ALL INDIA INSTITUTE OF MEDICAL SCIENCES JODHPUR

CERTIFICATE

This is to certify that thesis entitled "**A Randomized Controlled Trial on the role of Intraoperative Controlled Hypotension in Maxillofacial Trauma Patients**" is an original work of **Dr. Tanya Batra** carried out under our direct supervision and guidance at the Department of Dentistry, All India Institute of Medical Sciences, Jodhpur

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DECLARATION

I, hereby declare that the work reported in the thesis titled **"A Randomized Controlled Trial on the role of Intraoperative Controlled Hypotension in Maxillofacial Trauma Patients"** embodies the result of original research work carried out by me in the Department of Dentistry, All India Institute of Medical Sciences, Jodhpur. I further state that no part of the thesis has been submitted either in part or in full for any other degree of All India Institute of Medical Sciences or any other Institution/University.

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"A RANDOMIZED CONTROLLED TRIAL ON THE ROLE OF INTRAOPERATIVE CONTROLLED HYPOTENSION IN MAXILLOFACIAL TRAUMA PATIENTS"

THESIS

Submitted to

All India Institute of Medical Sciences, Jodhpur

In partial fulfilment of the requirement for the degree of

MASTER OF DENTAL SURGERY (MDS)

(ORAL AND MAXILLOFACIAL SURGERY)

JULY, 2020

AIIMS, JODHPUR **DR. TANYA BATRA**

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ACKNOWLEDGEMENT

This piece of work would not have been possible without the grace and blessings of almighty God that he has bestowed me to make me what I am today and showered on me which sustained me amazingly during my academic endeavors. I would like to reflect on the contributions of people who have supported and helped me so much throughout this period.

It is difficult to express in words the immense respect and sincere gratitude I owe to my esteemed teacher and guide ***Addl. Prof (Dr.) KIRTI CHAUDHRY DUTT****, unit of Oral and Maxillofacial Surgery, Department of Dentistry, All India Institute of Medical Sciences and Research Centre, Jodhpur has been a source of inspiration throughout post-graduation years. Without her everlasting inspiration, incessant encouragement and valuable suggestions for improvement, the completion of this study would not have been possible. Her meticulous supervision at every step and everlasting zeal for perfection has not only enabled me to complete the dissertation but have also helped me tremendously during the entire course. She has given me a great deal of moral support and built confidence in me. I deeply acknowledge her for her excellent guidance, and cooperation and for all the opportunities I was given to conduct my clinical trial and further my thesis work.*

I would particularly like to acknowledge with gratitude, my co-guide, ***Addl. Prof (Dr.) Ankita Chugh,*** *unit of Oral and Maxillofacial Surgery, Department of Dentistry, All India Institute of Medical Sciences and Research Centre, Jodhpur for her guidance and encouragement for this study, and she has been very kind enough to extend her help at various phases of this research. You definitely enlighten me with various knowledge that I needed to take the right direction and successfully complete my thesis project.*

I am also hugely appreciative of my co-guide Prof. ***(Dr.) Pradeep Kumar Bhatia****., Head of the unit of Anesthesiology and critical care, All India Institute of Medical Sciences and Research Centre, Jodhpur. This thesis would be incomplete without the cooperation of your team.*

It is my proud privilege to express my sincere regards and gratitude to my ***Head of the department, Prof (Dr.) Pravin Kumar*** *of the Department of Dentistry, All India Institute of Medical Sciences and Research Centre, Jodhpur, without his persistent help, this thesis work would not have been possible.*

I am thankful to the ***Director, of AIIMS, Jodhpur*** *for the thesis fund and for permitting me to avail all the facilities available in the institute for conducting this study. My thesis work would be incomplete without mentioning the unflinching support from you sir.*

Words fail me in acknowledging the constant support and encouragement from my parents ***S. Praveen Batra and Smt. Poonam Batra,*** *who has always taken the pain of my part and has been bearing with all my frustrations and making things much easier with their extraordinary tolerance and support and has always been there for me throughout all the rough patches of my life.*

It's my privilege to express my deep gratitude to my seniors ***Dr. Amanjot Kaur, Dr. Arun Kumar Patnana,*** *and for their insurmountable helpful insights on the workings of academic research in general. Their constant support, encouragement, and valuable suggestions meant a lot during the work.*

I am thankful to my seniors ***Dr. Gaurav Jain, Dr. Amanjot Kaur, Dr. Akash Kohli, Dr. Akhilesh Pandey, Dr. Archit Dhawan, Dr. Shailendra Kumar, Dr. Gigi P.G, Dr. Aparna Ganeshan, Dr. Shiv Kumar Chopane*** *for their valuable support and insights into the finer aspects of this project.*

I am obliged to my colleagues ***Dr. Astha Jani, Dr. Harshitha R, Dr. Shradha Somvanshi, Dr. Gayatri Kulkarni, and Dr. Somakshi Pise*** *for helping me in completing the study.*

My special thanks to all non-teaching staff ***Mr. Ramesh, Mr. Bansilal, Mr. Madanlal, Mr. Harpal, Ms. Neetu, Mr. Chandrashekhar, Mr. Nikhil*** *of our unit, and all the nursing staff for kind assistance and cooperation during this study.*

I am very thankful to ***Mr. Nitesh Kumawat,*** *entrostomal therapist, PG diploma in applied statistics for performing statistical analysis. I am grateful for his help during the use of IBM SPSS statistics and giving his valuable time for my thesis.*

I would also like to thank Mr. Nikhil for editing this dissertation which gave the final shape to this publication.

Behind the successful completion of my venture, many un-sung heroes should be recognized for their contribution. My special thanks to all of them and I pledge forgiveness from them not being individually singled out.

Dr. Tanya Batra


Dedicated
To
My Mentor
and
My Family...

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LIST OF ABBREVIATIONS

ABBREVIATIONS		FULL FORM
MFT	:	Maxillofacial trauma
RCT	:	Randomized Controlled Trial
HA	:	Hypotensive anesthesia
NIRS	:	Near Infrared Spectroscopy
ORIF	:	Open reduction and Internal fixation
NA	:	Normotensive anesthesia
GA	:	General Anesthesia
MAP	:	Mean Arterial Pressure
SBP	:	Systolic Blood Pressure
rSO2	:	Regional oxygen saturation
IV	:	Intravenous
OMFS	:	Oral and maxillofacial surgery
AIIMS	:	All India Institute of Medical Sciences
IEC	:	Institutional Ethical Committee
CONSORT	:	Consolidated Standards for the Reporting of Trials
ASA	:	American Society of Anesthesiologists
TMD	:	Temporomandibular disorders
MPDS	:	Myofascial pain dysfunction syndrome
SNOE	:	Sequentially numbered opaque sealed envelopes
Hb	:	Hemoglobin
HCT	:	Hematocrit
PR	:	Pulse rate
PLT	:	Platelet count
PT	:	Prothrombin time
INR	:	International normalized ratio
APTT	:	Activated partial thromboplastin time
ECG	:	Electrocardiography
ABG	:	Arterial blood gases
EtCO2	:	End tidal Carbon dioxide
VAS	:	Visual Analogue Scale
SPSS	:	Statistical package for Social Sciences
SpO2	:	Oxygen saturation
SD	:	Standard deviation
ANOVA	:	Analysis of variance
F-Z	:	Fronto-zygomatic
RTA	:	Road traffic accident
LA	:	Local anesthesia
%	:	Percentage
RBC	:	Red blood cell

SUMMARY

Background: Maxillofacial region being the most vulnerable and vascular part, may account for substantial blood loss especially in polytrauma cases. Impaired hemodynamics due to blood loss increases mortality and morbidity in trauma victims. Arrays of various pre-hospital and hospital procedures are available to reduce bleeding. Out of these, controlled hypotension during general anesthesia has been one of the effective tool in reducing intraoperative blood loss. However, its use in maxillofacial trauma (MFT) patients is relatively new and controversial especially due to the chances of accompanying traumatic brain injury. Thus, a Randomized Controlled Trial (RCT) was designed to estimate the effect of hypotensive anesthesia (HA) in maxillofacial trauma surgeries keeping an eye on regional cerebral oxygen desaturation as an early marker of adversity using NIRS (Near infrared spectroscopy) in both groups.

Aim: To evaluate the effect of controlled hypotension (hypotensive anesthesia) in maxillofacial trauma patients when compared to conventional normotensive anesthesia.

Methods: A prospective, double-blinded, double-arm RCT was conducted in which patients were randomly allotted into two groups. Group A (Control)- patients were treated with open reduction and internal fixation (ORIF) under standard normotensive anesthesia. Group B (Case)- Patients were treated with ORIF under hypotensive anesthesia after administration of Dexmedetomidine (0.2-0.7 mcg/kg/hour after a bolus dose of 1 mcg/hour over 10 mins). Various pre-operative, intra-operative and post-operative parameters were analyzed.

Results: Statistically significant lesser intra-operative volumetric blood loss in the hypotensive group in comparison with the normotensive group (p value<0.05) was found. HA group showed statistically significant better surgical field, surgeon's satisfaction than normotensive anesthesia (NA) group. The cerebral perfusion was monitored by NIRS to look for vital (cerebral) organ hypoperfusion. However, no statistically significant difference was found in cerebral perfusion establishing the superiority of hypotensive anesthesia on risk versus benefit ratio.

Conclusion:

In our study, it can be inferred that hypotensive anesthesia is beneficial in reducing intraoperative blood loss and also improving the quality of the surgical field, but it did not result in a reduction in surgical time in MFT surgeries. No cerebral oxygen saturation was hampered by hypotensive anesthesia intra-operatively, making this technique useful in maxillofacial trauma surgeries without causing vital organ hypoperfusion.

INTRODUCTION

Maxillofacial trauma (MFT) occurs in a significant percentage worldwide and can exist as an isolated injury or in association with other systemic injuries. Polytrauma patients with associated maxillofacial injuries (MFT positive) were more commonly seen with severity of concomitant cervical spine and head injury (62.6%) in contrast to those without associated maxillofacial injuries (34.8%) (1).

Major MFT cases can be life threatening from both airway obstruction and cardiovascular point of view because of its extensive vascularity. The average estimated intra-operative blood loss in various maxillofacial surgeries ranges from 343.3±256.3mL, in which trauma surgeries have less than 300mL blood loss (2). However, it is important to ascertain that this intra-operative blood loss is compromising the already compromised hemodynamic status of the patient due to the probable multiple injuries and previous blood losses.

Focusing on intraoperative blood loss, various local methods have been used like intravenous tranexamic acid, topical hemostatic anesthetic solutions, aprotonin to control the intraoperative bleeding. Hypotensive anesthesia is basically controlled hypotension induced during GA to decrease bleeding and enhance the surgical site according to the age of the patient, pre-operative blood pressure and past medical history. It usually involves lowering the mean arterial blood pressure (MAP) by 30% of the patient's MAP. The systolic blood pressure (SBP) is kept under 90 mmHg and MAP below 65 mmHg.

Harvey William Cushing invented this technique in 1917 during intracranial surgery but Gardner introduced this to the routine surgical procedures in 1946 (3). Reduced surgical bleeding and improved surgeon's vision was the outcome during the surgery. First study on hypotensive anaesthesia in craniofacial region was done by Schaberg *et al*. in 1976 (4).

Sufficient literature on HA for reducing blood loss is available in cardiac surgeries, neurosurgeries, spinal surgeries, numerous maxillofacial surgeries. Although in maxillofacial specialty, trial showing benefits of HA are available in cleft lip and palate surgeries, orthognathic and tumor resection surgeries (5)(6)(7).

Hypotensive anesthesia lowers the mean arterial pressure and permits a feasible plane of anesthesia at a decreased anesthetic requirement thus allows rapid recovery and improved wellbeing of the patient post operatively in addition to reduced blood loss. Several inhalational anesthetic drugs, beta-blockers (esmolol and propranolol), vasodilators (nitroglycerin and sodium nitroprusside), alpha-adrenergic agonists (clonidine and dexmedetomidine) and calcium channel blockers can be used to produce controlled hypotension.

In our study, dexmedetomidine has been used as a drug of choice for intervention. Dexmedetomidine is an imidazole derivative, highly selective alpha2 adrenergic agonist which reduces blood pressure, heart rate, cardiac output and norepinephrine release. It is primarily an effective sedative and anxiolytic agent (8). It's elimination half life ($t_{1/2}$) is 2 hours and a short redistribution half life is 6 minutes, making it a perfect drug for intravenous titration (9). Absence of any episode of reflex tachycardia or rebound hypotension are the chief advantages of this drug as the sympathetic nervous system is inhibited.

