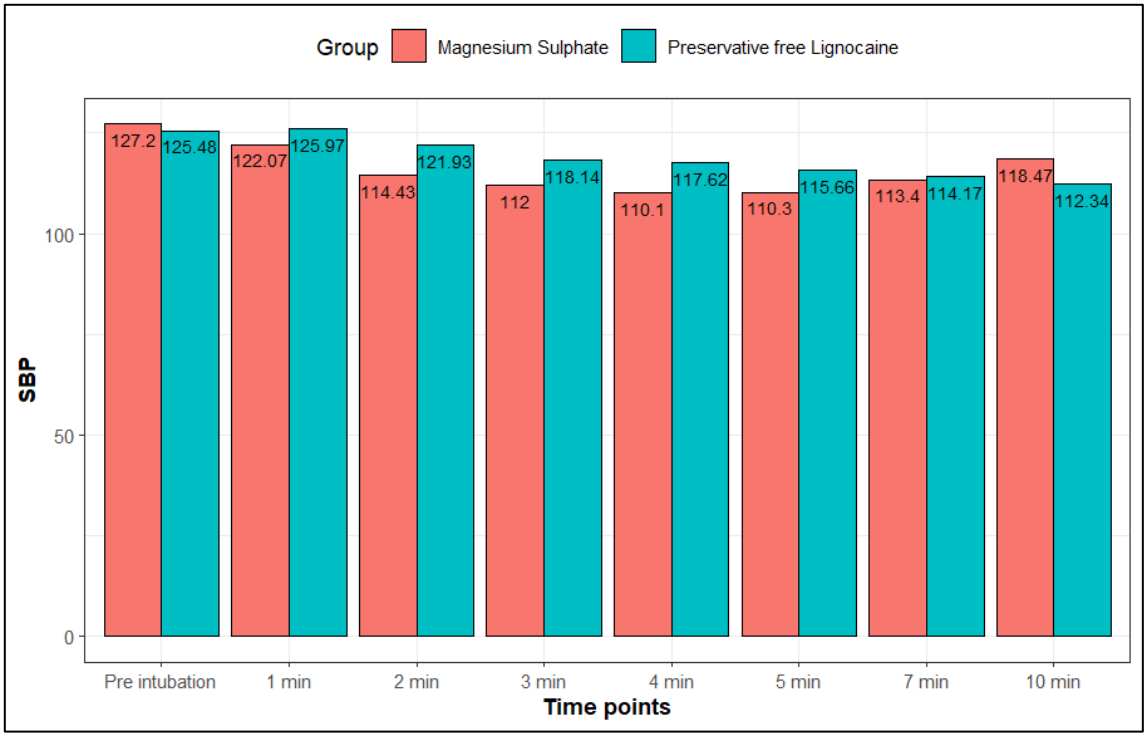
| SBP | 40-50 | | | 51-60 | | | 61-70 | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** |
| Pre-intubation | 127.2 ± 13.68<br>129.5 (100, 155) | 125.48 ± 13.4<br>124 (107, 152) | 0.6283$^{t}$ | 138.23 ± 12.87<br>130 (124, 160) | 126.13 ± 15.48<br>127 (101, 150) | **0.0443$^{MW}$ *** | 137.5 ± 17.03<br>133 (114, 166) | 123.86 ± 12.9<br>123 (107, 140) | 0.1078$^{t}$ |
| 1 min | 122.07 ± 17.86<br>121 (88, 157) | 125.97 ± 16.78<br>124 (100, 158) | 0.3915$^{t}$ | 125 ± 13.67<br>118 (112, 154) | 129.73 ± 24.88<br>136 (80, 173) | 0.3328$^{MW}$ | 128.75 ± 16.68<br>128 (101, 151) | 128.86 ± 22.39<br>134 (92, 149) | 0.9917$^{t}$ |
| 2 min | 114.43 ± 16.26<br>115.5 (85, 161) | 121.93 ± 15.85<br>125 (98, 153) | 0.0784$^{t}$ | 123.15 ± 17.84<br>113 (106, 154) | 126.2 ± 25.26<br>132 (84, 168) | 0.5039$^{MW}$ | 121.75 ± 13.98<br>126.5 (96, 138) | 114.71 ± 21.2<br>117 (84, 144) | 0.4558$^{t}$ |
| 3 min | 112 ± 14.95<br>113 (88, 149) | 118.14 ± 14.97<br>118 (92, 147) | 0.1207$^{t}$ | 118.92 ± 19.36<br>112 (92, 153) | 119.8 ± 24.59<br>116 (84, 155) | 0.9183$^{t}$ | 118 ± 12.6<br>118.5 (93, 133) | 110.86 ± 21.15<br>114 (83, 140) | 0.4339$^{t}$ |
| 4 min | 110.1 ± 13.25<br>108 (91, 136) | 117.62 ± 17.01<br>113 (84, 159) | 0.0628$^{t}$ | 116.54 ± 16.7<br>114 (86, 142) | 118.33 ± 22.4<br>124 (75, 146) | 0.8144$^{t}$ | 117.88 ± 13.05<br>116.5 (99, 140) | 109.29 ± 22.81<br>108 (81, 144) | 0.3789$^{t}$ |
| 5 min | 110.3 ± 12.25<br>107.5 (90, 133) | 115.66 ± 14.5<br>113 (93, 140) | 0.1304$^{t}$ | 115.38 ± 16.85<br>118 (80, 139) | 118.67 ± 19.53<br>118 (79, 141) | 0.6407$^{t}$ | 120.88 ± 9.4<br>123 (104, 137) | 109.57 ± 23.04<br>113 (81, 138) | 0.2239$^{t}$ |
| 7 min | 113.4 ± 12.15<br>115 (95, 137) | 114.17 ± 14.61<br>114 (90, 146) | 0.8258$^{t}$ | 120.15 ± 13.96<br>121 (92, 142) | 115.27 ± 17.42<br>114 (76, 136) | 0.4252$^{t}$ | 126.5 ± 10.98<br>125 (106, 145) | 109 ± 21.31<br>111 (81, 134) | 0.0621$^{t}$ |
| 10 min | 118.47 ± 9.1<br>118.5 (102, 137) | 112.34 ± 14.28<br>108 (93, 141) | **0.0391$^{MW}$ *** | 123.54 ± 10.19<br>120 (108, 141) | 114.33 ± 15.42<br>116 (73, 134) | 0.0786$^{MW}$ | 129.62 ± 9.55<br>131.5 (116, 143) | 107.57 ± 18.17<br>115 (80, 128) | **0.0102$^{t}$ *** |
| p-value | **< 0.001$^{F}$*** | **< 0.001$^{F}$*** | - | **< 0.001$^{F}$*** | **< 0.001$^{F}$*** | - | **< 0.001$^{F}$*** | **< 0.001$^{F}$*** | - |

For the 40-50 age group, no significant variation in SBP was noted among the groups at pre-intubation, 1-, 2-, 3-, 4-, 5- and 7-min. However, at 10 minutes, significant difference in SBP was noted among the groups with Magnesium Sulphate showing a significantly higher SBP (p-value = 0.0391). Over time, within each group, SBP changes significantly as indicated by Friedman's test (p-value < 0.001).

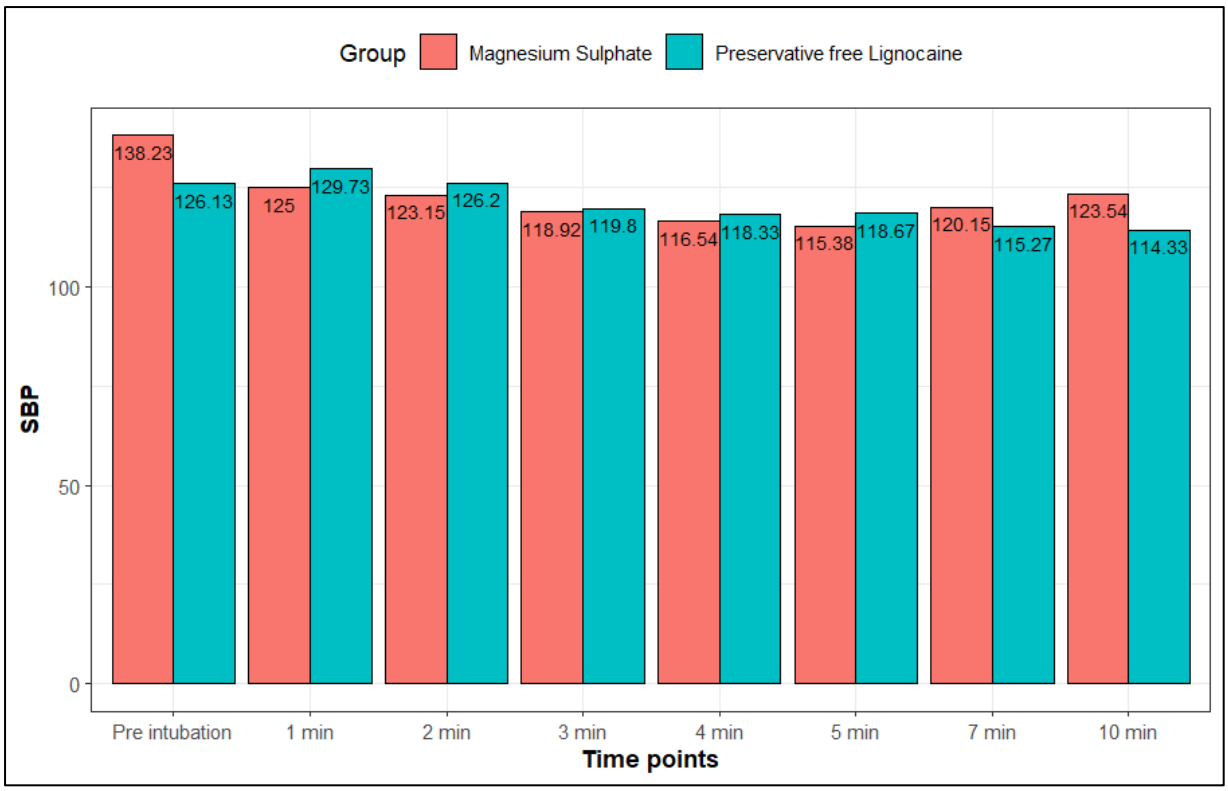
In 51-60 age group, pre-intubation SBP shows a significant difference, with Magnesium Sulphate yielding higher SBP (p-value = 0.0443). At following time-points (1-, 2-, 3-, 4-, 5-, 7- and 10-minutes) no significant SBP differences existed among the groups. However,

changes over time within each group are significant according to Friedman's test (p-value < 0.001).

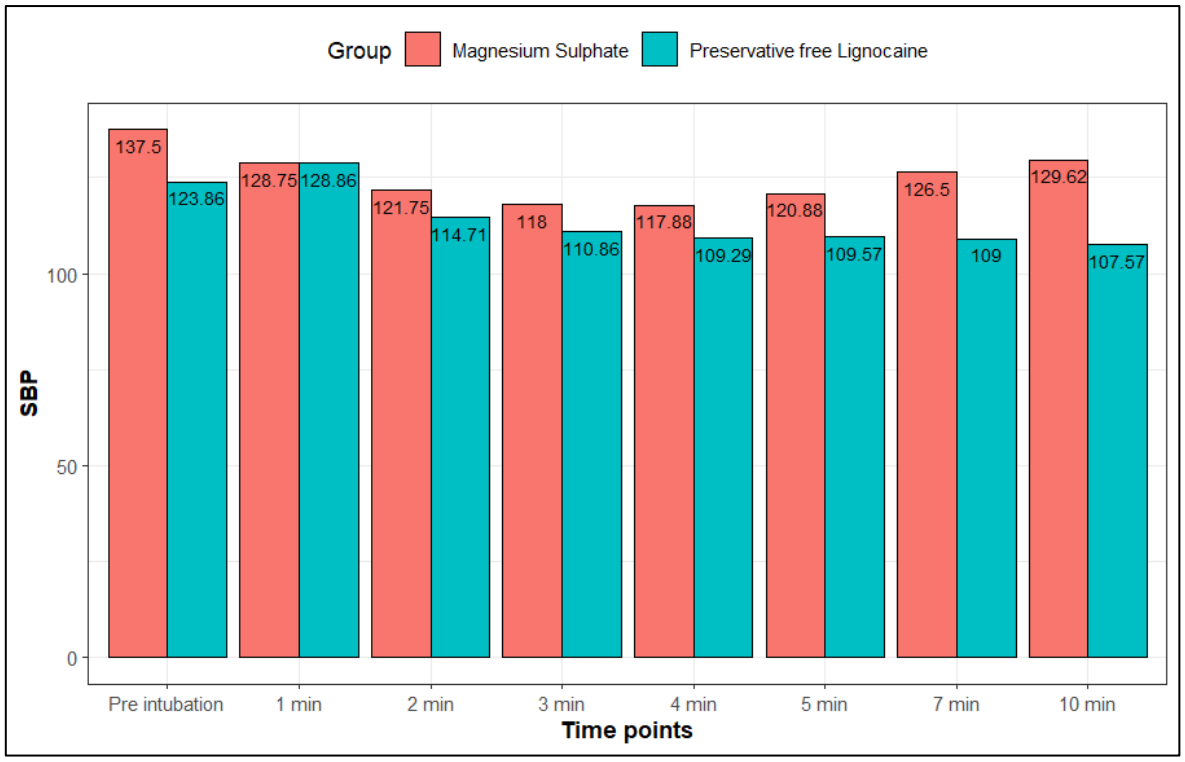
For those in 61-70, no significant SBP difference was noted among the two treatment groups at pre-intubation, 1-, 2-, 3-, 4-, 5- and 7-min. However, there was a significant SBP variation among the groups at 10-minutes, with Magnesium Sulphate showing higher SBP compared to Preservative free Lignocaine (p-value = 0.0102). The within-group changes over time are significant, as indicated by Friedman's-test. (p-value < 0.001).