Hypotensive anesthesia seems to have danger of hypoperfusion, thus hampering adequate tissue oxygenation which is very important for normal aerobic metabolism in the body. Failure to detect occult regional ischemia at the systemic level, may have implications in morbidity and mortality with the use of HA. Therefore, early detection methods for assessing the vital organ perfusion e.g. brain and heart would be beneficial in HA. Traditionally, invasive tools like Clark type needle electrodes and those which relied on toxic dyes for example, palladium phosphorescence were used. NIRS has been a broadly clinically used technique to assess cerebral oxygenation (rSO_2) during various surgeries.

However, the use of Hypotensive Anesthesia in MFT patients is relatively new and controversial (8). In the emergent operations of trauma patients sustaining severe injuries to face and neck or pan-facial trauma, bleeding is difficult to control. The hypotensive approach may limit bleeding but could aggravate any pre-existing associated clinical or occult brain injury.

With no literature support available in the use of hypotensive anesthesia in much vascular maxillofacial trauma surgeries, this RCT was designed to evaluate for the effect of hypotensive anesthesia in maxillofacial trauma patients with an account of

cerebral perfusion. The chief objective was to measure intraoperative blood loss, surgical field optimization with HA when compared to NA. Mainstay of our study was to adequately detect the prevalence of regional cerebral oxygen desaturation as an early marker of adversity using NIRS in both groups, along with the intra-operative and post-operative complications.

REVIEW OF LITERATURE

Dolman *et al.* in 2000 (10) conducted a Randomized controlled trial for 23 patients to compare the quality of surgical field, blood loss and operative time with either normotensive and hypotensive anesthesia during Le fort osteotomies. The quality of surgical field was assessed intra-operatively by direct observation and again post operatively using video imaging. A standardized rating scale was applied at specific intervals by surgeons blinded to the anesthetic technique. The surgical time was measured on the video tape and blood loss was measured by volumetric and gravimetric techniques. There was a statistically significant correlation between the surgeon's perception of the quality of the surgical field and significant reduction in blood loss of 120.3±70.4mL when using hypotensive anesthesia whereas, 270.2 ±153.6mL using normotensive anesthesia. However, there was no statistically significant reduction in operative time when using hypotensive anesthesia.

Boehm *et al.* in 2001 (11) conducted a prospective randomized study investigating influence of normotensive and hypotensive anesthesia on platelet aggregability, intra-operative blood loss and parameters of plasmatic coagulation during orthognathic surgery. 30 patients were randomly allocated into 2 groups, first maintained by infusion of propofol and remifentanil, second induced by remifentanil or nitroglycerin. Normotensive anesthesia caused significant decrease in platelet count (29%), PT (24%), fibrinogen (41%) and antithrombin (28%) and significant prolongation of APTT (21%) and thrombin time (18%), whereas hypotension did not. A negative correlation was observed among intra-operative arterial blood pressure, post-operative platelet count and routine coagulation parameters in cases of induced hypotension but it showed a reduced intra-operative blood loss, irrespective of the anesthetic regime. Comparison of the two anesthetic regimens for the hypotensive aesthesia revealed no significant difference in regard to platelet aggregability and parameters of plasma coagulation, except for fibrinogen.

Praveen *et al.* in 2001 (12) conducted a prospective randomized clinical study on 53 patients to find out whether hypotensive anesthesia minimized blood loss during orthognathic surgery. The patients were randomly allocated to either normotensive or hypotensive anesthesia group. Median blood loss under hypotensive anesthesia was 200mL and under normotensive anesthesia was 350mL and those for maxillary

segmental osteotomy under hypotensive anesthesia was 85 mL as compared to 175mL under normotensive anesthesia. Therefore, pronounced reduction in blood loss was concluded under hypotensive anesthesia compared to normotensive anesthesia.

W. S. Choi *et al.* in 2008 (4) conducted a systemic review regarding the risks and benefits of hypotensive anesthesia was performed using MEDLINE with PubMed and Ovid (National Library of Medicine) and the Cochrane Library from January 1966 to June 2007 was done. A total of 833 potentially relevant articles were retrieved and examined. They concluded that hypotensive anesthesia is most valuable in a lengthy operation where a large amount of blood loss and consequent blood transfusion are to be expected.

J. Ervens *et al.* in 2010 (7) conducted a a prospective, single-blinded, randomized controlled clinical study in which 60 healthy patients requiring either Le Fort I osteotomy or bimaxillary surgery were randomly allocated to receive normotensive anesthesia, induced hypotensive anesthesia, or induced hypotensive anesthesia combined with isovolumic hemodilution. They concluded that combining multiple blood-sparing strategies (i.e. induced hypotensive anesthesia, moderate anemia, consistent intra-operative hemostasis, head-up position) can help to minimize blood loss and transfusion requirements even during complex orthognathic surgery.

Scheeren *et al.* in 2011 (13) had reviewed NIRS offers non-invasive online monitoring of tissue oxygenation, to measure cerebral oxygenation (rSO_2) in various surgeries which may prevent post-operative complications. It may be used, even when systemic markers (e.g., blood pressure) are still within the normal range. However, it has complications as the unknown contribution of myoglobin in the NIRS measurement and NIRS monitoring is relatively expensive.

Neamat I. Abel Rahman *et al.* in 2013 (14) conducted a blinded randomized controlled trail of 45 patients, aged from 18 to 50 years, ASA physical status I and II, underwent endoscopic sinus surgery were enrolled in the study. They concluded that, dexmedetomidine regimen as pre-induction bolus dose 1 lg/kg iv followed by post-induction continuous iv infusion 0.8 lg/kg/h significantly decreased the MAP to the target level without the need of an additional hypotensive agent nitroglycerine, and it provides the excellent surgical field quality when compared to other regimens.

Abu Dakir *et al.* in 2014 (15) did a pilot study on 12 patients divided in two equal groups to assess the efficiency of the usage of tranexamic acid on reduction of hemorrhage in maxillary and mandibular trauma. Group I received tranexamic acid (10mg/kg) just before induction of anesthesia and group II received normal saline. Tranexamic acid significantly reduced the volume of blood loss during the surgery when compared with the control group (489.17±106.7 mL versus 900.83±113.7 mL). The average drop in hemoglobin was 2±1.4 g% in the tranexamic group and 4±1.09 g% in the saline group. Therefore, pre-operative intravenous bolus administration of tranexamic acid at 10 mg/kg reduces blood loss compared with placebo during the surgery.

Prashant *et al.* in 2014 (5) had studied 30 patients out of which, 14 underwent unilateral cleft lip surgery, 10 patients underwent SABG surgery and 6 underwent Lefort I osteotomy surgery, divided equally into control and study groups each. Estimation of blood loss, quality of the surgical field and duration of surgery was calculated for both control group using normotensive anesthesia and study group of hypotensive anesthesia. EBL was significantly less in all the procedures carried out under hypotensive anesthesia, in cleft lip surgery (110.2857mL vs 95.7143mL), in secondary alveolar bone graft surgery was 111.00 mL vs 140.80 mL. The mean EBL in Lefort I surgery was 254.00 mL vs 163.33 mL. The quality of the surgical field was better in cases with induced hypotension, but there was no significant difference in duration of the procedures with and without induced hypotension.

Maghawry *et al.* in 2014 (16) conducted a prospective, randomized, double blind study to compare the prevalence of rSO_2 during hypotensive anesthesia induced by intra-operative intra-venous infusion of either dexmedetomidine or esmolol in patients undergoing elective arthroscopic shoulder surgery in the BCP. No statistically significant difference between the 2 groups in regard to mean arterial blood pressure, heart rate and duration of surgery. However, statistically significant decrease in rSO_2 was obtained in esmolol group (66.3±4.4) as compared to dexmedetomidine group (70±3). Moreover, BCP significantly decreases rSO_2, with further slight decrease of rSO_2 with dexmedetomidine and esmolol induced hypotension. Dexmedetomidine and esmolol are safe drugs with better safety of dexmedetomidine over esmolol.

Michal Barack *et al.* in 2015 (17) reviewed the medical literature regarding hypotensive anesthesia during major maxillofacial surgery, the means to achieve it, and the risks and benefits of this technique, in comparison to normotensive anesthesia. He reported that since hypotensive anesthesia can reduce the extent of intra-operative bleeding and can potentially improve the quality of the surgical field conditions, it is considered to be beneficial. However, it carries the risk of hypoperfusion in vital organs, therefore, normotensive or modified hypotensive anesthesia should be used for patients with ischemic heart disease, carotid artery stenosis, disseminated vascular disease, kidney dysfunction, or severe hypertension who are scheduled to undergo a major maxillofacial operation.

Ettinger *et al.* in 2016 (18) did a retrospective cohort study comprising of 117 patients to evaluate the impact of induced hypotensive anesthesia on length of hospital stay (LOS) for patients undergoing maxillary Le Fort I osteotomy in isolation or in combination with mandibular orthognathic surgery. The results suggest that hypotensive anesthesia has the potential to shorten the duration of post-operative hospital stay with median 47.5 hours in normotensive anesthesia compared to median 45.9 hours in hypotensive anesthesia. However, Induced hypotensive anesthesia was not statistically associated with shorter duration of surgery.

Susie Lin *et al.* in 2016 (19) did a systematic review and meta-analysis of the 10 RCTs involving 358 patients who had undergone orthognathic surgery; 178 under hypotensive anesthesia and 180 were control patients. The estimate of total blood loss indicated that hypotensive anesthesia significantly reduced intra-operative blood loss compared with the control group with a mean difference of 168.98 mL. There was no statistically significant reduction of operation time between the hypotensive group and the control group with mean difference of 9.46 minutes, but the quality of the surgical field was improved. Subgroup analysis indicated that for blood loss in double jaw surgery, the weighted mean difference favored the hypotensive group, with the reduction in blood loss of 175mL, but no statistically significant reduction in blood loss was found for anterior maxillary osteotomy. If local anesthesia with epinephrine was used in conjunction with hypotensive anesthesia, the reduction in intra-operative blood loss was increased to 254.93mL.

Patel *et al.* in 2018 (20) conducted RCT comparing Dexmedetomidine (group D) and Nitroglycerin (group N), consisting of 20 patients each, for Controlled Hypotensive Anesthesia in Functional Endoscopic Sinus Surgery. They reported no significant difference in duration of surgery, 122.3±19.02 mins (group D) and 111.8±25.51 mins (group N). There was significant decrease in pulse rate; 15 min onwards in Group D, whereas increase in pulse rate in Group N. Optimum quality of surgical field as indicated by average category scale (ACS) of 2-3 was attained. Not much difference in amount of blood loss in both groups (160.8+28.11 mL vs 168.5+24.12 mL). It was concluded that both dexmedetomidine and nitroglycerine are safe agents for controlled hypotension and are effective in providing ideal surgical field, however, Dexmedetomidine has an added advantage of maintaining better cardiovascular stability as compared to Nitroglycerine.

Sharma *et al.* in 2020 (21) conducted prospective, randomized clinical trial including 36 patients who had undergone orthognathic surgery under general anesthesia. The patients were divided into 2 groups. The DT group received an intravenous bolus of tranexamic acid (15 mg/kg) and intravenous dexmedetomidine (0.25 to 0.7 mg/kg/hr.) as maintenance infusion. The DS group received only intravenous dexmedetomidine at the same dosage. The surgeon reported a significantly better surgical visual field in the DT group compared with that in the DS group. Also, the intra-operative blood loss significantly less in the DT group (231.11±137.64 mL vs 360.17±187.86 mL). However, no statistically significant differences were found in the baseline characteristics between the 2 treatment groups.

Shimelis Seid Tegegne *et al.* 2020 (22) conducted a systemic review in which a total of 6250 potentially relevant studies were retrieved and examined, however only 42 articles were grouped under high level evidence (6 meta-analysis studies, 9 systematic reviews and 27 articles were RCTs). They concluded that Hypotensive anesthesia protocol allowed perfect hemostasis control significantly with shorter operative time compared with other intra-operative controlling mechanisms for prevention of surgical site bleeding.

AIMS AND OBJECTIVES

AIMS

1. To evaluate the effect of anesthesia with controlled hypotension (hypotensive anesthesia) in maxillofacial trauma patients when compared to conventional normotensive anesthesia.

OBJECTIVES

1. **Primary objective**:

To estimate the optimization of the surgical field in hypotensive and normotensive anesthesia in maxillofacial trauma patients.

2. Secondary objectives:

a. To estimate the difference in blood loss in hypotensive and normotensive anesthesia in maxillofacial trauma patients.

b. To compare the prevalence of regional cerebral oxygen desaturation as a marker of adversities using NIRS in hypotensive and normotensive anesthesia in maxillofacial trauma patients.

c. To estimate the intra-operative and post-operative complications in both the groups.

RESEARCH QUESTION

Does maxillofacial surgical field improve with the use of controlled hypotension during general anesthesia?

NULL HYPOTHESIS

Maxillofacial surgical field characteristics doesn't vary with controlled hypotension during general anesthesia.

MATERIALS AND METHODS

A prospective, double blinded, double arm RCT was conducted in the Oral and Maxillofacial Surgery (OMFS) section in the Department of Dentistry, AIIMS Jodhpur after procuring ethical clearance from the Institutional Ethics Committee (AIIMS/IEC/2021/3365). This trial was performed strictly according to the Consolidated Standards of Reporting Trials (CONSORT) guidelines.

A total of 175 patients were analyzed from 15th March 2021 till November, 2022. Out of which, 114 trauma patients were registered after the written informed consent was taken and fulfilling the following inclusion and exclusion criteria.

SELECTION CRITERIA

While selecting the patients, the following criteria were used-

Inclusion criteria:

1. Patients who gave written informed consent to be a part of the study.
2. Patients posted for ORIF for maxillofacial trauma.
3. Patients in the age group between 16 to 65 years, of either sex.
4. Patients with minimal comorbidities- ASA I, II.
5. Absence of pre-existing maxillofacial pathologies especially any odontogenic tumor, cyst, neuralgias, TMDs and MPDS.

Exclusion criteria:

1. Age >16 years and <65 years.
2. Patients with severe debilitating conditions such as uncontrolled diabetes mellitus, uncontrolled hypertension, cardiorespiratory conditions, previous history of cerebrovascular accidents, myocardial infarction, coronary artery disease.
3. All pregnant and lactating females.
4. Patients on antiplatelet/anticoagulant therapy.
5. Patients with concomitant head injuries, cervical spine injuries or debilitating

thoracic or abdominal trauma.

SAMPLE SIZE CALCULATION

The sample size calculated was a total of 82 cases, with a 95% confidence interval with the power of the study assumed to be 80%.

Sample size was calculated by the following formula:

$$n = \frac{[Z_{(1-\alpha)} + Z_{(1-\beta)}]^2 \ 2 \ S_p^2}{\mu^2_d}$$

$$n = 41$$

$Z_{(1-\alpha)} = 1.64$ standard normal variable of 5% level (one side)

$Z_{(1-\beta)} = 0.842$ power at β=20%

S_p^2 = Pooled Variance = $(7.18)^2 = 51.55$

μ_d = Mean difference

Hence, a minimum of 41 cases were enrolled in each of the groups (Total = 82).

SAMPLE SIZE:

The maximum patients in the period of 16 months were screened and included in the study, thus 32 extra patients were taken from the calculated sample size of 82, bringing the sample size to 114.

SAMPLING FRAME:

The sampling frame consisted of 40 patients were randomized. As per the available time, a total of 3 sample frames were taken.

STUDY POPULATION

The study constituted a sum of 114 trauma patients, 56 patients in the intervention group and 58 patients in the control group. They were recruited as per inclusion and exclusion criteria.

Trial Design

This study was a single center, parallel group with active control, randomized controlled trial with an allocation ratio of 1:1 using block randomization.

Randomization

Block randomization using the Randomization Allocation Software 2.0 was done, and the code generated were sealed in sequentially numbered opaque sealed envelopes (SNOEs) for allocation concealment. This sequence generation and patient allocation was done by and individual separately who was not related to the trial. Pre-operatively, the randomization code was taken out and the patients were allotted to one of the 2 groups according to the randomization code.

1. **Group A (Control):** Patients were treated with Open Reduction and Internal fixation (ORIF) under standard normotensive anesthesia.

2. **Group B (Case):** Patients were treated with ORIF with hypotensive anesthesia after administration of dexmedetomidine (0.2-0.7 mcg/kg/hour after a bolus dose of 1mcg/hour over 10 mins).

Blinding

The study was double blinded, wherein the patient and surgeon were blinded to the intervention. SNOE was opened once the patient was moved to pre-operative area. Both the arms of the study were carried out when the patient was under general anesthesia, which ensured patient was blinded. Every effort was made to ensure surgeon blinding by ensuring that multipara monitor screen was away from the site of surgeon. The syringes used for drug administration were covered by sterile drape sheets.

Procedure

Routine investigations for the pre-anesthetic check-up were done for all the selected MFT patients. A stepwise surgical procedure was performed:

1. Step No. 1 (Induction of anesthesia): GA was induced by submental/ nasotracheal intubation. The throat pack was placed using Magill forceps.
2. Step No. 2 (Patient preparation): The patient was made to lie supine on the operation table with neck extension using a shoulder bag. The patient was painted and draped under sterile conditions.
3. Step No. 3 (Infiltration): A local infiltration of lignocaine with adrenaline (1:200,000) was given along the planned incision site.
4. Step No. 4 (Incision): By using a No.15 Bard-parker blade, extraoral or intraoral incisions were given progressively in layers depending on the site of fracture.
5. Step No. 5 (Exposing the fracture site): Subperiosteal dissection was done to reflect the periosteum and the fractured bony sites were exposed.
6. Step No. 6 (Intermaxillary fixation): The upper and lower teeth were brought in occlusion and fixed with intermaxillary wiring.
7. Step No. 7 (Anatomic reduction of fracture segments): The fracture segments were reduced into their anatomic position.
8. Step No. 8 (Simplification of fracture): In case of multiple fracture segments, simplification of fracture was done with wires or miniplates.
9. Step No. 9 (Fixation of fracture segments using miniplates or wires): Fixation of the fracture segments in their reduced anatomic position was done with miniplates and screws.
10. Step No. 10 (Irrigation of surgical field): Copious irrigation of the field was done with normal saline and betadine. Depending upon the surgical site contamination, antibiotic wash was also used, if needed.
11. Step No. 11 (Closure with sutures): The surgical site was closed with 3-0 vicryl sutures intra-orally and 3-0 vicryl and 4-0 prolene sutures in case of extraoral approach.
12. Step No. 12 (Patient extubation): Throat pack was removed. The general anesthesia was reversed, and finally patient was extubated.
13. Step No. 13 (End of surgery): Patients were shifted to the ward after stabilization and post-operative instructions were given. Strict perioperative monitoring of the patients in both the groups was done and the structured proforma was filled.

PARAMETERS

All the patients of both the groups (intervention as well as control) were assessed and the readings were noted in a previously designed proforma.

Parameters assessed were:

Preoperatively:

1. Patient's demographics along with randomization code.
2. Hemoglobin level/ Hematocrit level
3. Coagulation profile (Platelet count, Prothrombin time, INR, APTT, Fibrinogen)
4. Mean arterial blood pressure (average of 3 readings)
5. Baseline Pulse rate (average of 3 readings)
6. Oxygen saturation (average of 3 readings)

Intraoperatively:

Monitoring was done based on surgeon's and anesthetist's perspective.

1. Surgical field characteristics (assessed by operating surgeon)
    a. Quality of surgical field was estimated by Average Category Scale (adopted from Fromme *et al.*) at every 30 minutes once the Target MAP was reached.
    b. The duration of surgery from incision to closure
    c. Surgeon's satisfaction regarding the surgical field was measured by using 6 point Likert Scale.
    d. Any pauses during surgery with their cause were recorded.
2. Patients were continuously monitored for ECG, pulse rate, invasive arterial blood pressure, oxygen saturation and EtCO2 (end-tidal carbon dioxide).
3. Intraoperative ABG was noted, when needed.

4. Estimated blood loss during surgery was assessed at the end of surgery by:
    a. Volume collection in Suction and gauge pieces
5. Patients were observed for intra-operative complications in the form of:
    a. Bradycardia
    b. Reflex tachycardia
    c. Myocardial infarction
    d. Arrythmias
6. Cerebral oxygenation as an indicator of vital organ perfusion using Near Infrared Spectroscopy (NIRS).
7. Time for Intubation/ Extubation.
8. Any alternate intervention if required.

Postoperatively:

1. Hemoglobin levels
2. Hematocrit levels
3. Monitored for complications like nausea/vomiting, bradycardia, hypotension, shivering, myocardial infarction, renal failure, and cardiovascular accident for a period of up to 24 hours.
4. VAS Pain score at time intervals of 6 hours, 12 hours, and 24 hours

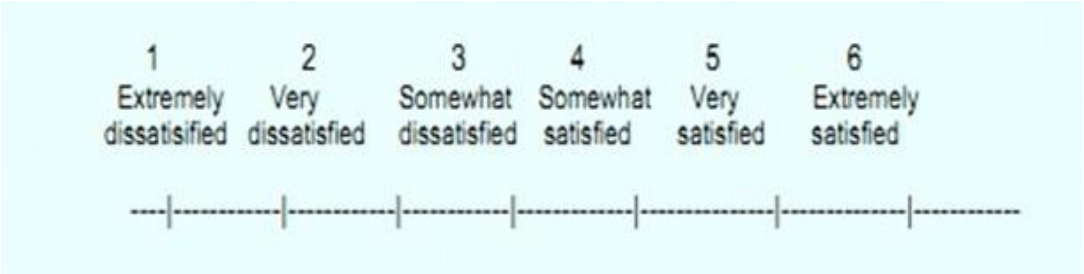
STUDY TOOLS

The following study tools were used

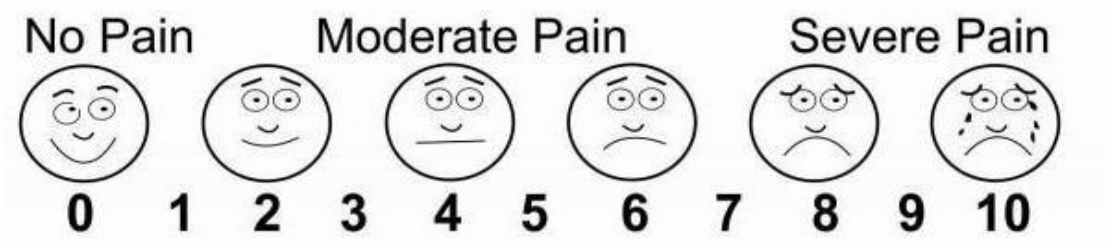
1. **Average Category Scale (adopted from Fromme *et al*.)**

5	Massive uncontrollable bleeding
4	Bleeding, heavy but controllable, that significantly interferes with dissection
3	Moderate bleeding that moderately compromises surgical dissection
2	Moderate bleeding, a nuisance but without interfering with accurate dissection
1	Bleeding so mild it is not even a surgical nuisance
0	No bleeding, virtually bloodless field.

2. **A Likert scale** is a psychometric scale composed of questionnaires, used to represent people's opinions and attitudes to subject matter. This scale has been used to rank surgeon's satisfaction at the end of surgery.



3. A **Visual Analogue Scale (VAS)** is often used in clinical research studies to objectify the amount of pain that a patient feels ranging across a reading from none (0) to an extreme amount of pain (10) according to the patient's perspective.



4. **Near Infrared Spectroscopy (NIRS)** provides a non-invasive monitoring of tissue oxygenation in clinical situations, widely used to measure cerebral oxygenation (rSO_2) during surgeries. The oxygenated blood appears red whereas de-oxygenated blood appears dark ranging from blue to black, because of the difference in absorption pattern between them, and thus in their apparent optical spectrum. It has a light source which generates NIR light, with a characteristic wavelength. Real-time assessment of regional (cerebral) oxygenation (rSO_2) is performed using sensors placed on the patient's forehead with an attached monitor giving the readings in percentage form.