Graph 21: Mean plot of SBP over time and group in age group 40-50 years.




Graph 22: Mean plot of SBP over time and group in age group 51-60 years.




Graph 23: Mean plot of SBP over time and group in age group 61-70 years.

The following table gives the comparison of DBP over time and groups.

Table 13: Comparison of DBP over time and groups.

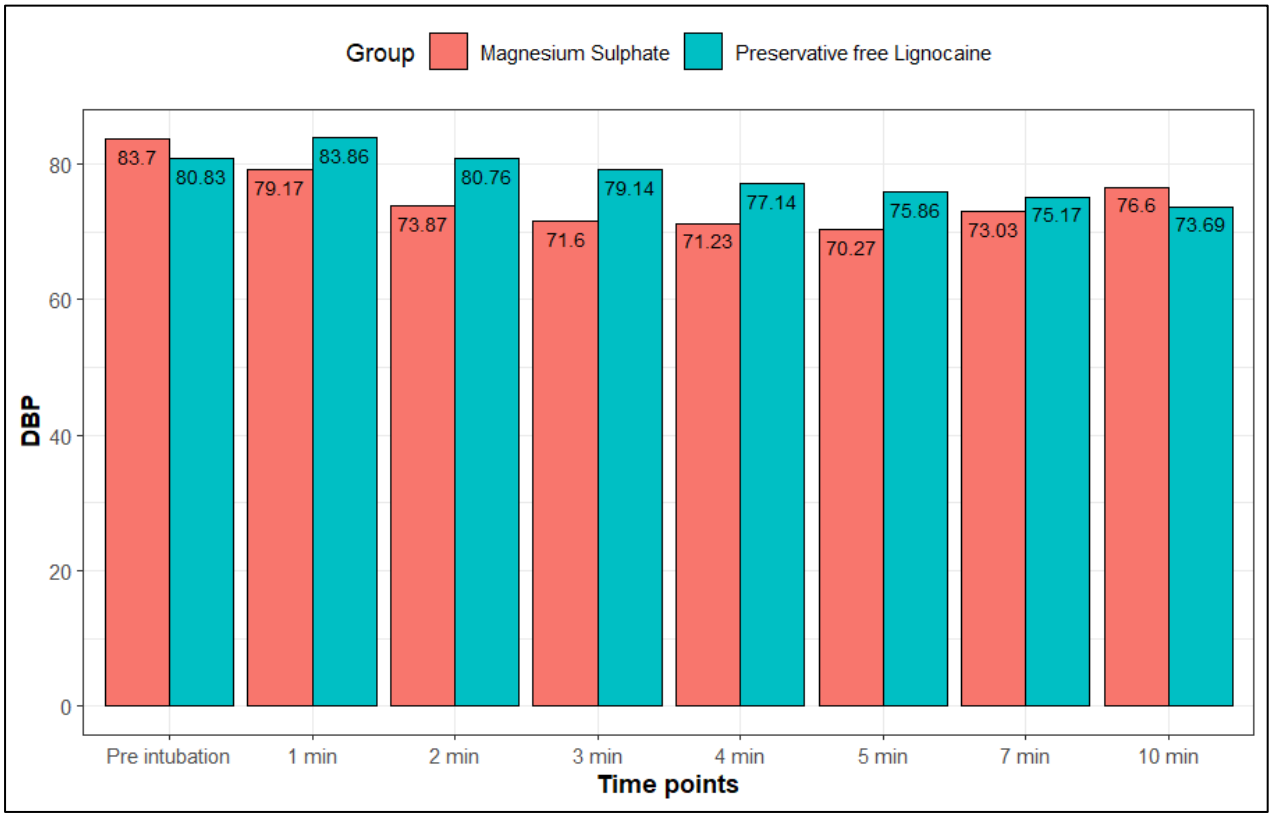
| DBP | 40-50 | | | 51-60 | | | 61-70 | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** |
| Pre-intubation | 83.7 ± 10.47<br>84 (63, 101) | 80.83 ± 11.08<br>79 (60, 100) | 0.3104$^{t}$ | 83.62 ± 7.88<br>83 (70, 96) | 80.07 ± 9.71<br>79 (66, 98) | 0.3029$^{t}$ | 84 ± 11.31<br>86 (68, 100) | 71.14 ± 12.71<br>70 (48, 88) | 0.0585$^{t}$ |
| 1 min | 79.17 ± 11.81<br>81 (54, 100) | 83.86 ± 12.09<br>80 (65, 108) | 0.1367$^{t}$ | 76.62 ± 10.78<br>74 (63, 96) | 82.73 ± 14.22<br>84 (50, 104) | 0.2166$^{t}$ | 77.88 ± 13.47<br>77 (58, 99) | 75 ± 15.99<br>80 (52, 92) | 0.7114$^{t}$ |
| 2 min | 73.87 ± 11.83<br>74.5 (53, 102) | 80.76 ± 14.08<br>80 (58, 119) | **0.0461$^{t}$*** | 72.85 ± 11.72<br>72 (57, 91) | 80.73 ± 13.79<br>82 (57, 102) | 0.1181$^{t}$ | 74.38 ± 11.13<br>73.5 (60, 89) | 70 ± 14.2<br>70 (50, 85) | 0.5154$^{t}$ |
| 3 min | 71.6 ± 13.12<br>71.5 (47, 98) | 79.14 ± 10.95<br>78 (63, 104) | **0.0187$^{t}$*** | 72.54 ± 12.27<br>70 (56, 96) | 78.93 ± 14.02<br>78 (56, 100) | 0.2138$^{t}$ | 72.88 ± 10.89<br>69.5 (61, 93) | 68 ± 15.45<br>70 (47, 87) | 0.4879$^{t}$ |
| 4 min | 71.23 ± 12.84<br>69.5 (51, 99) | 77.14 ± 13.07<br>76 (54, 105) | 0.0854$^{t}$ | 71.85 ± 10.47<br>69 (58, 93) | 77.53 ± 14.36<br>77 (51, 98) | 0.2484$^{t}$ | 73 ± 11.48<br>68.5 (63, 91) | 65.86 ± 14.55<br>68 (45, 82) | 0.4511$^{MW}$ |
| 5 min | 70.27 ± 11.4<br>71 (48, 94) | 75.86 ± 11.12<br>76 (58, 97) | 0.0613$^{t}$ | 71.46 ± 9.74<br>72 (58, 87) | 78.47 ± 11.5<br>77 (54, 94) | 0.0967$^{t}$ | 76.12 ± 8.76<br>72.5 (69, 93) | 64.57 ± 12.92<br>67 (43, 78) | 0.1176$^{MW}$ |
| 7 min | 73.03 ± 9.64<br>72.5 (55, 89) | 75.17 ± 12.14<br>73 (59, 105) | 0.4559$^{t}$ | 74.15 ± 9.75<br>74 (56, 88) | 75.8 ± 11.02<br>76 (48, 90) | 0.6812$^{t}$ | 79.88 ± 8.43<br>76 (72, 98) | 65.71 ± 9.48<br>70 (50, 75) | **0.0037$^{MW}$*** |
| 10 min | 76.6 ± 8.72<br>76 (63, 93) | 73.69 ± 10.88<br>72 (57, 96) | 0.2609$^{t}$ | 78.15 ± 8.42<br>78 (66, 92) | 74.87 ± 10.74<br>77 (45, 92) | 0.3814$^{t}$ | 82.88 ± 8.2<br>85.5 (73, 94) | 63.14 ± 10.01<br>66 (49, 74) | **0.0010$^{t}$*** |
| p-value | **< 0.001$^{F}$*** | **< 0.001$^{F}$*** | - | **< 0.001$^{F}$*** | **0.0042$^{F}$*** | - | **< 0.001$^{F}$*** | **< 0.001$^{F}$*** | - |

For the 40-50 age group, pre-intubation and 1-min, no significant DBP difference was noted among the groups. But, significant DBP differences are observed at 2$^{nd}$minute (p-value = 0.0461) and 3$^{rd}$ minute (p-value = 0.0187), with the Magnesium Sulphate-group having lower DBP compared to the Preservative-free Lignocaine group. Other time points (1, 4, 5, 7, and 10 minutes) show no significant differences. Over time, within each group, DBP changes significantly as indicated by Friedman's test (p-value < 0.001).

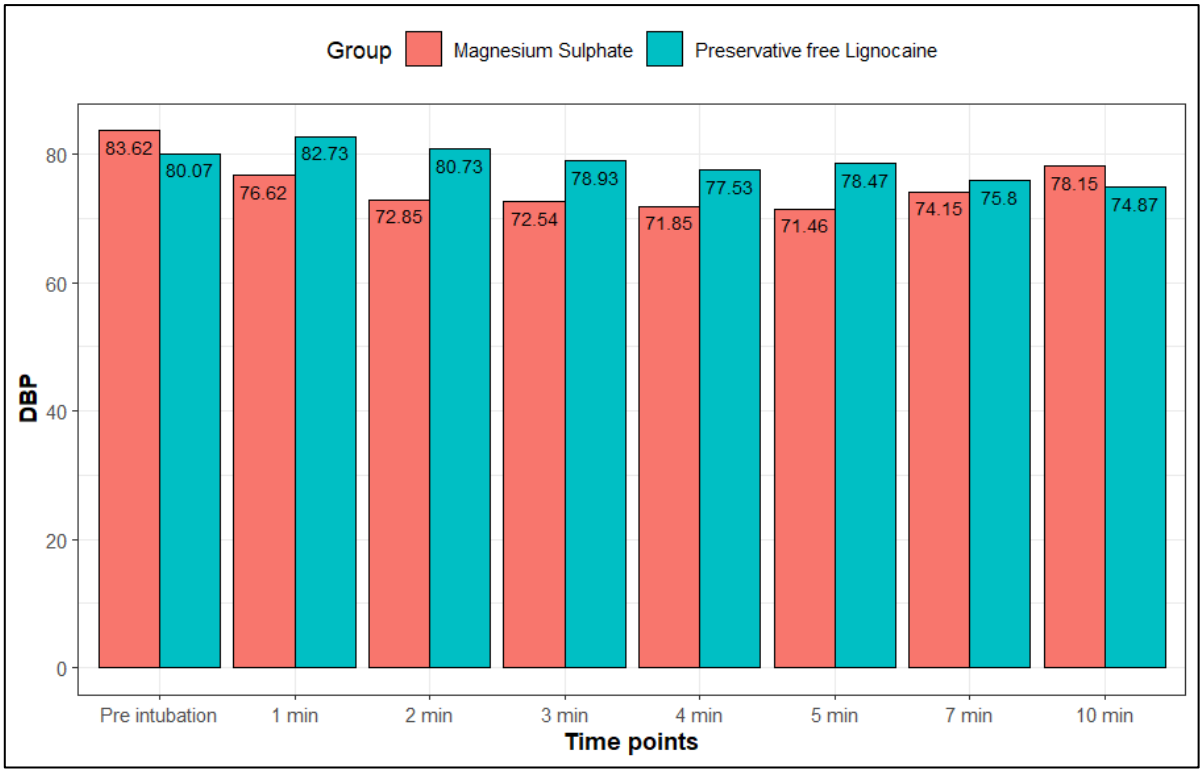
In 51-60 age group, no significant DBP variation was noted between the groups at all time-points. However, the changes over time within each group are significant according to Friedman's test (p-value < 0.001 -Magnesium Sulphate and p-value = 0.0042 for Preservative free Lignocaine).