FIGURE 1: NIRS Monitor

FIGURE 2: NIRS sensor probe attached on forehead

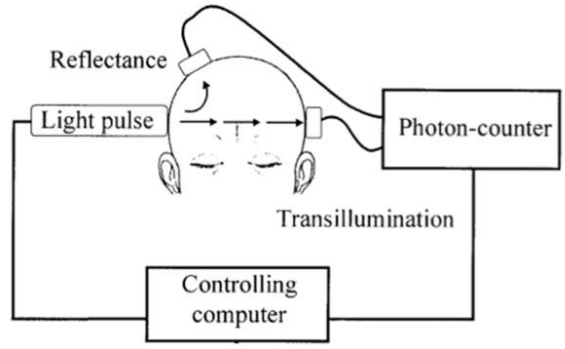


Figure 5. The basic structure of NIRS-based equipment for rSO_2 monitoring [81].

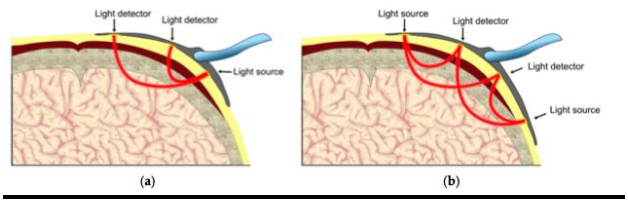


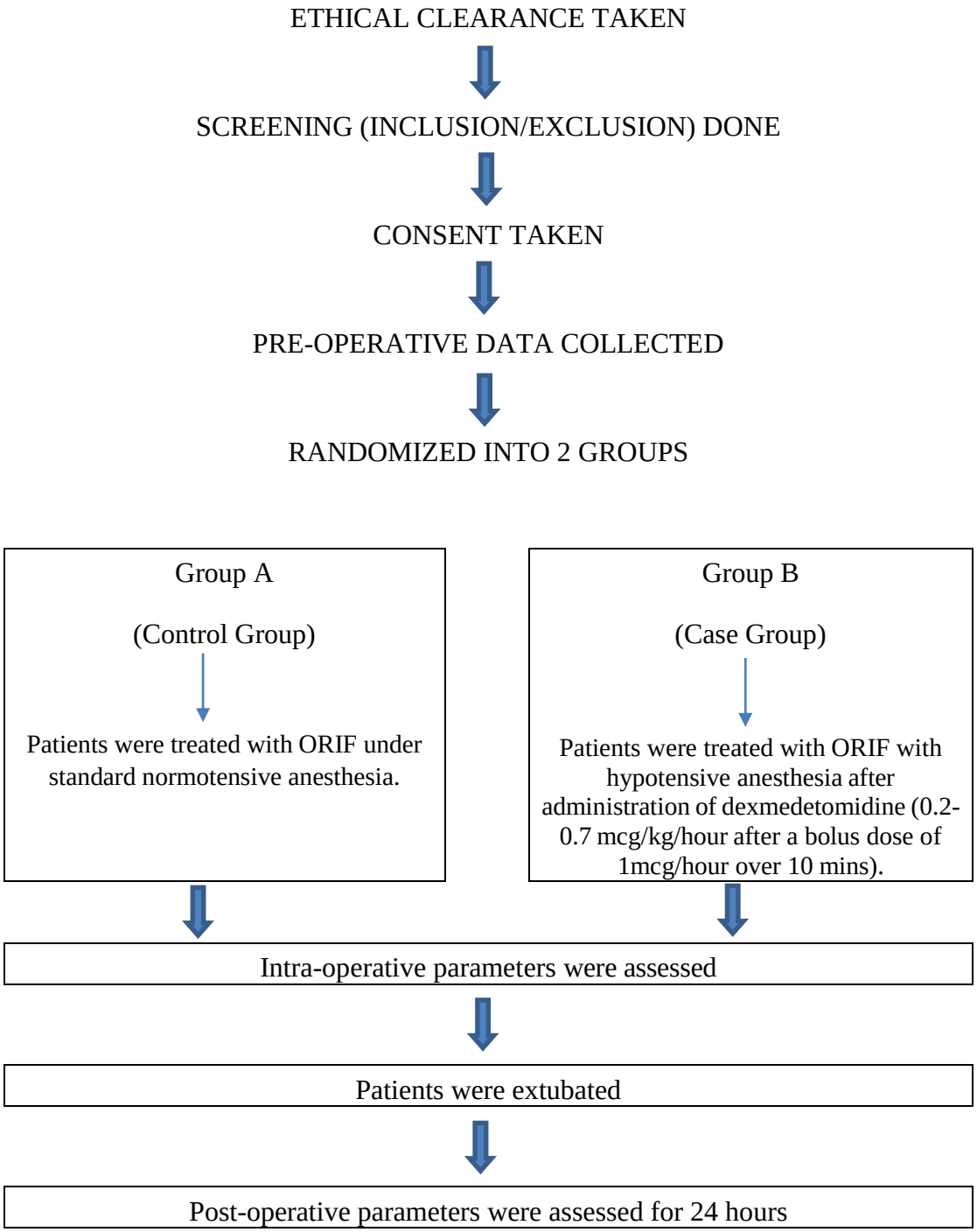
***FIGURE 3:* Pictographic representation of the NIRS sensor monitoring light path.**

a) Single light source, b) Dual light source (Zhong W *et al.* 2021) (23)

STATISTICAL ANALYSIS

All the data was entered into excel sheet and analyzed using SPSS software version 22 (IBM Com. Ltd Newark, USA). Categorical data (age code, Sex, fracture, ORIF site, Surgeon's satisfaction) was described using frequency and percentage, and numerical data was expressed as mean (SD) for normality distributed data and median (IOR) for not normally distributed data. Normally test was done using Shapiro-Wilk's test, Skewness, and Kurtosis analysis. Categorical data was analyzed using chi-square test. For NIRS, surgical field, pulse, MAP, Spo2, ETCO2, and VAS data was normally distributed, and data collected in form of ratio scale. Hence parametric statistical test of inference was applied, and repeated measure ANOVA was used for analysis of these variables. For post-operative Hb and HCT data was normally distributed, and data collected in form of ratio scale. Hence "t" test was used for analysis of these variables. Post HOC Bonferroni analysis was used for multiple comparison. For all the statistical analysis, a P-value less than 0.05 was considered as statistically significant.

STUDY FLOW CHART



CLINICAL CASES

A. MANDIBULAR FRACTURES

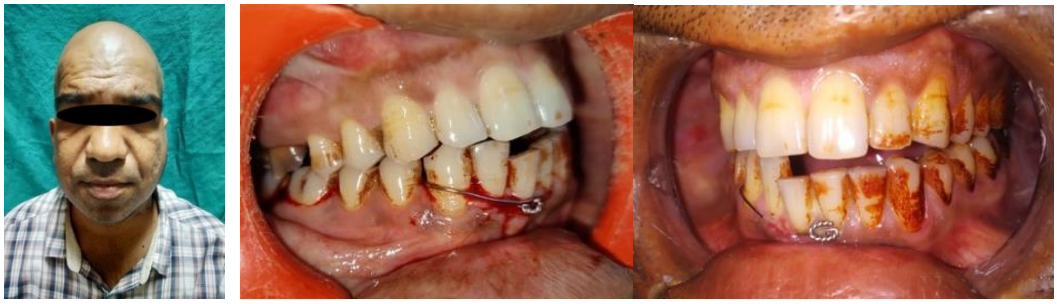


FIGURE 4: Pre-operative clinical photograph and occlusion in mandibular fracture

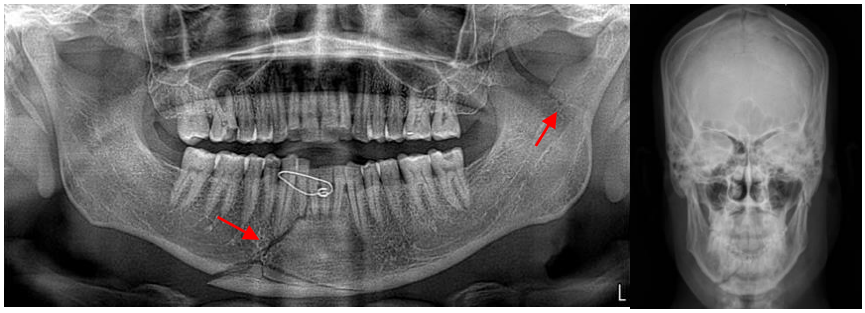


FIGURE 5: Pre-operative radiographs depicting mandibular fracture at various sites
A- Right parasymphysis fracture, B- Left subcondylar fracture

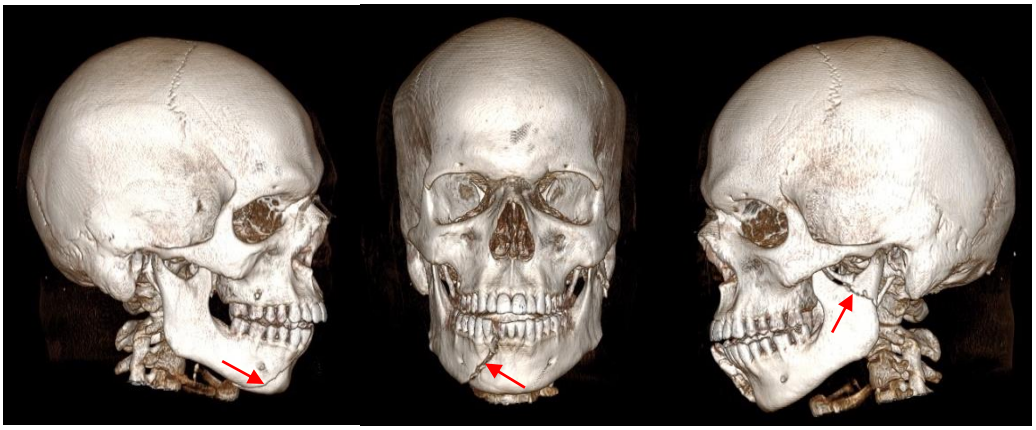


FIGURE 6: 3D Reconstruction of CT scan images depicting mandibular fracture at various sites

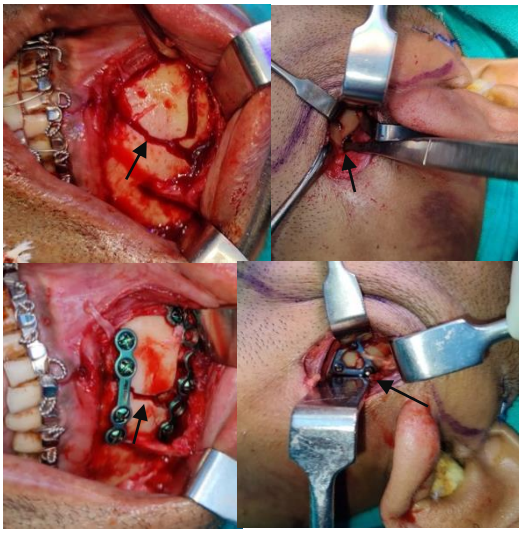


FIGURE 7: Intra-operative fracture site exposure and plating
A- Right parasymphysis, B- Left subcondylar

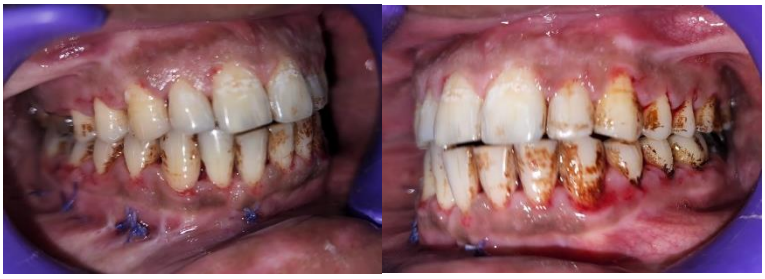


FIGURE 8: Post-operative clinical photograph of occlusion of the patient

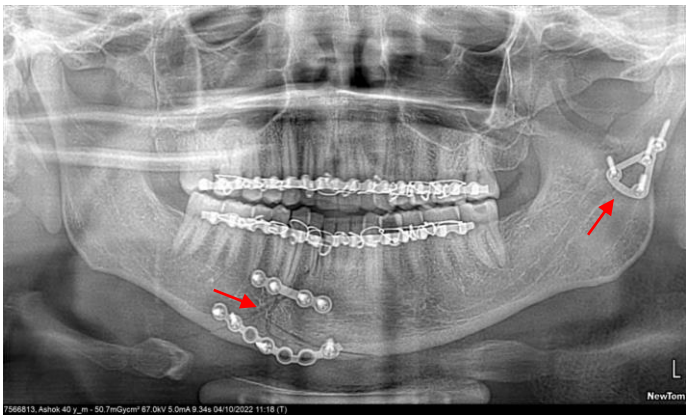


FIGURE 9: Post-operative radiograph showing fracture plating

B. MIDFACE AND MANDIBULAR FRACTURE

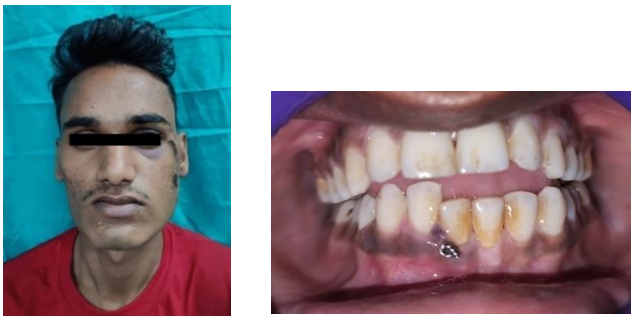


FIGURE 10: Pre-operative clinical photograph and occlusion in midface and mandibular fracture