For 61-70, significant variations were observed at 7$^{th}$minute (p-value = 0.0037) and 10$^{th}$minute (p-value = 0.0010), with the Magnesium Sulphate group showing higher DBP

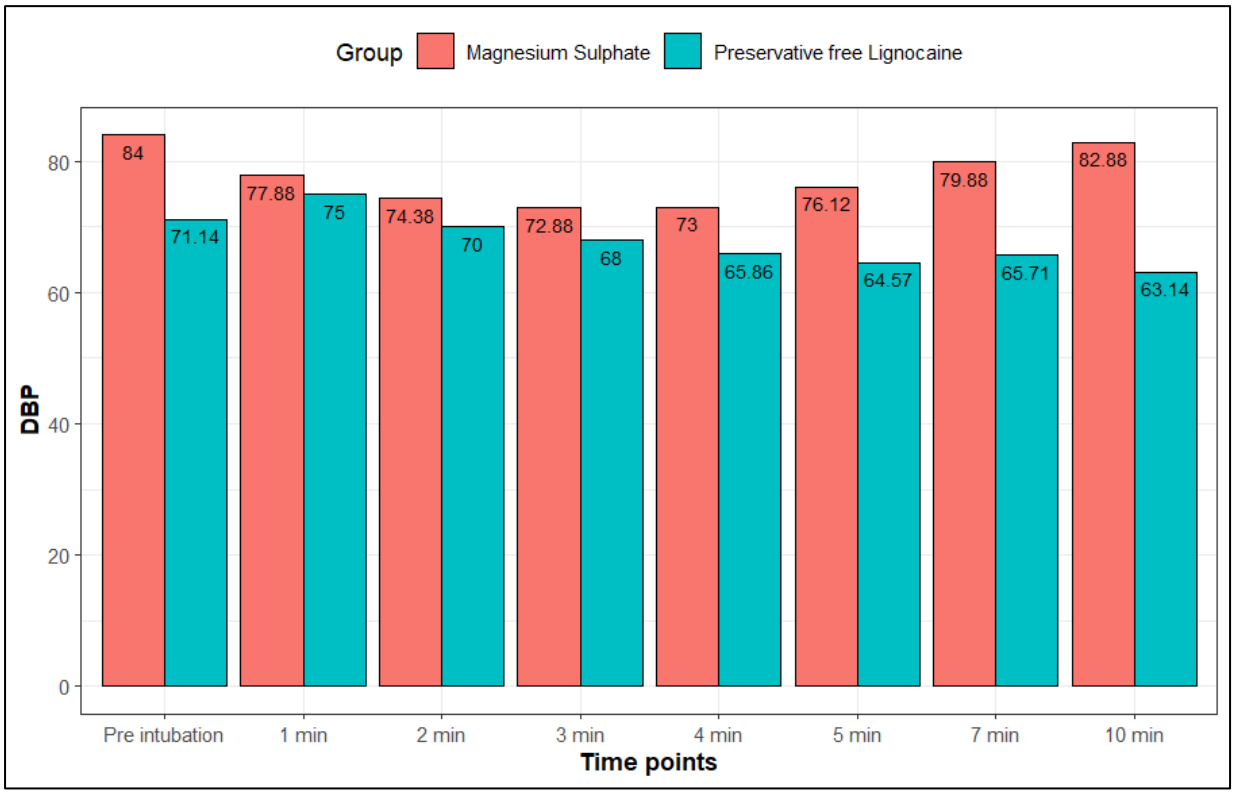
compared to the Preservative-free Lignocaine group. Other time points showed no significant differences. The within-group changes over time are significant, as indicated by Friedman's-test. (p-value < 0.001).




Graph 24: Mean plot of DBP over time and group in age group 40-50 years.




Graph 25: Mean plot of DBP over time and group in age group 51-60 years.




Graph 26: Mean plot of DBP over time and group in age group 61-70 years.

The following table gives the MAP comparison over time and groups.

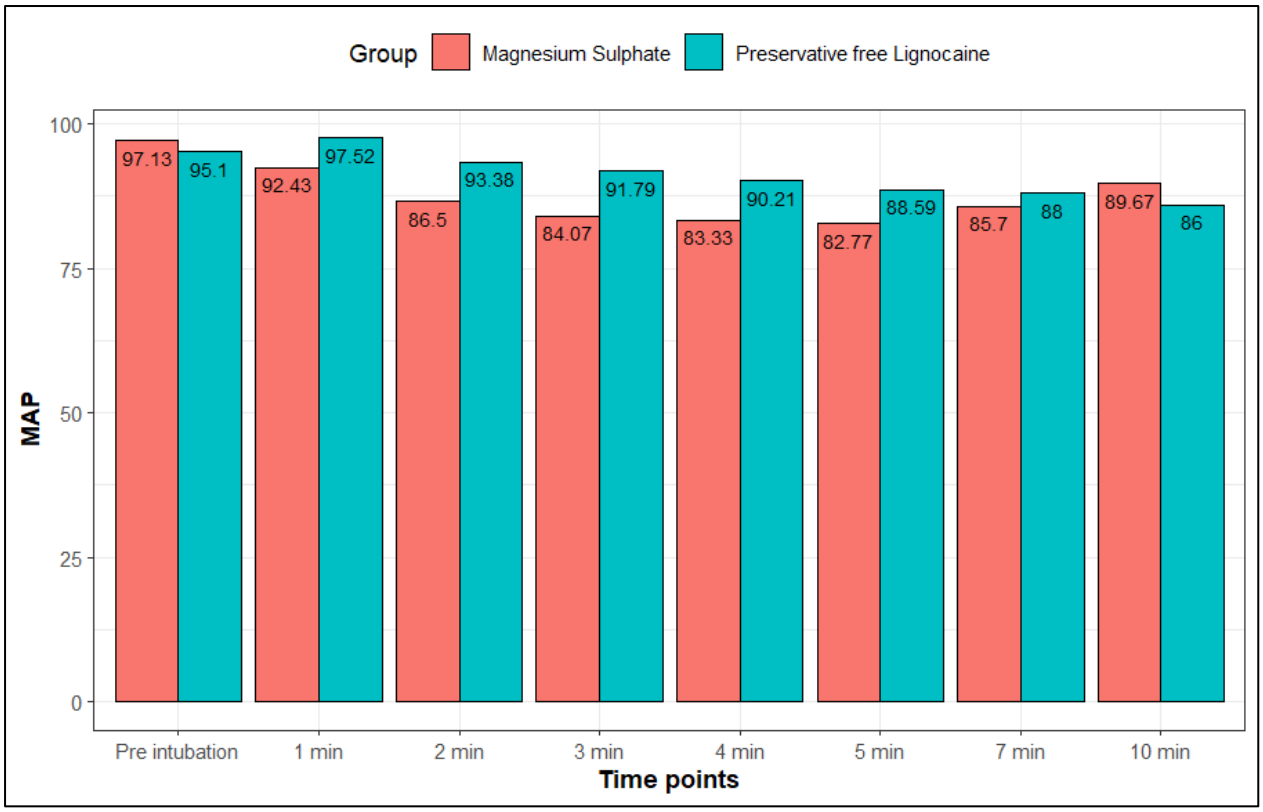
Table 14: MAP comparison over time and groups.

| MAP | 40-50 | | | 51-60 | | | 61-70 | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** | **Magnesium Sulphate** | **Preservative free Lignocaine** | **p-value** |
| Pre-intubation | 97.13 ± 11.18<br>96.5 (79, 119) | 95.1 ± 12.04<br>94 (77, 117) | 0.5850$^{MW}$ | 102.31 ± 9.6<br>100 (90, 117) | 94.8 ± 11.85<br>95 (77, 115) | 0.0799$^{t}$ | 101.62 ± 11.65<br>104.5 (83, 119) | 87 ± 13.19<br>93 (66, 102) | **0.0399$^{t}$*** |
| 1 min | 92.43 ± 13.46<br>92 (65, 118) | 97.52 ± 13.96<br>96 (75, 125) | 0.1598$^{t}$ | 92.77 ± 12.34<br>87 (79, 116) | 97.73 ± 18.07<br>101 (56, 121) | 0.4114$^{t}$ | 94.25 ± 13.45<br>95 (72, 111) | 91.71 ± 19.52<br>100 (63, 108) | 0.8166$^{MW}$ |
| 2 min | 86.5 ± 12.58<br>87 (64, 119) | 93.38 ± 14.91<br>93 (70, 130) | 0.0601$^{t}$ | 90.46 ± 15<br>85 (74, 117) | 95.33 ± 17.8<br>99 (64, 120) | 0.4448$^{t}$ | 90 ± 11.41<br>91.5 (73, 105) | 83.43 ± 18.05<br>83 (59, 104) | 0.4081$^{t}$ |
| 3 min | 84.07 ± 13.34<br>83 (64, 114) | 91.79 ± 12.02<br>90 (77, 116) | **0.0238$^{MW}$*** | 88.62 ± 14.9<br>79 (73, 118) | 92.33 ± 17.53<br>91 (66, 117) | 0.4468$^{MW}$ | 87.88 ± 11.12<br>86.5 (72, 106) | 81.14 ± 18.74<br>83 (54, 100) | 0.4052$^{t}$ |
| 4 min | 83.33 ± 12.71<br>80 (62, 107) | 90.21 ± 14.34<br>88 (64, 123) | 0.0561$^{t}$ | 87.31 ± 12.3<br>85 (74, 109) | 90.67 ± 17.34<br>93 (56, 114) | 0.5653$^{t}$ | 87.62 ± 11.76<br>84.5 (75, 107) | 79.29 ± 18.52<br>80 (54, 100) | 0.3101$^{t}$ |
| 5 min | 82.77 ± 11.48<br>82.5 (61, 102) | 88.59 ± 12.23<br>88 (67, 109) | 0.0645$^{t}$ | 86.69 ± 12.02<br>88 (70, 106) | 91.2 ± 14.81<br>90 (60, 109) | 0.3897$^{t}$ | 90.88 ± 8.74<br>89 (81, 108) | 78.86 ± 17.02<br>81 (53, 96) | 0.1026$^{t}$ |
| 7 min | 85.7 ± 10.49<br>86.5 (68, 105) | 88 ± 13.02<br>87 (68, 119) | 0.4572$^{t}$ | 89.77 ± 10.98<br>89 (68, 106) | 88.27 ± 13.76<br>87 (54, 105) | 0.7546$^{t}$ | 95 ± 9.12<br>94.5 (83, 114) | 79.14 ± 14.38<br>83 (57, 95) | **0.0225$^{t}$*** |
| 10 min | 89.67 ± 8.73<br>90 (75, 106) | 86 ± 12.15<br>83 (65, 109) | 0.1873$^{t}$ | 93.54 ± 8.64<br>91 (82, 108) | 87.67 ± 12.84<br>89 (51, 106) | 0.1746$^{t}$ | 98.25 ± 8.7<br>101.5 (86, 110) | 76.71 ± 14.24<br>80 (56, 92) | **0.0033$^{t}$*** |
| p-value | **< 0.001$^{F}$*** | **< 0.001$^{F}$*** | - | **< 0.001$^{F}$*** | **< 0.001$^{F}$*** | - | **< 0.001$^{F}$*** | **< 0.001$^{F}$*** | - |

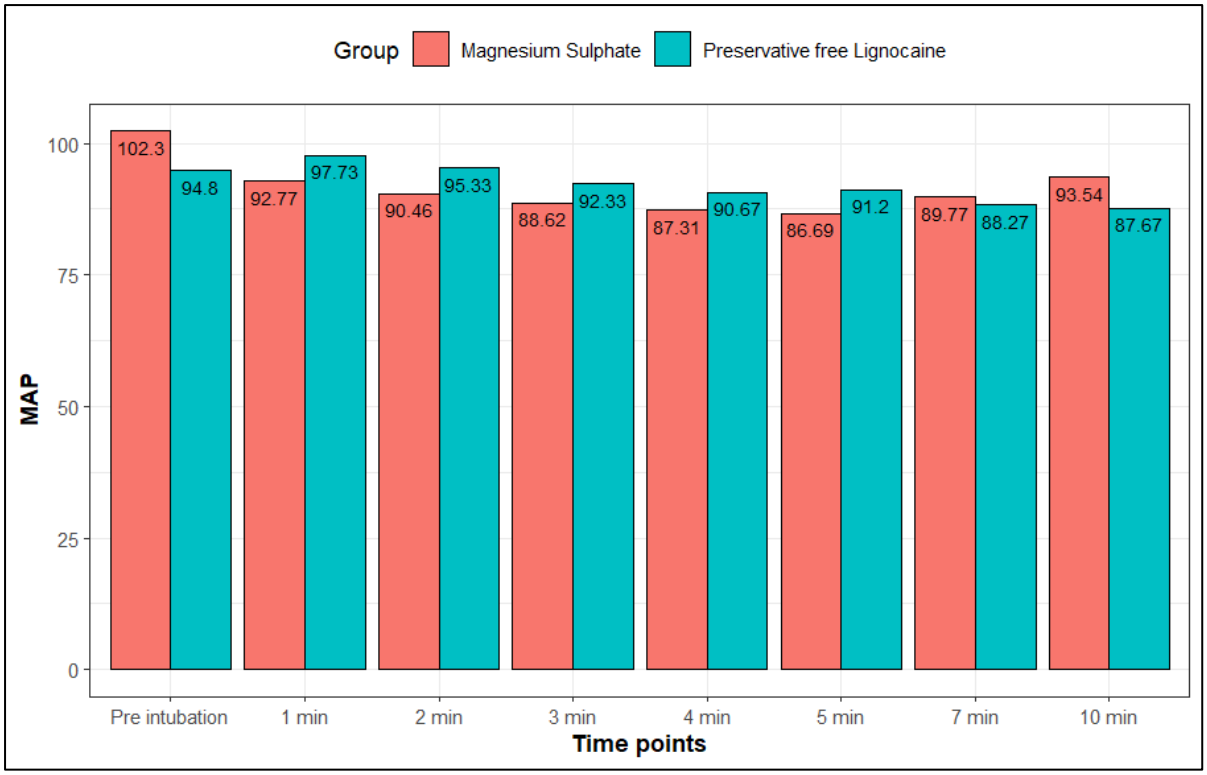
For the 40-50 age group, a significant MAP difference was noted among the groups at 3$^{rd}$min (p-value = 0.0238) with lesser MAP in the Magnesium Sulphate-group. Other time points did not show significant differences. However, from Friedman test, it is observed that changes over time within each group are significant (p-value < 0.001).