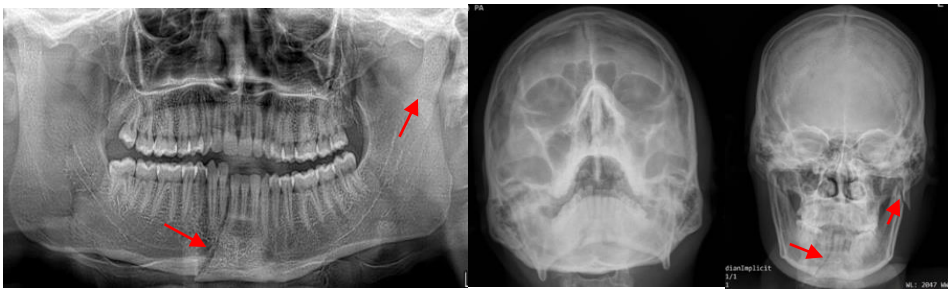


FIGURE 11: Pre-operative radiographs depicting midface and mandibular fracture at various sites

A- Right parasymphysis, B- left subcondylar fracture, C- Left F-Z fracture, D- left zygomatic buttress fracture

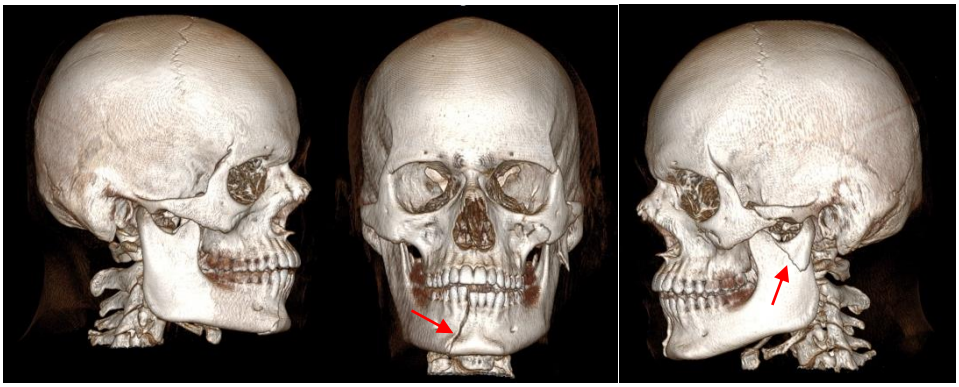


FIGURE 12: 3D reconstruction of CT scan images depicting midface and mandibular fracture

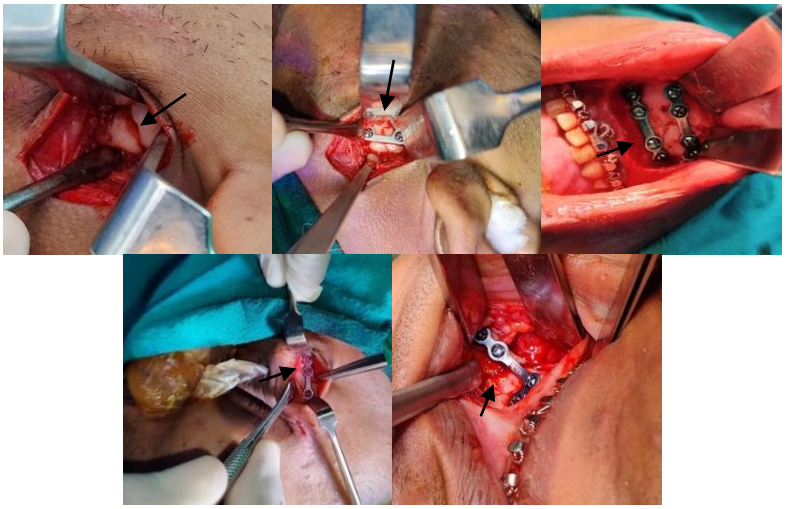


FIGURE 13: Intra-operative fracture site exposure and fracture site plating

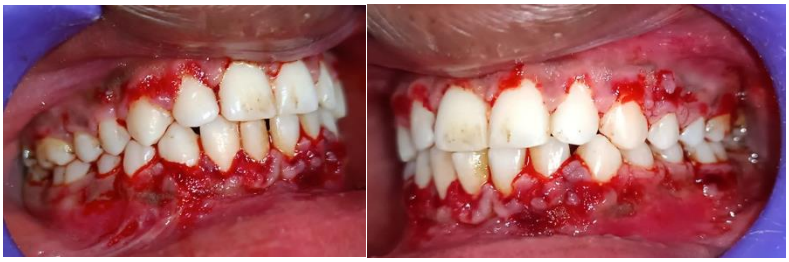


Figure 14: Post-operative occlusion of the patient

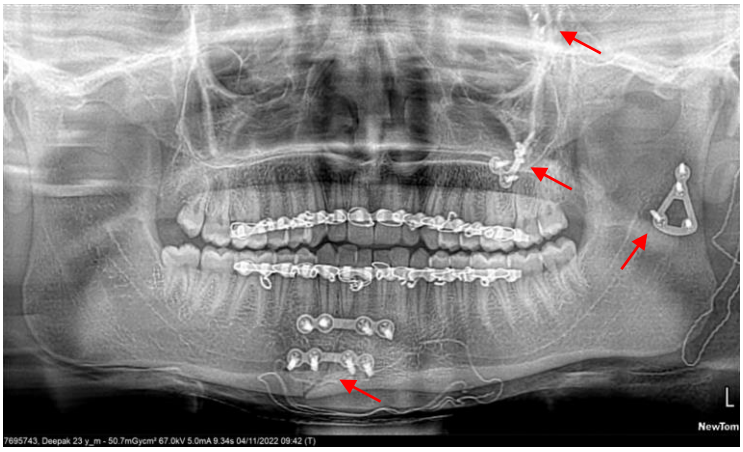


Figure 15: Post-operative radiograph showing fracture plating

RESULTS

A total of 175 patients with maxillofacial fractures who had presented to the Emergency and Trauma Centre and Department of Dentistry, AIIMS Jodhpur were analyzed as per the inclusion and exclusion criteria from 15th March, 2021 till November 2022. Sixty-one patients were excluded from the study out of which 17 patients had other distracting thoracic and abdominal injuries, 25 patients were excluded due to associated head injuries, 2 patients were excluded due to their medical condition such as uncontrolled hypertension. In 8 patients, extraoral approach through bi-coronal or hemi-coronal flap was taken and remaining 4 patients had denied the surgery. Thus, 114 patients were finally recruited in the study without any attrition in the follow up period. The CONSORT ("Consolidated Standards of Reporting Trials") flowchart of this study is shown.

CONSORT FLOW DIAGRAM

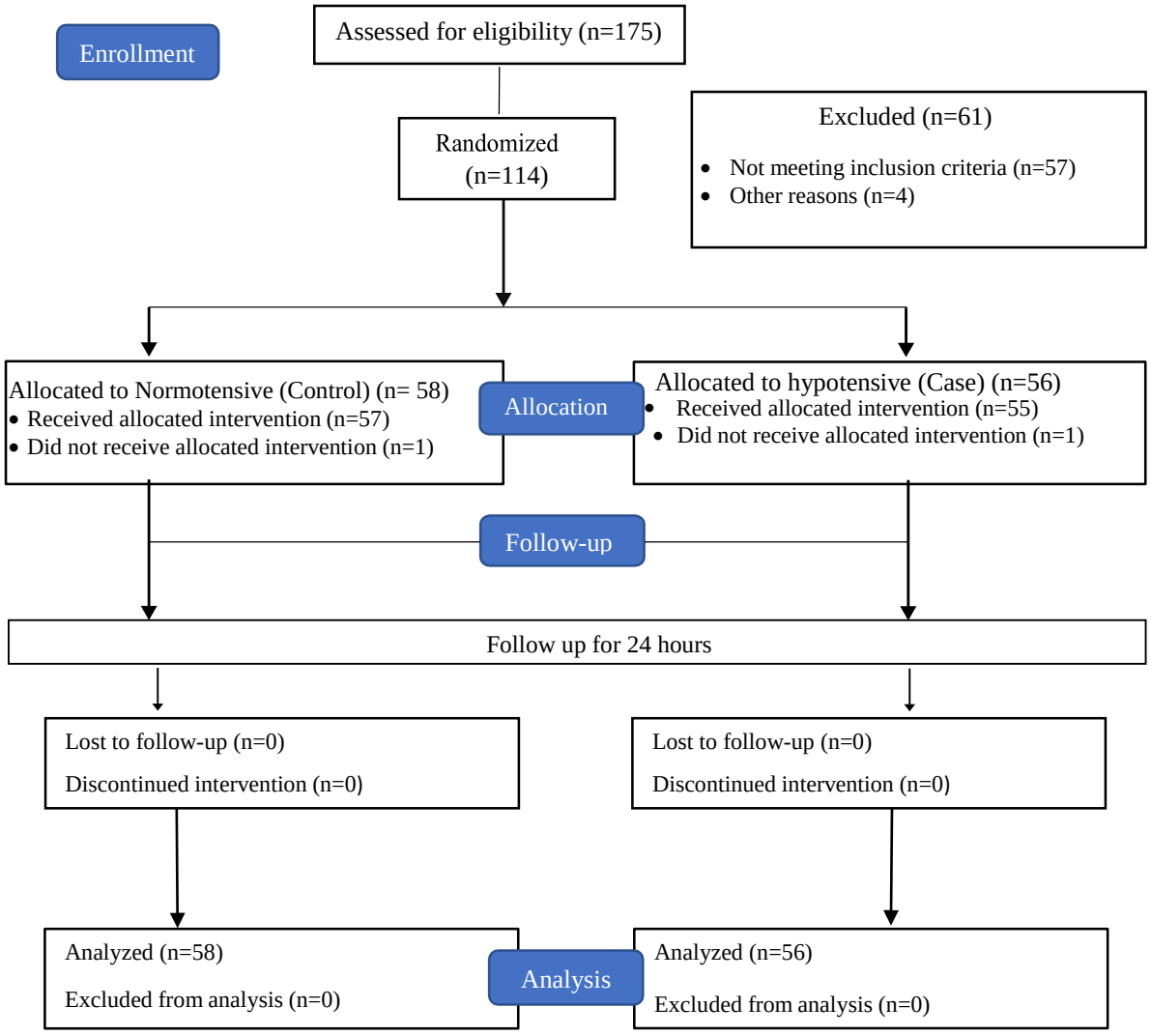


FIGURE 16: CONSORT flow diagram

1. DEMOGRAPHIC DISTRIBUTION

Parameters	Total (n=114)	Normotensive (n=58)	Hypotensive (n=56)	p-value
Age (years) Mean ± SD	32.37±12.07	31.60±11.54	33.16±12.64	0.458
Male/Female (n), (%)	107/7 (93.9/6.1)	56/2 (96.6/3.4)	51/5 (91.1/8.9)	0.223
p-value>0.05 was considered as not statistically significant				

TABLE 1: Baseline characteristics of the study population.

Out of the total 114 MFT patients, 58 patients were found in the normotensive and 56 patients in the hypotensive group. The mean age of the total participants was 32.37±12.07 years. Among the NA group, the mean age was 31.60±11.54 years and in the HA group, it was 33.16±12.64 years. This difference was not statistically significant (p value-0.458). Age wise distribution of patients in both the groups is as per shown in diagram.

Among all patients, 107 patients were male and 7 patients were female as shown in table. Out of normotensive group, there were 56 (96.6%) patients who were male and 2 (3.4%) patients were female. In the hypotensive group, 51 patients were male (91.1%) and 5 patients were female (8.9%). There was no statistically significant difference in the gender distribution between groups (p value-0.223).

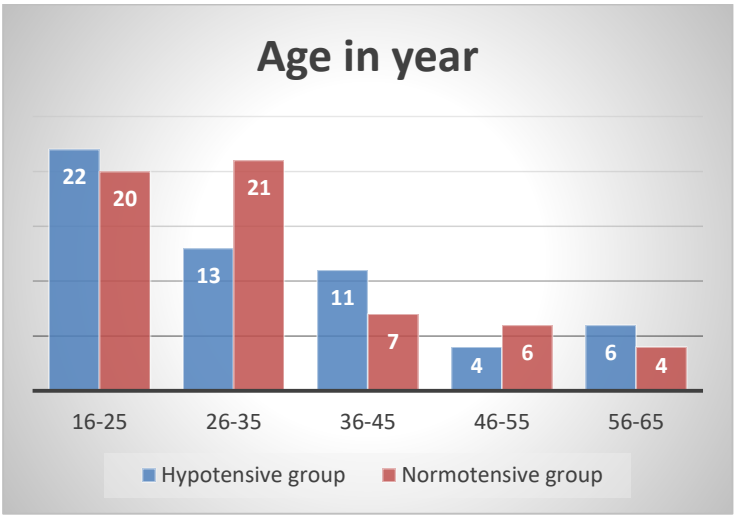


FIGURE 17: Bar diagram showing the age wise distribution of patients in both groups

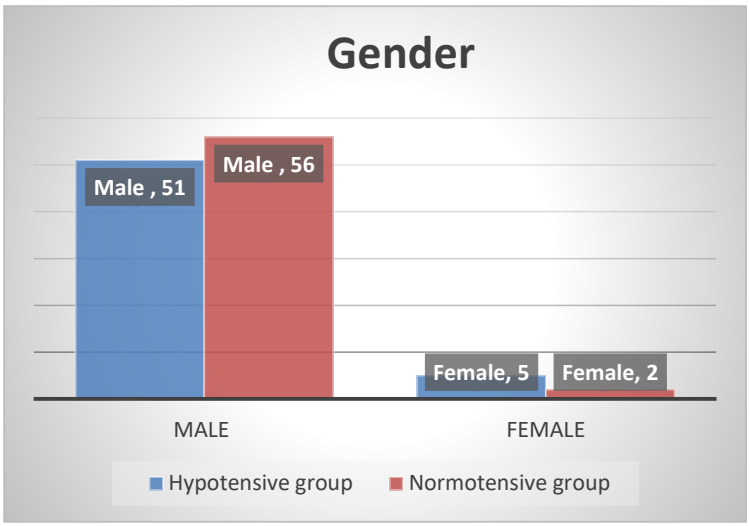


FIGURE 18: Bar diagram showing the distribution of gender of patients in both groups

2. TYPE OF FRACTURE

	Total (n=114)	**Normotensive (n=58)**	**Hypotensive (n=56)**	**p-value**
Midfacial (n/%) (Coded as 1)	52 (45.6%)	31 (53.4%)	21 (37.5%)	0.197
Mandible (n/%) (Coded as 2)	37 (32.5%)	15 (25.9%)	22 (39.3%)	
Pan facial (n/%) (Coded as 3)	25 (21.9%)	12 (20.7%)	13 (23.2%)	
Chi-square test used				

TABLE 2: Distribution of study participants according to the type of fracture

The type of fracture was coded for midfacial fracture as 1, mandibular fracture as 2 and pan-facial fracture category patients as 3. A total of 45.6% of patients had midfacial trauma followed by 32.5% with mandibular trauma and least 21.9% of patients had pan facial trauma. Among 58 patients in NA group, 53.4% of patients (n=31) had midface fracture, 25.9% of patients (n=15) had mandibular fractures, 20.7% of patients (n=12) were having pan facial fractures. Among 56 patients in HA group, 37.5% of patients (n=21) had midface fracture, 39.3% of patients (n=22) had mandibular fractures, 23.2% of patients (n=13) were having pan-facial fractures. There was no statistically significant difference (p value-0.197) in study participants in relation to type of fracture at 0.05 level of significance as evidenced by chi square test.

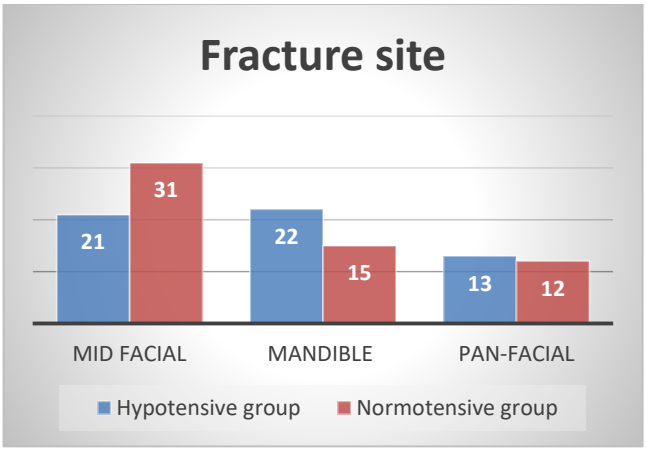


FIGURE 19: Bar diagram showing the distribution of patients in relation to type of fracture in both groups

3. PRE-OPERATIVE HEMOGLOBIN (Hb) LEVELS

Based on "t" test statistics

	Total (n=114)	**Normotensive (n=58)**	**Hypotensive (n=56)**	**p-value**
Hb levels (g%) (Mean±SD)	13.36±1.60	13.58±1.43	13.12±1.74	0.124

TABLE 3: Distribution of study participants according to pre-operative Hemoglobin levels

The mean pre-operative Hb levels in NA group (13.58±1.43)g% and in HA group (13.12±1.74)g% showed no statistical significant difference (p value-0.124) between the two groups in relation to Hb levels at 0.05 level of significance as evidenced by "t" test statistics.

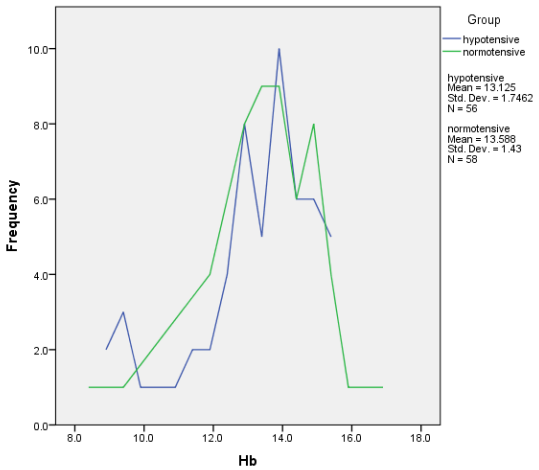


FIGURE 20: Line graph showing pre-operative hemoglobin values for patients in both groups

4. PRE-OPERATIVE HEMATOCRIT (HCT) LEVELS

Based on "t" test statistics

	Total (n=114)	**Normotensive (n=58)**	**Hypotensive (n=56)**	**p-value**
HCT levels (%) (mean±SD)	39.59±5.16	40.15±5.00	39.00±5.30	0.235

TABLE 4: Distribution of study participants according to pre-operative Hematocrit (HCT) levels

In the normotensive group, mean hematocrit (HCT) levels was 40.15±5.00% whereas, in hypotensive group, the mean hematocrit (HCT) levels were 39.00±5.30%. There was no statistical difference (p value-0.235) between the two groups with respect to HCT levels at 0.05 level of significance as evidenced by "t" test statistics.

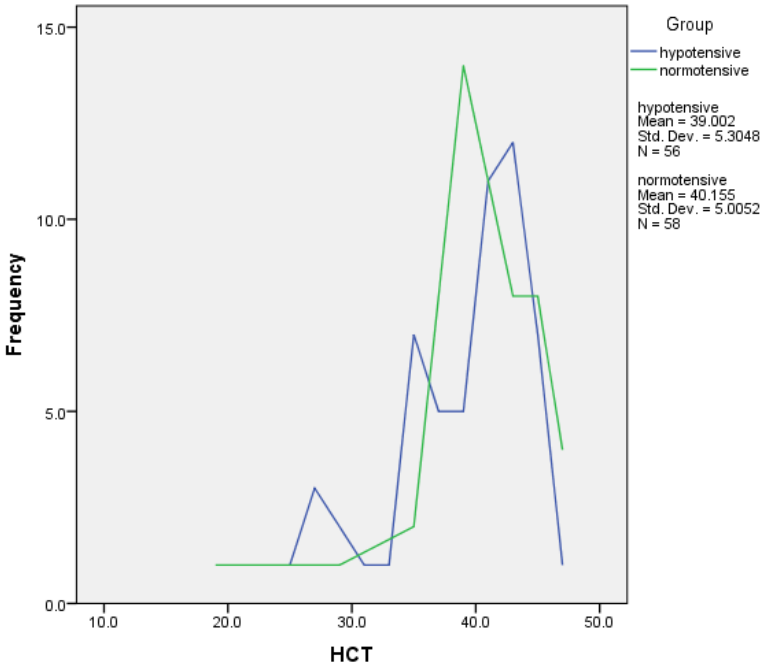


FIGURE 21: Line graph showing pre-operative HCT values for patients in both groups

5. COAGULATION PROFILE

Based on "t" test statistics

	Total (n=114)	Normotensive (n=58)	Hypotensive (n=56)	p-value
Platelet count (/cu-mm)	254.94±91.82	254.21± 95.08	255.70±89.17	0.931
PT (seconds)	14.57±1.85	14.72±1.86	14.40±1.83	0.355
INR (n)	1.09±0.09	1.09±0.78	1.07±0.09	0.276
APTT (seconds)	27.44±4.81	27.393±4.28	27.39±5.33	0.911
Fibrinogen (g/L)	353.49±117.42	352.48±117.42	354.53±115.41	0.925

TABLE 5: Distribution of study participants according to the coagulation profile

Among the variables in coagulation profile tests, the normotensive anesthesia group had mean of 254.21±95.08/cu-mm platelet count, mean of 14.72±1.86 seconds Prothrombin Time, mean of 1.09±0.78 INR values, mean of 27.393±4 seconds APTT values and mean of 352.48±117.42 g/L fibrinogen values. The hypotensive anesthesia group had mean of 255.70±89.17/cu-mm PLT, mean of 14.40±1.83 seconds PT, mean of 1.07±0.09 INR values, mean of 27.39±5.33 seconds APTT values and 354.53±115.41g/l fibrinogen. There was no statistically significant difference (p value>0.005) between the two groups in relation to coagulation profile tests of the patients as evidenced by "t" test statistics.