In 51-60 age group, no significant MAP difference was noted among the two groups at all time-points. Nonetheless, within-group changes over time are significant as indicated by Friedman test (p-value < 0.001).

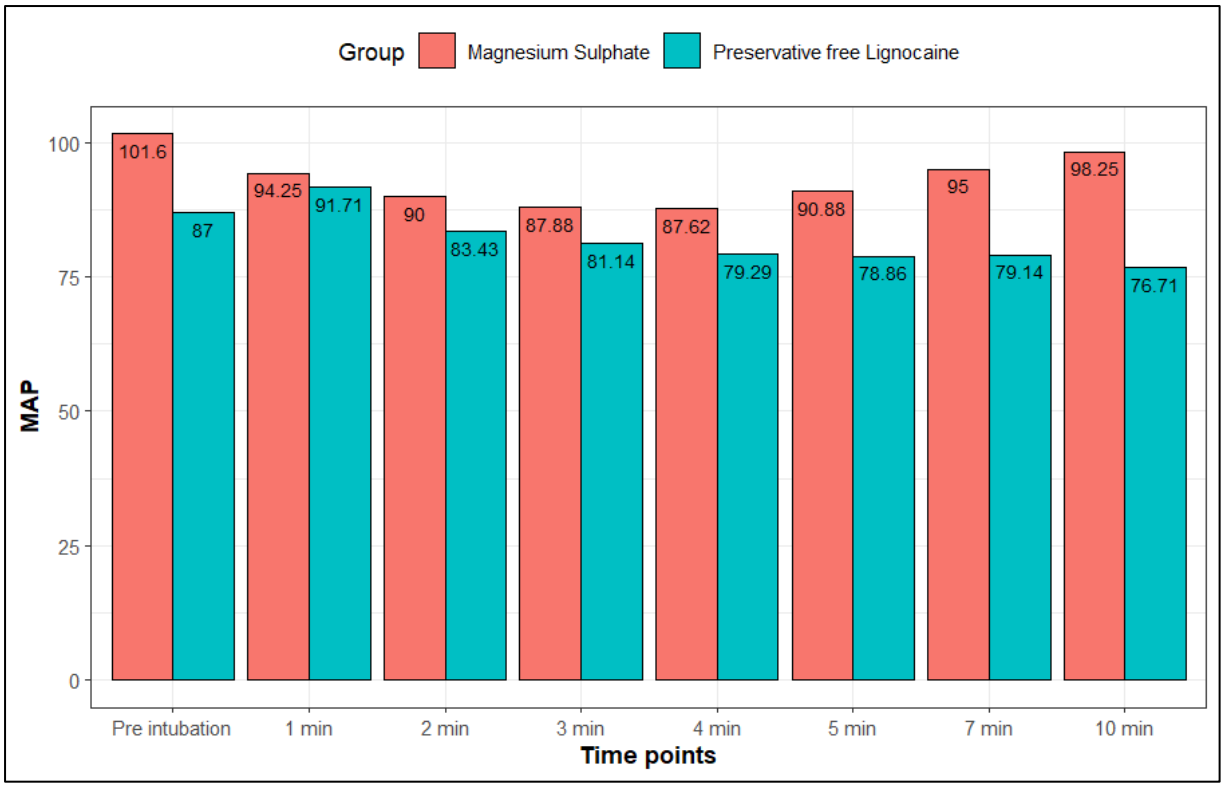
For 61-70, the pre-intubation MAP indicates a significant difference (p-value = 0.0399), with higher MAP in the Magnesium Sulphate group. Significant differences are observed at 7-minutes (p-value = 0.0225) and 10-minutes (p-value = 0.0033), with higher MAP in the Magnesium Sulphate group. Other time-points (1-, 2-, 3-, 4-, and 5-minutes) did not show significant differences. The changes over time within each group are significant as indicated by Friedman test (p-value < 0.001).




Graph 27: Mean plot of MAP over time and group in age group 40-50 years.




Graph 28: Mean plot of MAP over time and group in age group 51-60 years.




Graph 29: Mean plot of MAP over time and group in age group 61-70 years.

# DISCUSSION

The purpose of our research was to evaluate the effectiveness of two drugs: magnesium sulphate and preservative-free-lignocaine, that could potentially reduce the cardio-vascular sympathetic-reflex due to laryngoscopy & endotracheal intubation, in patients scheduled for surgical procedures with general anesthesia.

After making sure the criteria for exclusion and inclusion were met, 102 ASA grade-1 and grade-2 patients were chosen for the study. They were randomly allocated into two groups of 51 each. Magnesium sulphate at a dosage of 30 mg /kg slow IV was given to Group-M subjects and Group-L subjects were administered 1.5 mg /kg IV of preservative-free lignocaine, both 3-minutes prior to laryngoscopy & intubation. Hemodynamic parameters –systolic, diastolic and mean pressures and heart rate readings were noted before intubation and at 1-min, 2-min, 3-min, 4-min, 5-min, 7-minand 10-minutes after laryngoscopy & intubation.

This study aimed to determine whether magnesium sulphate, which is not commonly used by anesthesiologists, is more efficacious than preservative-free-lignocaine, the most widely used medication, for preventing the cardio-vascular sympathetic-response to laryngoscopy & intubation. Additionally, it sought to determine whether magnesium sulphate could be safely given to all patients on a regular basis prior to laryngoscopy & intubation.

Magnesium sulphate inhibits the catecholamine-release from the adrenergic-nerve endings & adrenal-medulla. This is believed to prevent the cardio-vascular sympathetic-reflex to laryngoscopy & intubation. Additionally, it uncouples excitation and contraction, directly suppressing myometrial action potentials, and thereby producing a negative impact on chronotropic & inotropic effects on heart. The antagonizing action on NMDA receptors is responsible for its analgesic effects.

DEMOGRAPHIC DISTRIBUTION:

Comparing the mean-ages of patients in magnesium sulphate and preservative-free-lignocaine groups, no notable variation in the age-distribution was noted over groups according to MW-U test. (p-value = 0.6386)

In both the magnesium sulphate-group and preservative-free-lignocaine-group, no remarkable variation in the gender-distribution was noted over groups as per Chi-square test. (p-value = 0.6874)

Considering the mean-weights of patients in magnesium sulphate and lignocaine groups, no notable variation in weight-distribution was noted among the two groups from two-sample-t-test (p-value = 0.5018)

In both the magnesium sulphate and the preservative-free-lignocaine groups, no notable difference in ASA grade-distribution was noted among the two groups from Chi-square test. (p-value = 0.4210)

GENERAL GROUP VARIATION:

COMPARISON OF VARIATION IN HEART-RATE AMONG THE TWO GROUPS:

When the heart-rate in the groups were compared, the heart-rate distribution did not vary significantly among the groups. However, there were notable changes in heart-rate over time with-in both groups (p-value <0.001) with better control noted within preservative-free lignocaine group.

Similar results were observed in the investigation carried out by Abebaw Misganaw et al. [1] Here, 112 patients were divided into three groups for the study: 37 patients received

lignocaine, 38 received magnesium sulphate, and 37 had no exposure. The heart-rate of the lignocaine and magnesium sulphate groups did not differ statistically substantially, whereas the non-exposed group's heart-rate was noticeably higher.

In contrast, a research by Archana Vaghela et al. [15] involved 42 patients, 21 of whom were placed in the lignocaine-group (1.5 mg/kg) and 21 in the magnesium sulphate-group (50 mg/kg). According to their research, the lignocaine-group experienced a markedly elevated heart-rate that did not return to baseline 5-minutes after intubation. However, postintubation, the magnesium sulphate-group experienced a spike in heart-rate that lasted for one minute before falling off after five minutes and ten minutes. They concluded that magnesium sulphate controlled heart-rate more effectively than lignocaine during laryngoscopy & intubation.

COMPARISON OF VARIATION IN SYSTOLIC-BLOOD PRESSURE AMONG THE TWO GROUPS:

Prior to intubation, there was a significant variation in the mean of the systolic-pressure (p-value = 0.0309) between the groups, with the magnesium sulphate-group having a higher SBP. Nonetheless, it is regarded as clinically unimportant given that no intervening drug was administered prior to intubation. There were no discernible variations in the groups' systolic-pressure distribution at the ensuing time points. At 10-minutes after intubation, there was a notable variation in the groups' distribution of systolic-pressure, with the magnesium sulphate-group having greater systolic-pressure than the lignocaine-group. (p-value = 0.0004). However, the within group variation was better controlled with magnesium sulphate.

In contrast, at the pre-intubation, 2- and 5-minutes after intubation, the magnesium sulphate-group's systolic-pressure was significantly lower than that of the lignocaine-group,

according to a study by Abebaw Misganaw et al. [1] Additionally, at the immediate, 2-, 5- and 7-minutes after intubation, the magnesium sulphate-group showed a statistically significant reduced systolic-pressure compared to the non-exposed group.

COMPARISON OF VARIATION IN DIASTOLIC-BLOOD PRESSURE AMONG THE TWO GROUPS:

The diastolic-blood pressure differences between the groups at pre-intubation were found to be significant, with the magnesium sulphate-group having a higher diastolic-blood pressure. However, since no intervention drug was administered, these differences are deemed clinically unimportant. Additionally, at 2- , 3- and 10-minutes, the results showed a significant difference in the diastolic-blood pressure between the two groups, with the lignocaine-group having a greater diastolic-blood pressure than the magnesium sulphate-group at those time points. (p-values less than 0.05). There were no notable differences at the other time points, though.

Similar results were found in the study of Abebaw Misganaw et al. [1] who found that the diastolic-pressure of the magnesium sulphate-group was lower than the lignocaine-group in the 1- and 2-minutes after intubation.

Similar results were observed in a trial conducted by Shweta Bulle et al. [3] wherein at 1- and 3-minutes after intubation, the diastolic-pressure of the lignocaine-group was considerably higher than that of the magnesium sulphate-group.

COMPARISON OF VARIATION IN MEAN-ARTERIAL PRESSURE AMONG THE TWO GROUPS:

The mean-arterial pressure difference among the magnesium sulphate-group and the lignocaine-group at pre-intubation was statistically significant but clinically unimportant because no intervention medication was administered. (p-value = 0.0242). Nevertheless, there were no appreciable variations in the groups' MAP distribution at the next time periods. At 10 minutes, there was a noteworthy difference in the distribution of MAP across the groups, with the lignocaine-group exhibiting a higher MAP. (p-value = 0.0027).

Similar results were obtained in the study by Abebaw Misganaw et al. **(1)** who found that the group receiving magnesium sulphate had considerably lower MAP than the lignocaine-group at the instant, 2-, and 5-minute post-intubation.

Similar observations were also made in the study by Sachin Padmawar et al. **(13)** which showed that at 1-,3- and 5-minutes after intubation, the MAP in the lignocaine-group was significantly higher than in the magnesium sulphate-group. The MAP increased in both groups, but in the magnesium sulphate-group it reverted to pre-intubation levels 3-minutes after intubation, while the lignocaine group did not.

GENDER VARIATION:

In females, no significant variation was noted in heart-rate among the two groups at all time-points. But in males, a significant difference was observed pre-intubation (p-value=0.0303), with the magnesium sulphate-group having a higher heart-rate. But this is to be considered clinically insignificant considering that no intervention drug was given pre-intubation. No significant differences were seen at subsequent time points.

In females, no significant variation was noted in systolic-blood-pressure among the groups at any time-points. But, in males, a significant variation was noted in SBP between the groups at 10-min, with the magnesium sulphate-group having a higher systolic-blood pressure compared to the lignocaine-group (p-value=0.0004).

In females, significant variation was observed in diastolic-pressure at 2- and 3-minutes post-intubation, with the lignocaine-group having higher diastolic-pressure (p-value = 0.0175, p-value = 0.0361 respectively). At other time-points, no significant DBP differences were noted. In males, a significant diastolic-blood pressure variation was noted between the groups at 10-minutes with the magnesium sulphate-group having higher diastolic-blood pressure compared to the lignocaine-group (p-value = 0.0268).

In females, no significant mean-arterial pressure variation was noted among the two groups at all time-points. But in males, a significant MAP difference was noted among the groups at 10-minutes with the magnesium sulphate-group having higher mean-arterial pressure than the lignocaine-group (p-value = 0.0047).

No other studies were found that reported results based on gender variation between the two drug groups that could support or contradict our study.

AGE GROUP VARIATION:

No significant heart-rate variation was noted among the two groups at all time-points in the 40-50 group, 51-60 group and the 61-70 group.