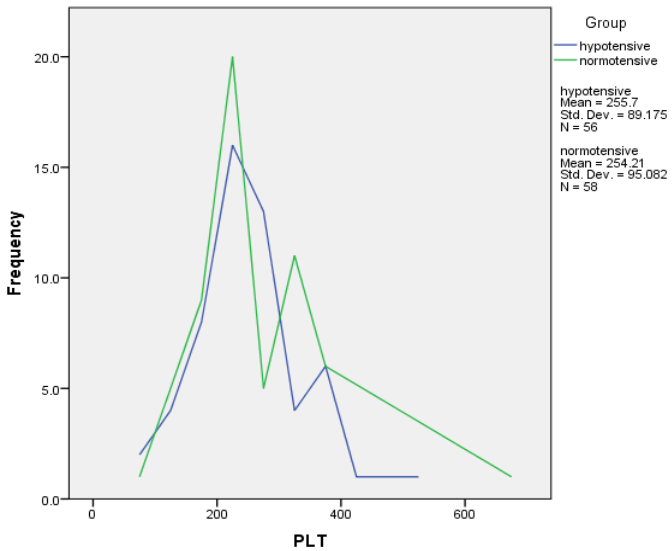


FIGURE 22: Line graph showing platelet values (PLT) for patients in both groups

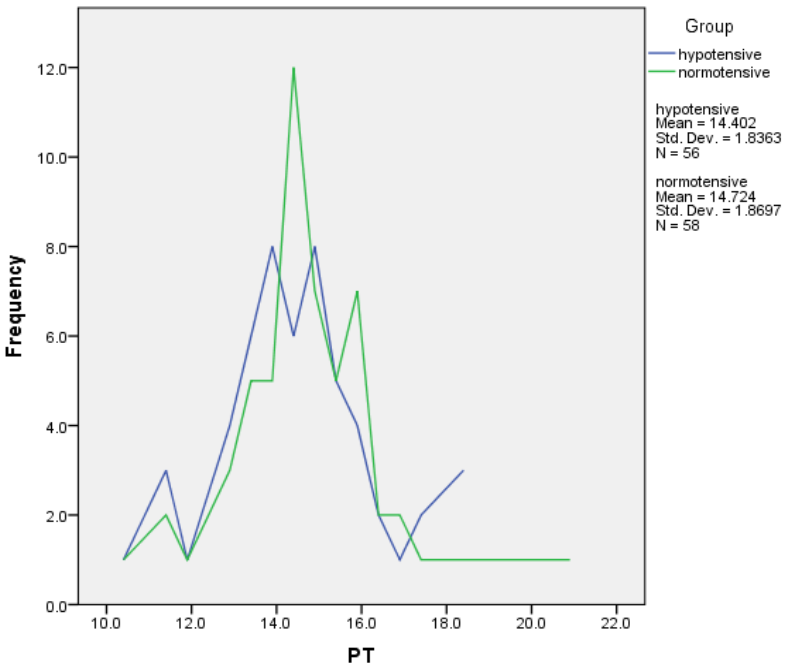


FIGURE 23: Line graph showing prothrombin time (PT) values for patients in both groups

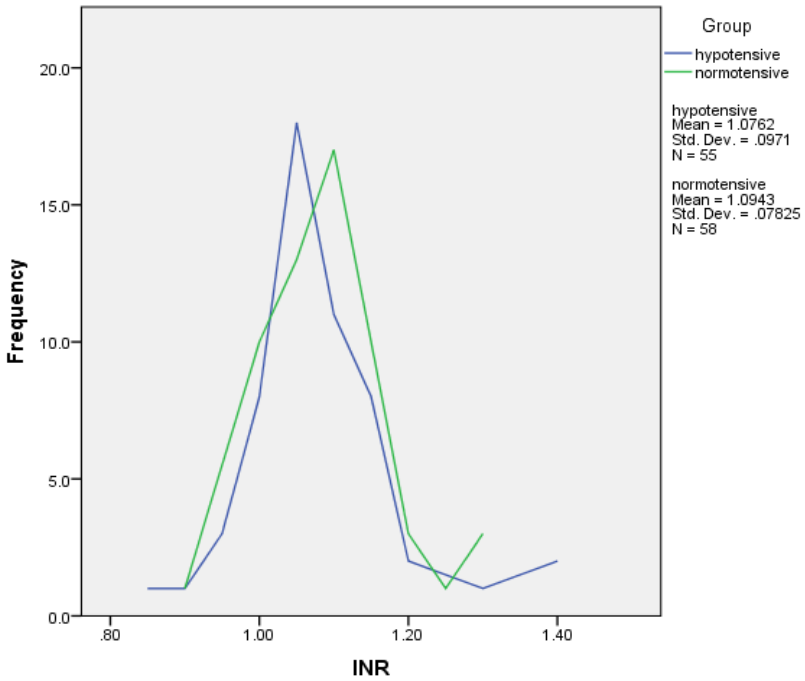


FIGURE 24: Line graph showing INR values for patients in both groups

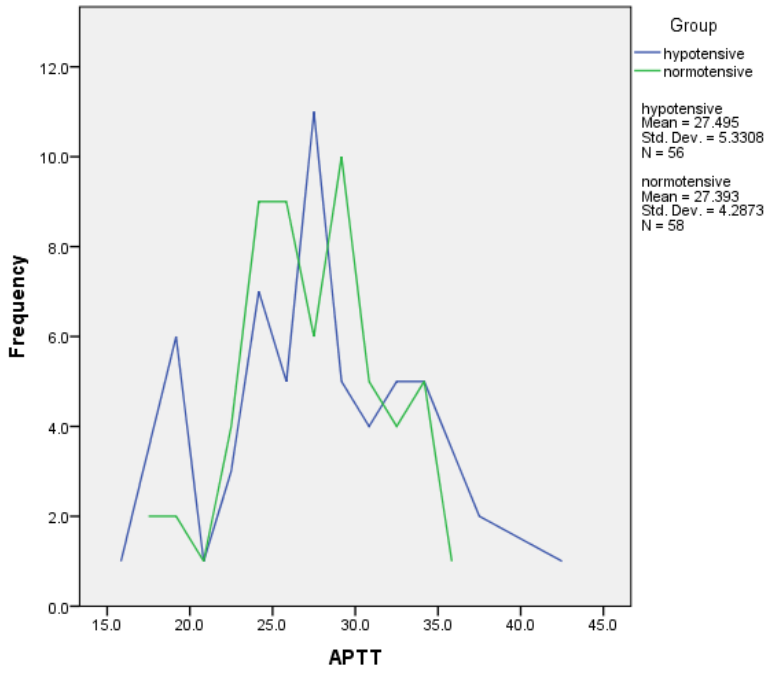


FIGURE 25: Line graph showing APTT values for patients in both groups.

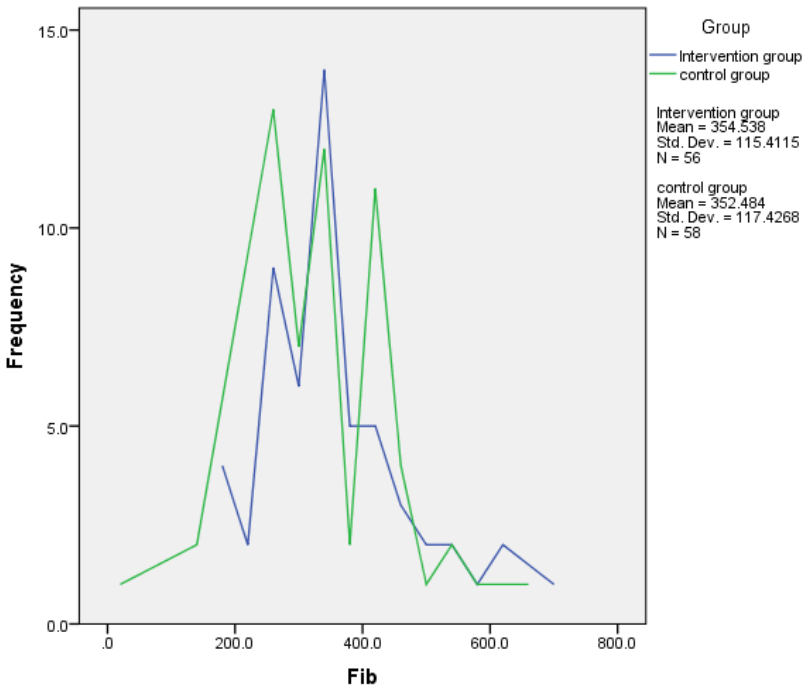


FIGURE 26: Line graph showing fibrinogen values for patients in both groups

6. PRE-OPERATIVE MEAN ARTERIAL PRESSURE (MAP) LEVELS

Based on "t" test statistics

	Total (n=114)	**Normotensive (n=58)**	**Hypotensive (n=56)**	**p-value**
MAP levels (mmHg) (Mean±SD)	90.94±7.37	92.15±7.57	89.67±6.98	0.72

TABLE 6: Distribution of study participants according to Pre-operative Mean Arterial Pressure (MAP) levels

Among 58 patients in NA group, the mean pre-operative MAP levels was 92.15±7.57mmHg and among 56 patients in HA group, the mean pre-operative MAP levels were 89.67±6.98mmHg. There was no statistical significant difference between the two groups (p value- 0.72) in relation to pre-operative MAP levels as evidenced by "t" test statistics.

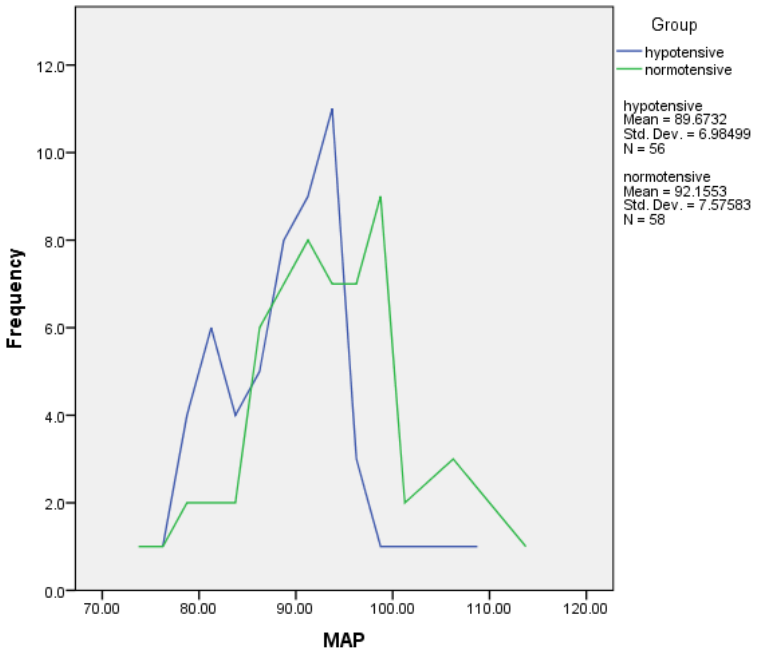


FIGURE 27: Line graph showing pre-operative MAP values for patients in both group

7. PRE-OPERATIVE PULSE LEVELS

Based on "t" test statistics

	Total (n=114)	**Normotensive (n=58)**	**Hypotensive (n=56)**	**p-value**
Pulse levels (beats/min) (Mean±SD)	76.99±8.21	77.05±7.95	76.91±8.53	0.928

TABLE 7: Distribution of study participants according to pre-operative Pulse levels

A mean of 77.05±7.95 beats/min pre-operative pulse levels was found in normotensive group and mean of 76.91±8.53beats/min pre-operative pulse levels was found in hypotensive group. There was no statistical significant difference found between the two groups in relation to pre-operative pulse levels at 0.05 level of significance as evidenced by "t" test statistics.

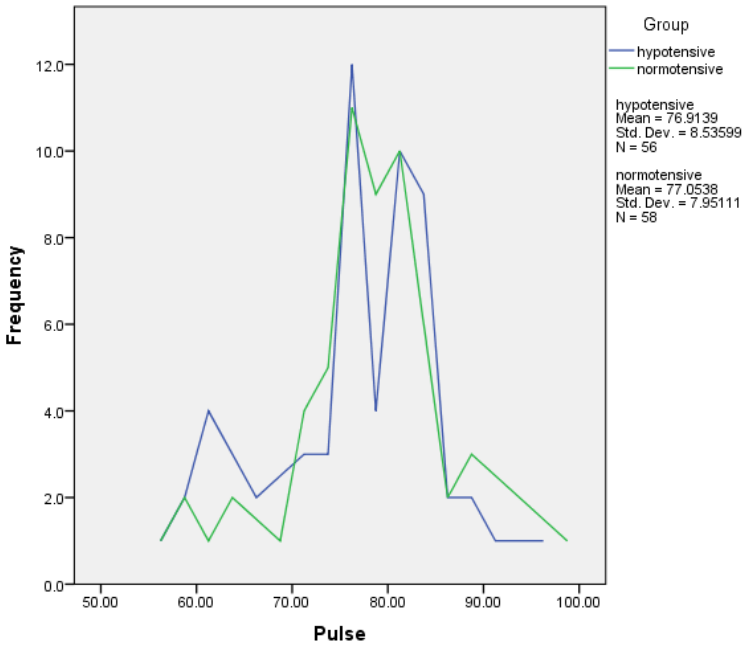


FIGURE 28: Line graph showing pre-operative pulse values for patients in both groups

8. PRE-OPERATIVE OXYGEN SATURATION LEVELS

Based on "t" test statistics

	Total (n=114)	**Normotensive (n=58)**	**Hypotensive (n=56)**	**p-value**
Oxygen saturation levels (%) (Mean±SD)	99.55±0.72	99.27±0.84	99.46±0.74	0.207

TABLE 8: Distribution of study participants according to pre-operative oxygen saturation levels

There was no statistical significant difference found between the NA group (99.27±0.84)% and HA group (99.46±0.74)% in respect to pre-operative oxygen saturation levels at 0.05 level of significance as evidenced by "t" test statistics.