In the 40-50 age group, a significant systolic-pressure variation was noted among the groups with magnesium sulphate showing a significantly higher systolic-pressure at 10-minutes (p-value = 0.0391). In the 51-60 age group, pre-intubation systolic-pressure showed a significant

difference, with magnesium sulphate having higher systolic-pressure. But considering the fact that no intervening drug was given at this time point, this is considered to be clinically insignificant. (p-value = 0.0443). In the61-70 years group, a significant SBP difference was noted between the groups at 10-minutes, with magnesium sulphate-group showing higher systolic-blood pressure compared to lignocaine-group (p-value = 0.0102).

In the 40-50 age group, significant variations were observed in diastolic-blood pressure at 2-minutes (p-value = 0.0461) and 3-minutes (p-value = 0.0187), with the magnesium sulphate-group having lesser diastolic-blood pressure than the lignocaine-group. Other time points showed no significant differences. In the 51-60 age group, no significant DBP difference was noted among the two groups at all time-points. But in the 61-70 years group, significant DBP differences were observed at 7-minutes (p-value = 0.0037) and 10-minutes (p-value = 0.0010), with the magnesium sulphate-group showing higher diastolic-pressure compared to the lignocaine-group. Other time points showedno significant variations.

In the 40-50 age group, a significant variation was noted in mean-pressure among the groups at 3-minutes (p-value = 0.0238) with lesser mean-arterial pressure in the magnesium sulphate-group. Other time points did not show any significant differences. In the 51-60 age group, no significant MAP difference was noted among the groups at all time-points. In61-70 years, the pre-intubation mean-arterial pressure indicated a significant variation (p-value = 0.0399), with higher mean-pressure in the magnesium sulphate-group, but this is considered clinically insignificant since no intervention drug was given. There were significant differences at 7-min (p-value = 0.0225) and 10-min (p-value = 0.0033), with higher mean-arterial pressure in the magnesium sulphate-group.

No other studies were found that reported results based on age group variation between the two drug groups that could support or contradict our study.

Laryngoscopy& intubation are stimuli that are noxious and are always accompanied with increased autonomic response and manifest most commonly as tachycardia and hypertension. The association between elevated plasma catecholamines and sympathetic responses to endo-tracheal intubation has been demonstrated by Derby Shire and Smith in 1984. [(41)] This is a transient response, occurring 30-seconds after laryngoscopy and intubation and lasts for less than 10 minutes. [(41)] The reflex to laryngoscopy &intubation is due to autonomic nervous system. Sympathetic reflex due to intubation leads to tachycardia and hypertension as a result of increased discharge from cardio-acceleratory fibers and catecholamine-release. [(42)] Laryngoscopy along with intubation is associated with profound increase in heart rate than laryngoscopy alone. Parasympathetic response is rare and is more commonly seen children but also can occur in adults which may lead to bradycardia and sometimes even asystole. [(41,43)]

Laryngoscopy & intubation cause an average elevation in blood-pressures up to 40% - 50% and a rise in heart-rate up to 20%. [(44)] As discussed before, these haemodynamic changes are of minimal concern in patients without any other associated comorbidities, but can be detrimental in patients with coronary vessel disease, hypertension, valvular pathologies of heart, preeclampsia and in patients with intra-cranial hypertension. [(45)] Patients with hypertension have augmented cardiovascular reflex to laryngoscopy and intubation. [(46)]

Lignocaine and magnesium sulphate are considered to be efficacious pharmacological agents and they have shown to reduce the hemodynamic reflex to laryngoscopy & intubation. Lignocaine is one of the most frequently used drugs by the anesthesiologists in day-to-day procedures. Lignocaine acts by antagonizing at the NMDA receptors and at sodium channels and thereby prevents the release of substance-P and this inhibits the reactivity of airways to laryngoscopic procedures. Magnesium sulphate inhibits the adrenal gland by inhibiting catecholamine release. [(47)] It also has antiarrhythmic and cardio-protective effect. It produces

systemic vasodilation since it is an antagonist at calcium channels in vascular smooth-muscle and thus reduces systemic vascular resistance [48] and provides hypotensive anesthesia.

Overall, in our study, considering immediate post-intubation response within the first five minutes, no significant variations in heart-rate, systolic-pressure and mean-pressure were noted among the two groups, but there was only a notably higher diastolic-pressure at 2nd, 3rd in the lignocaine-group than the magnesium sulphate-group.

Comparing the gender variation among the two groups, no significant variations were noted in heart-rate, systolic and mean pressures in females, but only a notably higher diastolic-pressure at 2- and 3-minutes postintubation in the lignocaine-group than the magnesium sulphate-group. In males we observed that no significant variation in heart-rate existed among the two groups, but only a notably higher systolic, diastolic and mean pressures at 10th minute in the lignocaine-group than the magnesium sulphate-group.

Comparing the age group variation, no variation in heart-rate existed between any of the age-groups. The systolic-pressure was higher only at 10-minutes in 61-70 age group that received magnesium sulphate. The diastolic-pressure was lower at 2nd and 3rd min in the 40-50 age group and higher at 7th and 10th minute in the 61-70 age group that received magnesium sulphate. The mean-pressure was lower at the 3rd min post intubation in the 40-50 age group and higher at 7th and 10th minute in 61-70 group that received magnesium sulphate.

In conclusion, we found that Magnesium sulphate was better than lignocaine in controlling diastolic pressure at 2- and 3-minutes post-intubation. But there were no notable differences in heart rate, systolic pressure and mean pressure between the two groups within the first five minute post-intubation period where maximum complications are expected to occur.

# LIMITATIONS

Our study consisted of only over a hundred participants and we recommend that this study be done on a larger population that would provide further in-depth analysis between the two drugs. We could also not evaluate the effects of the study drugs in ASA grades 3 and 4 patients in who it would have been more helpful.

# STRENGTHS

We have tried to keep both the study groups uniform by inducing with the same induction agents and following similar methods of airway management in all the patients. We also have tried to assess the variations based on gender and age-groups and we could not find any other studies that analysed results based on gender and age groups.

# SUMMARY

The present study entitled "COMPARISON OF INTRAVENOUS MAGNESIUM SULPHATE AND INTRAVENOUS LIGNOCAINE FOR ATTENUATION OF CARDIOVASCULAR RESPONSE TO LARYNGOSCOPY AND INTUBATION IN PATIENTS UNDERGOING ELECTIVE SURGERIES UNDER GENERAL ANESTHESIA – A ONE YEAR HOSPITAL BASED RANDOMISED CLINICAL TRIAL" was conducted at KLE Dr Prabhakar Kore Hospital at Belagavi-590010

Following the institutional ethical committee's clearance, 102 subjects, who satisfied the inclusion and exclusion criteria, that were scheduled for surgical procedures under general anesthesia were included in our study.

Group-M: Subjects were administered 50% Magnesium Sulphate 30 milligrams/kilogram body weight slow IV 3-minutes prior to intubation.

Group-L: Subjects were administered 2% preservative-free-Lignocaine 1.5 milligrams/kilogram body weight IV 3-minutes prior to intubation.

Patients were induced under general anesthesia and hemodynamic parameters – systolic, diastolic & mean pressures and heart rate were noted at various time points: prior to intubation, each minute up to 5th minute, at 7th minute and at 10th minute post-intubation.

Considering immediate post-intubation response within the first five minutes, we observed that there were no significant variations in heart rate, systolic-pressure and mean-pressure were noted among the two groups, but there was only a notably higher diastolic-pressure at 2nd, 3rd in the lignocaine-group than the magnesium sulphate-group.

In females, higher diastolic-pressure at 2- and 3-minutes post-intubation was observed in the lignocaine-group than the magnesium sulphate-group. In males there was no significant variations up to 5-minutes post-intubation between the two groups.

In the 40-50 group, the diastolic-pressure was lower at 2nd and 3rd minutes and mean-pressure was lower at the 3rd minute post intubation in the magnesium sulphate group.

# CONCLUSION

Both preservative free lignocaine and magnesium sulphate are equally efficacious in attenuation of the cardio-vascular sympathetic response to direct laryngoscopy & intubation with respect to heart rate, systolic and mean pressures without causing any remarkable adverse effects, when given at the doses mentioned in the study.

Magnesium sulphate was better in attenuation of diastolic pressure at second and third minutes immediate post-intubation and tachycardia response was better attenuated by preservative free lignocaine.

Both drugs can be safely used in all the patients in routine anesthesia practice.

# BIBLIOGRAPHY

1. Misganaw A, Sitote M, Jemal S, Melese E, Hune M, Seyoum F, Sema A, Bimrew D. Comparison of intravenous magnesium sulphate and lidocaine for attenuation of cardiovascular response to laryngoscopy and endotracheal intubation in elective surgical patients at Zewditu Memorial Hospital Addis Ababa, Ethiopia. PloS one. 2021 Jun 1;16(6):e0252465.

2. Jakushenko N, Kopeika U, Nagobade D, Mihelsons M. Laryngoscopy and endotracheal intubation induced changes in human salivary alpha amylase activity-Associations with adrenergic activity: 19AP10–3. European Journal of Anaesthesiology| EJA. 2010 Jun 12;27(47):271.

3. Bulle S, Bande BD. Comparative study of intravenous lignocaine and intravenous magnesium sulphate in attenuating stress response to laryngoscopy and intubation. International Journal of Research and Review. 2017;4(2):47-55.

4. Rose DK, Cohen MM. The airway: problems and predictions in 18,500 patients. Canadian Journal of Anaesthesia. 1994 May;41:372-83.5.

5. Jay Prakash, Shailesh Kumar, GirishkumarSodar et al. Attenuation of Cardiovascular Responses to Laryngoscopy and Intubation: A Comparative Study between i.v. Esmolol Hydrochloride and Fentanyl Citrate. Indian J AnesthAnalg. 2019;6(3):713-720.

6. Madhu Kumar B S, Prameela V S, Sunil Chhabria, Brijesh K, Srikanta Murthy TN. A randomized double blind comparative study of intravenous magnesium sulphate and intravenous lignocaine for attenuation of haemodynamic response to laryngoscopy and tracheal intubation. MedPulse International Journal of Anesthesiology. February 2021; 17(2): 83-89.

7. Dahlgren N, Messeter K. Treatment of stress response to laryngoscopy and intubation with fentanyl. Anaesthesia. 1981;36:1022–6.

8. 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 Sep;9(9):UC06-9.

9. Sameenakousar, Mahesh, Srinivasan KV. Comparison of fentanyl and clonidine for attenuation of the haemodynamic response to laryngocopy and endotracheal intubation. J Clin Diagn Res. 2013 Jan;7(1):106-11.

10. Singh SP, Quadir A, Malhotra P. Comparison of esmolol and labetalol, in low doses, for attenuation of sympathomimetic response to laryngoscopy and intubation. Saudi J Anaesth. 2010 Sep;4(3):163-8.

11. Sebastian B, Talikoti AT, Krishnamurthy D. Attenuation of haemodynamic responses to laryngoscopy and endotracheal intubation with intravenous dexmedetomidine: A comparison between two doses. Indian J Anaesth. 2017 Jan;61(1):48-54.

12. Becker DE, Reed KL. Essentials of local anesthetic pharmacology. Anesth Prog. 2006 Fall;53(3):98-108;

13. Sachin Padmawar, Manish Patil. A comparative study of 2% lignocaine vs 50% magnesium sulphate for attenuation of stress responses to laryngoscopy and endotracheal intubation. International Journal of Contemporary Medical Research 2016;3(8):2317-2321.

14. Valia Khalid, Muhammad Amin Khuwaja, Aftab Ahmed, Kamal Kumar, Rabia Iqtdar, Syed Aqeel Hussain. Magnesium sulphate versus Lignocaine at induction for hemodynamic response in patients undergoing cardiac surgery. Pak Armed Forces Med J 2021; 71 (Suppl-2): S338

15. Vaghela A p, Modi PN. A COMPARATIVE STUDY OF 2% LIGNOCAINE VS 50% MAGNESIUM SULPHATE FOR ATTENUATION OF STRESS RESPONSE TO LARYNGOSCOPY AND ENDOTRACHEAL INTUBATION. Natl J Med Res [Internet]. 2021 Mar. 31 [cited 2024 Jun. 24];11(01):15-7.

16. Kasar PN, Karhade S. Comparision of intravenous magnesium sulphate and lignocaine in attenuation of pressor response to laryngoscopy and endotracheal intubation. International Journal of Medical Anesthesiology. 2022;5(3):21-26

17. Megha Tajne, Kanchan Sheth. ”Comparison of Intravenous Lignocaine and Magnesium Sulphate for Attenuation of Pressor Response during Tracheal Intubation”. Journal of Evidence based Medicine and Healthcare; Volume 2, Issue 12, March 23, 2015; Page: 1812-1822

18. Mendonça FT, de Queiroz LM, Guimarães CC, Xavier AC. Os efeitos da lidocaína e do sulfato de magnésio na atenuação da resposta hemodinâmica à intubação orotraqueal: estudo unicêntrico, prospectivo, duplamente encoberto e aleatorizado [Effects of lidocaine and magnesium sulfate in attenuating hemodynamic response to tracheal intubation: single-center, prospective, double-blind, randomized study]. Rev Bras Anestesiol. 2017 Jan-Feb;67(1):50-56. Portuguese.

19. 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. PMID: 25191450; PMCID: PMC4153229.

20. Miller RD, Eriksson LI, Fleisher LA, Wiener-Kronish JP, Cohen NH, Young WL. Miller's anesthesia e-book. Elsevier Health Sciences; 2014 Oct 20.

21. Clark CM, Kugler K, Carr MM. Common causes of congenital stridor in infants. JAAPA. 2018 Nov;31(11):36-40. [PubMed]

22. De Rose V, Molloy K, Gohy S, Pilette C, Greene CM. Airway Epithelium Dysfunction in Cystic Fibrosis and COPD. Mediators Inflamm. 2018;2018:1309746.

23. Ball M, Hossain M, Padalia D. Anatomy, Airway. [Updated 2023 Jul 25]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-.

24. Detsky ME, Jivraj N, Adhikari NK, Friedrich JO, Pinto R, Simel DL, Wijeysundera DN, Scales DC. Will This Patient Be Difficult to Intubate?: The Rational Clinical Examination Systematic Review. JAMA. 2019 Feb 05;321(5):493-503.

25. Hicks MA, Tyagi A. Magnesium Sulfate. [Updated 2023 May 1]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-.

26. Lu JF, Nightingale CH. Magnesium sulfate in eclampsia and pre-eclampsia: pharmacokinetic principles. Clin Pharmacokinet. 2000 Apr;38(4):305-14.

27. Hypertension in pregnancy. Report of the American College of Obstetricians and Gynecologists' Task Force on Hypertension in Pregnancy. Obstet Gynecol. 2013 Nov;122(5):1122-1131.

28. Urbano FL. Review of the NAEPP 2007 Expert Panel Report (EPR-3) on Asthma Diagnosis and Treatment Guidelines. J Manag Care Pharm. 2008 Jan-Feb;14(1):41-9.

29. Link MS, Berkow LC, Kudenchuk PJ, Halperin HR, Hess EP, Moitra VK, Neumar RW, O'Neil BJ, Paxton JH, Silvers SM, White RD, Yannopoulos D, Donnino MW. Part 7: Adult Advanced Cardiovascular Life Support: 2015 American Heart Association Guidelines Update

for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2015 Nov 03;132(18 Suppl 2):S444-64.

30. Schwalfenberg GK, Genuis SJ. The Importance of Magnesium in Clinical Healthcare. Scientifica (Cairo). 2017;2017:4179326.

31. Beecham GB, Nessel TA, Goyal A. Lidocaine. [Updated 2022 Dec 11]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-.

32. Calatayud J, González A. History of the development and evolution of local anesthesia since the coca leaf. Anesthesiology. 2003 Jun;98(6):1503-8.

33. Tetzlaff JE. The pharmacology of local anesthetics. Anesthesiol Clin North Am. 2000 Jun;18(2):217-33, v.

34. Ueno T, Tsuchiya H, Mizogami M, Takakura K. Local anesthetic failure associated with inflammation: verification of the acidosis mechanism and the hypothetic participation of inflammatory peroxynitrite. J Inflamm Res. 2008;1:41-8.

35. Foo I, Macfarlane AJR, Srivastava D, Bhaskar A, Barker H, Knaggs R, Eipe N, Smith AF. The use of intravenous lidocaine for postoperative pain and recovery: international consensus statement on efficacy and safety. Anaesthesia. 2021 Feb;76(2):238-250.

36. Zaric D, Christiansen C, Pace NL, Punjasawadwong Y. Transient neurologic symptoms (TNS) following spinal anaesthesia with lidocaine versus other local anaesthetics. Cochrane Database Syst Rev. 2003;(2):CD003006.

37. Becker DE, Reed KL. Local anesthetics: review of pharmacological considerations. Anesth Prog. 2012 Summer;59(2):90-101; quiz 102-3.

38. Yukioka H, Hayashi M, Fujimori M. Lidocaine intoxication during general anesthesia. AnesthAnalg. 1990 Aug;71(2):207-8.

39. Covino BG. Recent advances in local anaesthesia. Can Anaesth Soc J. 1986 May;33(3 Pt 2):S5-8.

40. Sekimoto K, Tobe M, Saito S. Local anesthetic toxicity: acute and chronic management. Acute Med Surg. 2017 Apr;4(2):152-160.

41. Shribman AJ, Smith G, Achola KJ. Cardiovascular and catecholamine responses to laryngoscopy with and without tracheal intubation Br J Anaesth. 1987;59:295–9

42. Chaithanya K, Vaddineni J, Reddy N, et al. A comparative study between I.V. 50 % magnesium sulphate and dexmedetomidine for attenuation of cardiovascular stress response during laryngoscopy and endotracheal, intubation. J of Evolution of Med and Dent Sci 2014;3(32):8741-9.

43. Evans C. Blunting the intubation response: fact for fiction.Discipline of Anaesthetics 2014;2:1-26

44. Bruder N, Ortega D, Granthil C. Conséquences et moyens de prévention des modifications hémodynamiqueslors de la laryngoscopie et de l'intubationendotrachéale [Consequences and prevention methods of hemodynamic changes during laryngoscopy and intratracheal intubation]. Ann Fr AnesthReanim. 1992;11(1):57-71. French.

45. Kovac AL. Controlling the hemodynamic response to laryngoscopy and endotracheal intubation. J Clin Anesth. 1996 Feb;8(1):63-79.

46. Nandal S, Chatrath V, Kaur H, et al. Dose response study of magnesium sulphate for attenuation of haemodynamic response to intubation. J Evolution Med Dent Sci 2021;10(13):956-961,

47. James MF, Beer RE, Esser JD. Intravenous magnesium sulfate inhibits catecholamine release associated with tracheal intubation. AnesthAnalg. 1989 Jun;68(6):772-6.

48. Altura BM, Altura BT. Magnesium and cardiovascular biology: an important link between cardiovascular risk factors and atherogenesis. Cell Mol Biol Res. 1995;41(5):347-59.

# ANNEXURE I: INFORMED CONSENT FORM

**TITLE OF THE STUDY** – **"**COMPARISON OF INTRAVENOUS MAGNESIUM SULPHATE AND INTRAVENOUS LIGNOCAINE FOR ATTENUATION OF CARDIOVASCULAR RESPONSE TO LARYNGOSCOPY AND ENDOTRACHEAL INTUBATION IN PATIENTS UNDERGOING ELECTIVE SURGERIES UNDER GENERAL ANAESTHESIA - A ONE YEAR HOSPITAL BASED DOUBLE BLINDED RANDOMISED CLINICAL TRIAL**"**

Name of Student/Principal Investigator:

Name of Guide/Co Investigators:

**Objective**: To compare intravenous lignocaine with intravenous magnesium sulphate with respect to:

a) Hemodynamic variables - Mean Arterial Pressure, Systolic Blood Pressure, Diastolic Blood Pressure, Heart Rate

b) Incidence of side effects and complications, if any, of the study drugs

**Introduction**: Mr./Mrs._____ we are requesting you to enroll yourself in study titled

"COMPARISON OF INTRAVENOUS MAGNESIUM SULPHATE AND INTRAVENOUS LIGNOCAINE FOR ATTENUATION OF CARDIOVASCULAR RESPONSE TO LARYNGOSCOPY AND ENDOTRACHEAL INTUBATION IN PATIENTS

UNDERGOING ELECTIVE SURGERIES UNDER GENERAL ANAESTHESIA - A ONE YEAR HOSPITAL BASED DOUBLE BLINDED RANDOMISED CLINICAL TRIAL" conducted by **BA0121007**, Post Graduate in M.D. Anesthesiology, Department of Anesthesiology, J.N. Medical College, Belagavi under KAHER, Belagavi.

Respected Sir/Madam, we request you to participate in our study as you are eligible for the proposed study. During the study you will be asked some questions regarding the present complaints that you are having.

Your participation in this research is voluntary. Your decision whether or not to participate in the study will not affect your relationship with J.N.Medical College. If you decide to participate you are free to withdraw at any time.

**Explanation of procedure**: If you agree to enroll in my study, I will ask you the present and past medical history and family history. Then you will be clinically examined in detail. On the day of surgery general anaesthesia will be given by a senior anaesthesiologist with the administration of the study drugs in the intraoperative period and the hemodynamic parameters will be measured.

**Withdrawal from participation in the study:** Participation in this study is voluntary. You will be free to decide whether to participate in this study or continue participation once enrolled. In case you decide to withdraw your participation, you are free to do so. However, please convey the decision to the principal investigator.

**Possible benefits from participating in the study:** You will/will not have nor get any benefits

by participating in this study. The data gathered will help the population at large.

**Possible risks from participating in the study:** There are no risks involved in participating in this study.

**Privacy and confidentiality:** The information collected from you will be coded, to prevent any person from identifying you. Your identity will never be revealed. The data collected from you will be kept confidential and only processed or aggregated data will be used for publication.

**Financial incentives:** You will not receive any payment for participating in this study.

**Authorization for publication of aggregated data:** Results obtained after processing of the aggregated data will be published for scientific purposes and or presented to scientific groups. However, your identity will never be revealed.

Questions: If you have any question or complaints with regard to your right as study participant you may contact Dr Harsha Hegde, Chairperson, Ethical committee of JNMC, 0831-2473777 Extension 4052.

**Legal rights:** By signing this consent form, we are not waving any of your legal rights.

# CONSENT STATEMENT

I am making a voluntary decision to participate in the study "COMPARISON OF INTRAVENOUS MAGNESIUM SULPHATE AND INTRAVENOUS LIGNOCAINE FOR ATTENUATION OF CARDIOVASCULAR RESPONSE TO LARYNGOSCOPY AND ENDOTRACHEAL INTUBATION IN PATIENTS UNDERGOING ELECTIVE SURGERIES UNDER GENERAL ANAESTHESIA - A ONE YEAR HOSPITAL BASED DOUBLE BLINDED RANDOMISED CLINICAL TRIAL". My signature below indicates that I have decided to participate and I have read the information provided above or the information provided above has been read to me in the language that I understand best. I was given the opportunity to ask questions and that they have been answered to my satisfaction.

Name of the participant:

Signature or left thumb impression of the participant:

Name of the witness:

Signature or left thumb impression of the witness:

Name of the investigator:

Signature of the investigator:

# ANNEXURE II: PROFORMA

**Title: "COMPARISON OF INTRAVENOUS MAGNESIUM SULPHATE AND INTRAVENOUS LIGNOCAINE FOR ATTENUATION OF CARDIOVASCULAR RESPONSE TO LARYNGOSCOPY AND ENDOTRACHEAL INTUBATION IN PATIENTS UNDERGOING ELECTIVE SURGERIES UNDER GENERAL ANAESTHESIA - A ONE YEAR HOSPITAL BASED DOUBLE BLINDED RANDOMISED CLINICAL TRIAL".**

Name : I.P No. :

Age : Date of Examination :

Gender : Anesthesiologist :

Address :

**Pre-anesthetic evaluation:**

**Chief complaints:**

**HOPI:**

**Past History:**

- H/o co-morbidities and drug intake:
- H/o previous surgery/(s) where difficult airway was encountered:
- Previous anesthetic experience:

**Family History:**

**General physical examination:**

Height (cm) : Weight (Kg): BMI :

Pallor : Icterus :

Cyanosis : Clubbing:

PR : RR : SpO2 :

**Systemic examination:**

**RS:** **CVS:**

**CNS:** **GIT:**

**Airway Assessment:**

**Teeth:**

**Jaw movements:**

**Local examination:**

**Investigations:**

Hb(gm/dl): TLC: Platelet count:

Serum Creatinine**:** FBS: PT/INR:

Chest x-ray: ECG:

**Preoperative physical status:** ASA Grade I II III

**Diagnosis:**

**Proposed surgery:**

HR (bpm), SBP, DBP and MAP (mm of Hg) variation at pre-intubation and from 1 min of intubation till 10 mins.

**GROUP M:**

| **TIME** | **HR** | **SBP** | **DBP** | **MAP** |
|---|---|---|---|---|
| **BASELINE** | | | | |
| **1MIN** | | | | |
| **2 MINS** | | | | |
| **3MINS** | | | | |
| **4MINS** | | | | |
| **5 MINS** | | | | |
| **7 MINS** | | | | |
| **10MINS** | | | | |

**GROUP L:**

| TIME | HR | SBP | DBP | MAP |
|---|---|---|---|---|
| **BASELINE** | | | | |
| **1MIN** | | | | |
| **2 MINS** | | | | |
| **3MINS** | | | | |
| **4MINS** | | | | |
| **5 MINS** | | | | |
| **7 MINS** | | | | |
| **10MINS** | | | | |

# ANNEXURE III: PHOTOGRAPHS

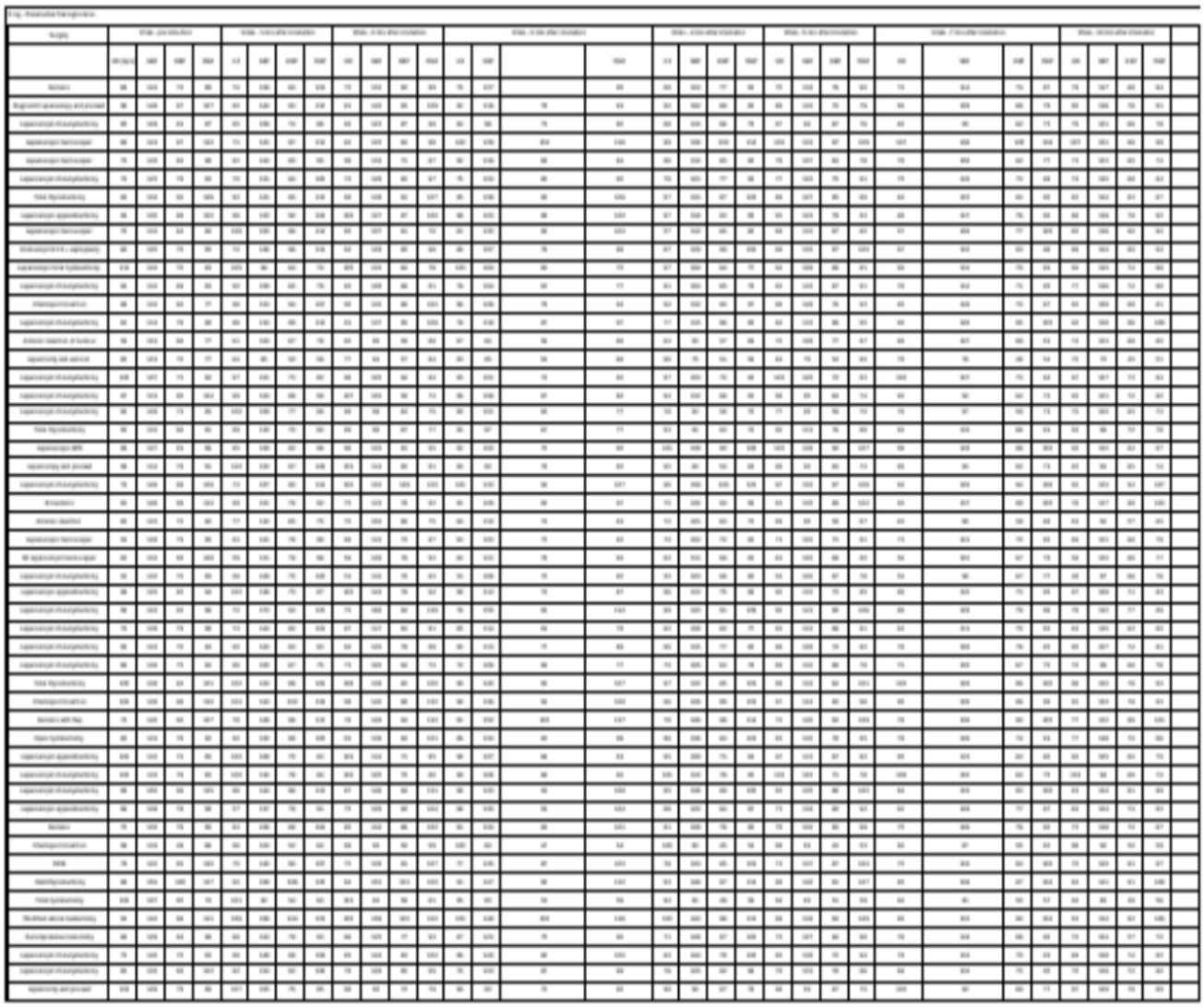
**PHOTOGRAPH-1: PRESERVATIVE-FREE LIGNOCAINE 2%**

**PHOTOGRAPH-2: MAGNESIUM SULPHATE 50%**

# ANNEXURE IV: MASTERCHART

Drug - Magnesium Sulphate

| Sl no. | Age (years) | Gender | Weight (kg) | ASA grade | Diagnosis | Surgery | Vitals - pre induction | | | | Vitals - 1 min after intubation | | | | Vitals - 2 min after intubation | | | | Vitals - 3 min after intubation | | | | Vitals - 4 min after intubation | | | | Vitals - 5 min after intubation | | | | Vitals - 7 min after intubation | | | | Vitals - 10 min after intubation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | HR (bpm) | SBP | DBP | MAP | HR | SBP | DBP | MAP | HR | SBP | DBP | MAP | HR | SBP | DBP | MAP | HR | SBP | DBP | MAP | HR | SBP | DBP | MAP | HR | SBP | DBP | MAP | HR | SBP | DBP | MAP |
| 1 | 42 | Female | 75 | Grade 1 | Carcinoma Endometrium | Total laparoscopic hysterectomy | 84 | 143 | 94 | 110 | 70 | 128 | 90 | 102 | 75 | 112 | 75 | 88 | 66 | 127 | 80 | 103 | 75 | 122 | 77 | 91 | 68 | 107 | 71 | 82 | 65 | 105 | 69 | 81 | 77 | 116 | 78 | 91 |
| 2 | 60 | Female | 55 | Grade 1 | Left parotid adenoma | Excision | 107 | 140 | 82 | 108 | 112 | 132 | 73 | 93 | 113 | 113 | 72 | 88 | 108 | 92 | 70 | 79 | 106 | 96 | 68 | 76 | 104 | 80 | 62 | 79 | 114 | 103 | 77 | 88 | 102 | 108 | 82 | 90 |
| 3 | 41 | Female | 61 | Grade 1 | Cholelithiasis | Laparoscopic cholecystectomy | 84 | 132 | 71 | 91 | 84 | 110 | 72 | 79 | 86 | 99 | 60 | 73 | 88 | 97 | 57 | 66 | 89 | 96 | 51 | 62 | 89 | 94 | 50 | 65 | 88 | 103 | 63 | 76 | 98 | 111 | 74 | 82 |
| 4 | 48 | Female | 68 | Grade 1 | Cholelithiasis | Laparoscopic cholecystectomy | 91 | 141 | 91 | 101 | 97 | 144 | 94 | 108 | 94 | 101 | 101 | 118 | 94 | 115 | 77 | 84 | 93 | 119 | 87 | 94 | 91 | 121 | 84 | 100 | 94 | 107 | 79 | 93 | 92 | 107 | 78 | 79 |
| 5 | 43 | Male | 60 | Grade 1 | Chronic otitis media | Tympanoplasty | 74 | 135 | 72 | 87 | 70 | 108 | 66 | 80 | 69 | 105 | 65 | 77 | 71 | 105 | 59 | 73 | 73 | 96 | 56 | 69 | 69 | 93 | 55 | 68 | 71 | 104 | 61 | 75 | 68 | 110 | 65 | 79 |
| 6 | 62 | Female | 50 | Grade 1 | Solitary thyroid nodule | Hemithyroidectomy | 89 | 130 | 90 | 103 | 83 | 132 | 81 | 95 | 81 | 118 | 77 | 91 | 79 | 113 | 73 | 84 | 79 | 109 | 68 | 81 | 76 | 112 | 69 | 83 | 82 | 118 | 72 | 87 | 83 | 115 | 75 | 88 |
| 7 | 40 | Male | 57 | Grade 1 | Latent Fracture | ORIF | 91 | 136 | 84 | 97 | 105 | 133 | 85 | 97 | 99 | 97 | 67 | 77 | 98 | 92 | 81 | 71 | 97 | 105 | 70 | 81 | 98 | 106 | 71 | 83 | 90 | 119 | 80 | 91 | 90 | 105 | 87 | 93 |
| 8 | 57 | Male | 65 | Grade 2 | Left renal calculi | Left PCNL | 67 | 156 | 91 | 117 | 70 | 143 | 96 | 116 | 76 | 154 | 91 | 117 | 69 | 153 | 96 | 118 | 65 | 145 | 82 | 105 | 69 | 117 | 85 | 106 | 62 | 138 | 86 | 108 | 62 | 141 | 82 | 106 |
| 9 | 41 | Female | 58 | Grade 1 | Left axilla Lymphadenopathy | Excision | 114 | 133 | 81 | 95 | 109 | 133 | 74 | 87 | 101 | 98 | 64 | 75 | 115 | 99 | 62 | 74 | 109 | 93 | 59 | 70 | 101 | 96 | 61 | 73 | 117 | 95 | 58 | 70 | 115 | 103 | 80 | 88 |
| 10 | 42 | Female | 55 | Grade 1 | Cholelithiasis | Laparoscopic cholecystectomy | 131 | 130 | 79 | 96 | 138 | 149 | 87 | 108 | 139 | 138 | 82 | 93 | 130 | 101 | 70 | 81 | 125 | 101 | 69 | 80 | 112 | 101 | 68 | 78 | 106 | 97 | 63 | 74 | 101 | 117 | 71 | 86 |
| 11 | 54 | Male | 49 | Grade 1 | Duodenal ulcer | Gastrojejunostomy | 79 | 139 | 79 | 99 | 79 | 132 | 88 | 81 | 77 | 108 | 69 | 75 | 73 | 108 | 61 | 77 | 77 | 104 | 66 | 76 | 70 | 110 | 69 | 77 | 69 | 114 | 63 | 80 | 71 | 119 | 67 | 84 |
| 12 | 40 | Female | 55 | Grade 1 | Acute cholelithiasis | Laparoscopic cholecystectomy | 108 | 132 | 84 | 93 | 108 | 134 | 90 | 105 | 101 | 115 | 75 | 88 | 95 | 113 | 75 | 88 | 90 | 106 | 76 | 85 | 89 | 105 | 72 | 83 | 86 | 101 | 69 | 80 | 84 | 117 | 81 | 93 |
| 13 | 62 | Female | 55 | Grade 1 | Carcinoma right lobe thyroid | Hemithyroidectomy | 105 | 135 | 93 | 79 | 113 | 157 | 95 | 109 | 112 | 131 | 98 | 74 | 101 | 113 | 47 | 64 | 103 | 97 | 59 | 67 | 103 | 108 | 48 | 62 | 107 | 108 | 56 | 68 | 101 | 107 | 66 | 79 |
| 14 | 42 | Male | 52 | Grade 2 | Carcinoma colon | Hemicolectomy | 81 | 145 | 101 | 112 | 67 | 134 | 76 | 87 | 85 | 123 | 71 | 88 | 85 | 110 | 66 | 79 | 77 | 104 | 59 | 73 | 71 | 101 | 61 | 73 | 72 | 108 | 65 | 84 | 78 | 111 | 69 | 83 |
| 15 | 35 | Male | 72 | Grade 1 | Right clavicle fracture | ORIF with plating | 88 | 130 | 82 | 98 | 85 | 127 | 80 | 96 | 88 | 120 | 76 | 91 | 87 | 117 | 74 | 88 | 85 | 114 | 71 | 85 | 83 | 111 | 73 | 89 | 83 | 110 | 68 | 85 | 80 | 110 | 66 | 82 |
| 16 | 46 | Female | 63 | Grade 2 | Cholelithiasis | Laparoscopic cholecystectomy | 82 | 126 | 73 | 91 | 85 | 110 | 64 | 79 | 86 | 108 | 65 | 79 | 83 | 105 | 62 | 76 | 80 | 104 | 66 | 80 | 81 | 111 | 71 | 84 | 79 | 115 | 69 | 84 | 78 | 119 | 73 | 88 |
| 17 | 41 | Male | 64 | Grade 1 | Incisional hernia | Laparoscopic hernia repair | 92 | 128 | 82 | 91 | 88 | 131 | 74 | 83 | 86 | 103 | 74 | 81 | 86 | 108 | 64 | 72 | 83 | 110 | 71 | 83 | 85 | 110 | 70 | 81 | 82 | 101 | 69 | 78 | 76 | 102 | 69 | 73 |
| 18 | 47 | Male | 65 | Grade 1 | Colocolic intussusception | Exploratory laparotomy | 104 | 139 | 89 | 90 | 104 | 107 | 69 | 79 | 92 | 110 | 75 | 81 | 94 | 136 | 90 | 109 | 94 | 136 | 82 | 102 | 99 | 139 | 88 | 99 | 94 | 128 | 88 | 97 | 95 | 123 | 90 | 97 |
| 19 | 40 | Male | 75 | Grade 1 | Cholelithiasis | Laparoscopic cholecystectomy | 101 | 150 | 100 | 117 | 91 | 130 | 73 | 88 | 92 | 146 | 70 | 83 | 90 | 113 | 67 | 82 | 93 | 109 | 65 | 80 | 91 | 105 | 66 | 79 | 89 | 118 | 72 | 87 | 87 | 107 | 77 | 91 |
| 20 | 52 | Female | 48 | Grade 1 | Obstructive uropathy | Bilateral stenting | 75 | 150 | 83 | 110 | 83 | 130 | 82 | 98 | 89 | 140 | 85 | 113 | 79 | 138 | 81 | 104 | 75 | 134 | 77 | 95 | 70 | 118 | 77 | 92 | 66 | 131 | 78 | 95 | 65 | 116 | 77 | 91 |
| 21 | 45 | Female | 56 | Grade 2 | Left pleomorphic adenoma | Excision | 88 | 140 | 98 | 82 | 85 | 104 | 63 | 77 | 86 | 100 | 59 | 73 | 86 | 97 | 56 | 70 | 83 | 101 | 59 | 73 | 81 | 107 | 62 | 77 | 76 | 105 | 60 | 75 | 77 | 113 | 64 | 80 |
| 22 | 41 | Male | 79 | Grade 2 | Right parathyroid adenoma | Right parathyroidectomy | 88 | 138 | 87 | 97 | 74 | 134 | 75 | 87 | 79 | 134 | 91 | 101 | 79 | 117 | 90 | 109 | 75 | 118 | 95 | 108 | 72 | 110 | 69 | 75 | 69 | 119 | 75 | 88 | 68 | 122 | 81 | 94 |
| 23 | 44 | Male | 66 | Grade 1 | Zygomatico maxillary fracture | ORIF | 85 | 143 | 89 | 107 | 84 | 146 | 92 | 110 | 78 | 154 | 102 | 119 | 75 | 149 | 97 | 114 | 69 | 132 | 85 | 107 | 73 | 129 | 81 | 97 | 71 | 127 | 80 | 105 | 71 | 129 | 81 | 97 |
| 24 | 48 | Female | 52 | Grade 1 | Fibroadenoma left breast | Excision | 87 | 138 | 82 | 94 | 90 | 138 | 81 | 92 | 90 | 117 | 82 | 93 | 88 | 138 | 84 | 95 | 92 | 139 | 86 | 97 | 89 | 138 | 81 | 92 | 87 | 138 | 82 | 94 | 94 | 134 | 83 | 103 |
| 25 | 41 | Female | 56 | Grade 1 | Lumbar disc prolapse | Primary discompression | 73 | 130 | 88 | 102 | 85 | 108 | 81 | 90 | 73 | 103 | 70 | 81 | 74 | 105 | 62 | 73 | 81 | 100 | 58 | 72 | 81 | 99 | 62 | 74 | 86 | 123 | 79 | 93 | 80 | 117 | 68 | 84 |
| 26 | 67 | Female | 60 | Grade 2 | Carcinoma right breast | Modified radical mastectomy | 81 | 149 | 82 | 107 | 71 | 161 | 76 | 97 | 73 | 138 | 70 | 89 | 79 | 147 | 68 | 84 | 65 | 109 | 63 | 77 | 69 | 110 | 69 | 83 | 79 | 134 | 74 | 87 | 68 | 134 | 73 | 86 |
| 27 | 43 | Female | 62 | Grade 2 | Carcinoma left breast | Modified radical mastectomy | 86 | 141 | 88 | 104 | 90 | 139 | 85 | 102 | 91 | 139 | 81 | 97 | 89 | 133 | 83 | 100 | 86 | 131 | 83 | 100 | 86 | 131 | 79 | 96 | 84 | 129 | 74 | 92 | 85 | 126 | 78 | 97 |
| 28 | 41 | Female | 70 | Grade 2 | Fibroadenoma right breast | Excision | 89 | 155 | 101 | 119 | 108 | 151 | 109 | 117 | 95 | 135 | 91 | 99 | 112 | 140 | 89 | 109 | 108 | 136 | 90 | 103 | 108 | 133 | 89 | 101 | 105 | 129 | 93 | 103 | 101 | 127 | 91 | 106 |
| 29 | 60 | Female | 60 | Grade 2 | Cholelithiasis | Laparoscopic cholecystectomy | 75 | 143 | 89 | 107 | 84 | 127 | 80 | 96 | 86 | 112 | 72 | 85 | 79 | 94 | 65 | 74 | 77 | 99 | 62 | 74 | 75 | 94 | 58 | 70 | 72 | 92 | 56 | 68 | 72 | 119 | 90 | 103 |
| 30 | 56 | Female | 48 | Grade 2 | Cholelithiasis | Laparoscopic cholecystectomy | 108 | 150 | 94 | 113 | 104 | 141 | 90 | 107 | 107 | 144 | 89 | 107 | 100 | 146 | 92 | 110 | 98 | 142 | 93 | 109 | 95 | 139 | 87 | 104 | 93 | 136 | 85 | 102 | 96 | 133 | 82 | 99 |
| 31 | 45 | Female | 58 | Grade 1 | Acute appendicitis | Laparoscopic appendicectomy | 82 | 155 | 98 | 79 | 84 | 92 | 65 | 75 | 84 | 90 | 58 | 69 | 85 | 86 | 58 | 68 | 81 | 91 | 55 | 67 | 79 | 95 | 59 | 75 | 76 | 96 | 63 | 74 | 78 | 103 | 65 | 78 |
| 32 | 41 | Male | 48 | Grade 1 | Acute appendicitis | Laparoscopic appendicectomy | 76 | 133 | 78 | 93 | 75 | 137 | 81 | 96 | 77 | 134 | 80 | 93 | 73 | 118 | 75 | 89 | 75 | 113 | 72 | 86 | 76 | 110 | 77 | 91 | 72 | 121 | 76 | 91 | 70 | 121 | 78 | 94 |
| 33 | 57 | Male | 84 | Grade 2 | BH COPD | BH mastoidectomy | 79 | 136 | 86 | 99 | 79 | 134 | 74 | 87 | 75 | 130 | 68 | 83 | 75 | 106 | 66 | 79 | 77 | 106 | 68 | 81 | 72 | 112 | 71 | 85 | 73 | 135 | 73 | 87 | 70 | 118 | 75 | 89 |
| 34 | 47 | Male | 50 | Grade 1 | Right inguinal hernia | Laparoscopic hernia repair | 102 | 132 | 88 | 103 | 104 | 134 | 86 | 99 | 99 | 131 | 83 | 99 | 96 | 118 | 82 | 94 | 94 | 116 | 81 | 93 | 98 | 128 | 89 | 102 | 94 | 128 | 89 | 102 | 98 | 127 | 93 | 104 |
| 35 | 51 | Male | 63 | Grade 1 | Cholelithiasis | Laparoscopic cholecystectomy | 88 | 134 | 79 | 95 | 89 | 138 | 71 | 87 | 85 | 133 | 67 | 82 | 88 | 107 | 63 | 78 | 88 | 104 | 59 | 74 | 84 | 101 | 58 | 72 | 81 | 111 | 63 | 79 | 83 | 115 | 88 | 83 |
| 36 | 43 | Female | 45 | Grade 1 | Cholelithiasis | Laparoscopic cholecystectomy | 99 | 140 | 97 | 111 | 95 | 134 | 109 | 118 | 90 | 138 | 81 | 93 | 86 | 114 | 77 | 89 | 92 | 99 | 71 | 88 | 93 | 106 | 71 | 83 | 92 | 107 | 73 | 84 | 90 | 116 | 81 | 93 |
| 37 | 54 | Female | 68 | Grade 2 | Follicular neoplasm of Thyroid | Hemithyroidectomy | 84 | 149 | 96 | 117 | 99 | 154 | 90 | 111 | 97 | 147 | 98 | 108 | 103 | 140 | 83 | 103 | 100 | 137 | 85 | 103 | 97 | 134 | 81 | 99 | 98 | 142 | 84 | 108 | 93 | 140 | 83 | 106 |
| 38 | 57 | Female | 72 | Grade 2 | Cyst in diverticulum colostomy | Re-exploration and closure of colostomy | 82 | 126 | 72 | 90 | 85 | 132 | 63 | 79 | 81 | 108 | 67 | 74 | 82 | 112 | 62 | 78 | 82 | 117 | 69 | 85 | 80 | 115 | 71 | 86 | 78 | 133 | 72 | 89 | 81 | 130 | 78 | 95 |
| 39 | 75 | Male | 66 | Grade 1 | Soft tissue sarcoma - R axilla | Excision | 73 | 134 | 84 | 102 | 74 | 133 | 76 | 91 | 80 | 135 | 78 | 84 | 79 | 130 | 74 | 84 | 83 | 116 | 69 | 85 | 81 | 123 | 73 | 90 | 74 | 139 | 76 | 94 | 76 | 136 | 80 | 104 |
| 40 | 47 | Male | 75 | Grade 2 | Umbilical hernia | Laparoscopic hernia repair | 79 | 139 | 96 | 107 | 80 | 138 | 80 | 92 | 83 | 111 | 77 | 88 | 81 | 114 | 75 | 88 | 79 | 104 | 65 | 85 | 84 | 112 | 72 | 85 | 79 | 123 | 78 | 92 | 75 | 120 | 78 | 89 |
| 41 | 48 | Male | 75 | Grade 1 | Cholelithiasis | Laparoscopic cholecystectomy | 84 | 140 | 98 | 79 | 82 | 98 | 54 | 65 | 85 | 86 | 63 | 64 | 79 | 86 | 57 | 66 | 82 | 93 | 59 | 70 | 83 | 90 | 63 | 72 | 77 | 96 | 65 | 75 | 80 | 104 | 75 | 82 |
| 42 | 43 | Female | 68 | Grade 1 | Acute cholecystitis | Laparoscopic cholecystectomy | 79 | 134 | 89 | 91 | 75 | 103 | 68 | 79 | 77 | 105 | 65 | 78 | 81 | 101 | 61 | 74 | 78 | 104 | 64 | 78 | 76 | 106 | 68 | 79 | 77 | 118 | 71 | 88 | 75 | 119 | 88 | 89 |
| 43 | 75 | Female | 75 | Grade 1 | Acute calculous cholecystitis | Laparoscopic cholecystectomy | 88 | 148 | 88 | 107 | 93 | 137 | 79 | 98 | 90 | 133 | 76 | 85 | 84 | 126 | 71 | 88 | 88 | 127 | 75 | 92 | 85 | 123 | 73 | 88 | 87 | 134 | 79 | 95 | 85 | 127 | 83 | 101 |
| 44 | 52 | Female | 61 | Grade 1 | Recurrent incisional hernia | Laparoscopic hernia repair | 86 | 135 | 79 | 98 | 90 | 138 | 83 | 91 | 88 | 132 | 80 | 77 | 87 | 107 | 66 | 73 | 85 | 113 | 85 | 81 | 87 | 121 | 73 | 88 | 84 | 128 | 74 | 91 | 83 | 123 | 79 | 93 |
| 45 | 58 | Female | 60 | Grade 2 | Carcinoma right breast | Excision | 84 | 130 | 86 | 101 | 83 | 127 | 68 | 84 | 87 | 114 | 65 | 81 | 88 | 122 | 73 | 89 | 87 | 125 | 77 | 93 | 90 | 118 | 74 | 89 | 86 | 124 | 81 | 95 | 87 | 120 | 84 | 96 |
| 46 | 62 | Male | 68 | Grade 2 | Right inguinal hernia | Laparoscopic hernia repair | 89 | 132 | 94 | 107 | 89 | 134 | 99 | 111 | 95 | 139 | 89 | 102 | 99 | 131 | 95 | 106 | 99 | 127 | 90 | 102 | 91 | 114 | 89 | 99 | 86 | 124 | 84 | 97 | 83 | 130 | 89 | 102 |
| 47 | 74 | Male | 72 | Grade 2 | Acute cholelithiasis | Laparoscopic cholecystectomy | 84 | 134 | 98 | 97 | 88 | 138 | 84 | 81 | 87 | 106 | 83 | 76 | 88 | 114 | 81 | 81 | 85 | 117 | 88 | 84 | 86 | 123 | 71 | 88 | 89 | 126 | 76 | 92 | 87 | 124 | 73 | 90 |
| 48 | 63 | Male | 68 | Grade 1 | Umbilical hernia | Laparoscopic hernia repair | 84 | 134 | 88 | 85 | 88 | 101 | 58 | 73 | 85 | 96 | 81 | 73 | 85 | 93 | 81 | 72 | 87 | 99 | 83 | 75 | 88 | 104 | 69 | 81 | 86 | 108 | 73 | 85 | 79 | 110 | 79 | 89 |
| 49 | 43 | Male | 64 | Grade 1 | Acute appendicitis | Laparoscopic appendicectomy | 96 | 132 | 84 | 103 | 91 | 124 | 81 | 95 | 93 | 117 | 76 | 90 | 95 | 121 | 74 | 90 | 93 | 126 | 78 | 94 | 89 | 126 | 82 | 97 | 91 | 136 | 86 | 103 | 94 | 130 | 85 | 99 |
| 50 | 69 | Female | 67 | Grade 2 | Carcinoma sigmoid colon | Exploratory laparotomy | 79 | 139 | 86 | 101 | 83 | 133 | 79 | 93 | 79 | 117 | 71 | 86 | 81 | 110 | 66 | 81 | 83 | 109 | 65 | 79 | 79 | 114 | 70 | 89 | 77 | 124 | 83 | 97 | 78 | 119 | 89 | 104 |
| 51 | 65 | Female | 57 | Grade 1 | Cholelithiasis | Laparoscopic cholecystectomy | 78 | 136 | 100 | 119 | 82 | 147 | 93 | 111 | 85 | 138 | 89 | 105 | 88 | 133 | 85 | 101 | 82 | 140 | 91 | 107 | 79 | 137 | 93 | 108 | 78 | 145 | 98 | 114 | 76 | 140 | 94 | 110 |



# ANNEXURE V: KEY TO MASTER CHART

HR - HEART RATE

SBP - SYSTOLIC BLOOD PRESSURE

DBP - DIASTOLIC BLOOD PRESSURE

MAP - MEAN ARTERIAL PRESSURE

ASA - AMERICAN SOCIETY OF ANESTHESIOLOGISTS