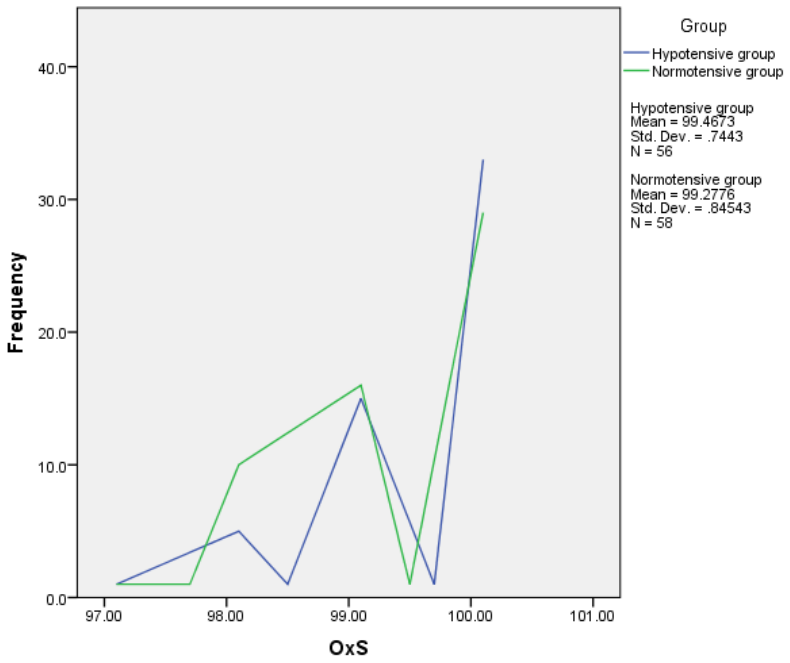


FIGURE 29: Line graph showing pre-operative oxygen saturation values for patients in both groups

9. INTUBATION TIME

Based on "t" test statistics

	Normotensive (n=58)	Hypotensive (n=56)	p-value
Intubation time (min) (Mean±SD)	5.59±2.47	6.29±3.41	0.212

TABLE 9: Difference in intubation time between the two groups

Among 58 patients in NA group, the mean intubation time was 5.59±2.47min and among 56 patients in HA group, the mean intubation time was 6.29±3.41min. There was no statistical significant difference (p value-0.212) between the two groups in relation to intubation time at 0.05 level of significance as evidenced by "t" test statistics.

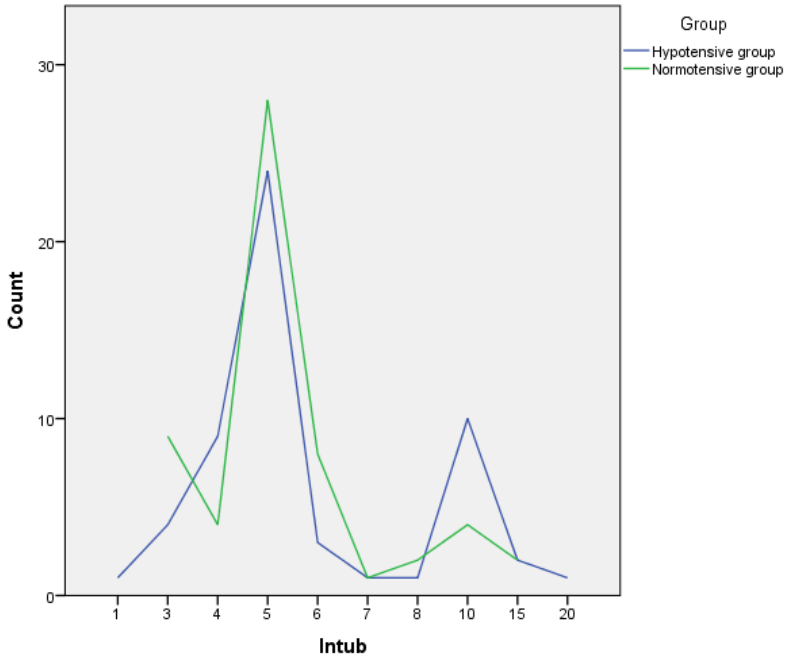


FIGURE 30: Line graph showing intubation time for patients in both groups

10. EXTUBATION TIME

Based on "t" test statistics

	Normotensive (n=58)	**Hypotensive (n=56)**	**p-value**
Extubation time (min) (Mean±SD)	5.66±2.90	5.93±2.47	0.590

TABLE 10: Difference in extubation time between the two groups

There was no statistical significant difference (p value-0.590) between the NA (5.66±2.90 min) and HA group (5.93±2.47min) in terms of extubation time at 0.05 level of significance as evidenced by "t" test statistics.

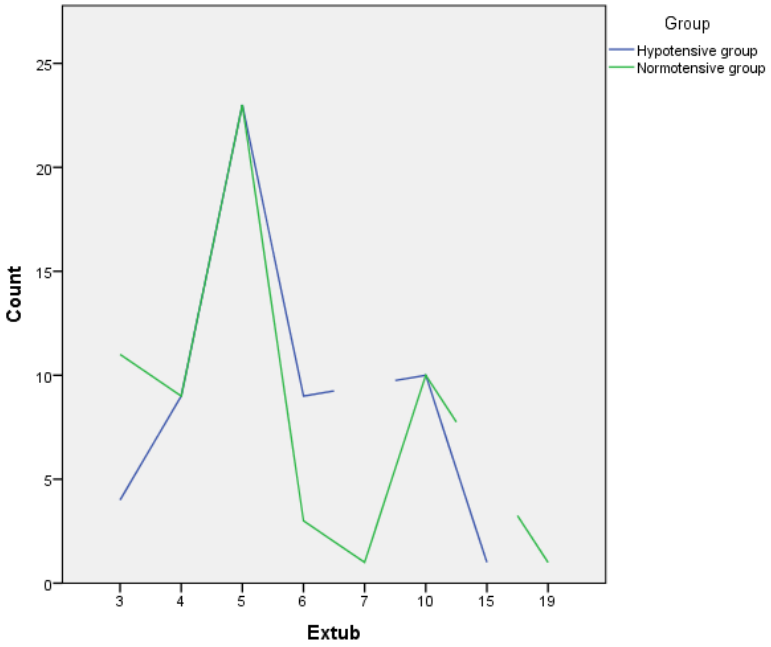


FIGURE 31: Line graph showing extubation time for patients in both groups

11. NUMBER OF FRACTURE FIXATION (ORIF) SITES

Based on "t" test statistics

	Total (n=114)	**Normotensive (n=58)**	**Hypotensive (n=56)**	**p-value**
ORIF site (n) (mean±SD)	2.21±1.11	2.33±1.20	2.09±0.99	0.253

TABLE 11: Difference in number of fracture fixation sites between the two groups

A mean of 2.21±1.11 number of fracture sites in all the study patients were fixed with miniplates intra-operatively. All the 58 patients in NA group had undergone ORIF at 2.33±1.20 number of fracture sites, whereas all the 56 patients in HA group underwent ORIF at 2.09±0.99 number of fracture sites. There was no statistically significant difference (p value-0.253) between the groups in relation to number of fracture fixation sites.

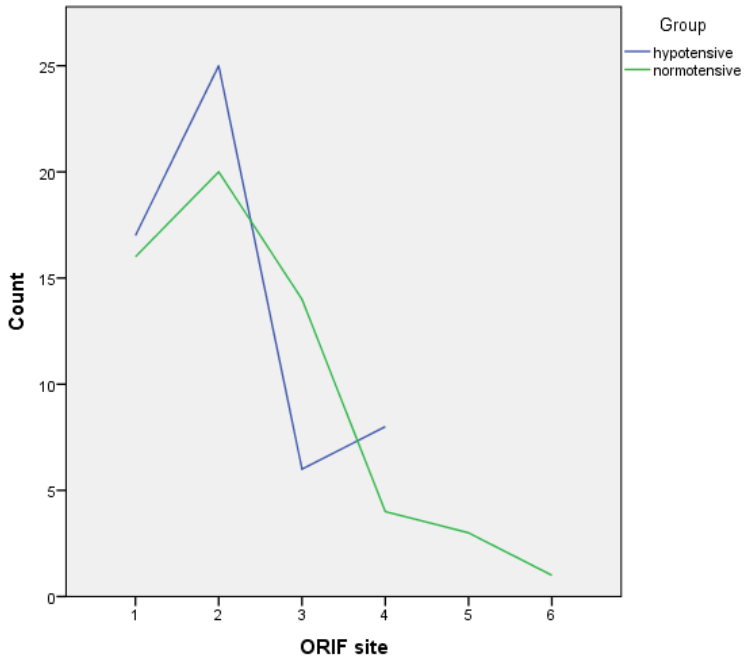


FIGURE 32: Line graph showing number of fracture fixation (ORIF) sites for samples

12. SURGICAL DURATION

Based on "t" tests of analysis

	Normotensive (n=58)	Hypotensive (n=56)	p-value
Duration of surgery (hours) (mean±SD)	2.31±1.00	2.4±0.95	0.619

TABLE 12: Difference in surgical duration between the two groups

A mean of 2.3±1.00 hours of surgical duration was noted in NA group and 2.4±0.95 hours of surgical duration in HA group. There was no statistically significant difference (p value-0.619) found in the surgical duration between the groups.

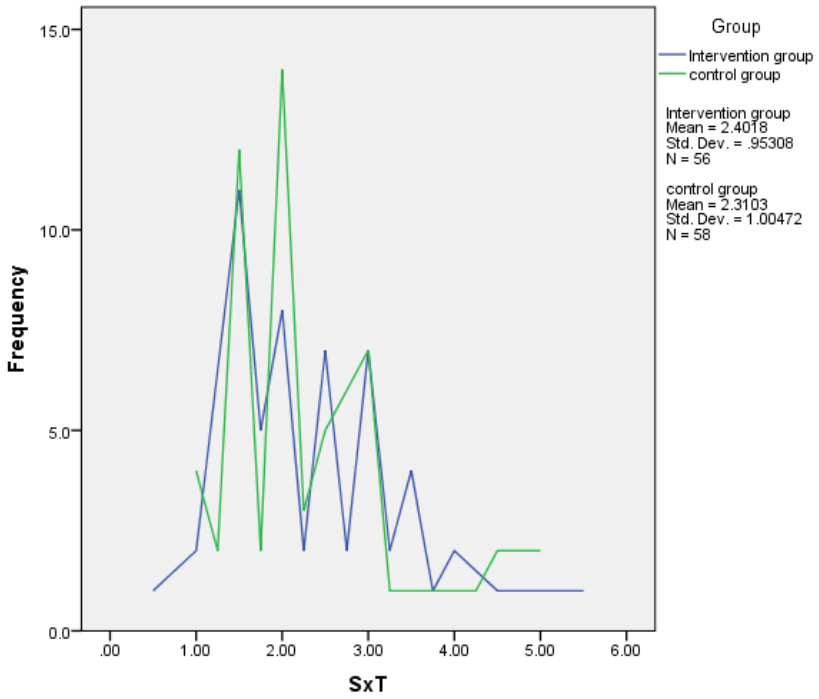


FIGURE 33: Line graph showing difference in surgical duration (hours) for patients in both groups

13. QUALITY OF SURGICAL FIELD

Based on repeated measure ANOVA tests

Tests of Between-Subjects Effects					
Measure: Surgery field					
Transformed Variable: Average					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Group	15.478	1	15.478	11.741	.001
Error	147.647	112	1.318		

TABLE 13: Difference in quality of surgical field between the two groups

A statistically significant difference in quality of surgical field (measured by Fromme *et al.* ordinal scale) between hypotensive (1.68±0.64) and normotensive group (2.05±0.49) as evidenced by repeated measures ANOVA (F=11.741) df(1,112) and p value-0.001.

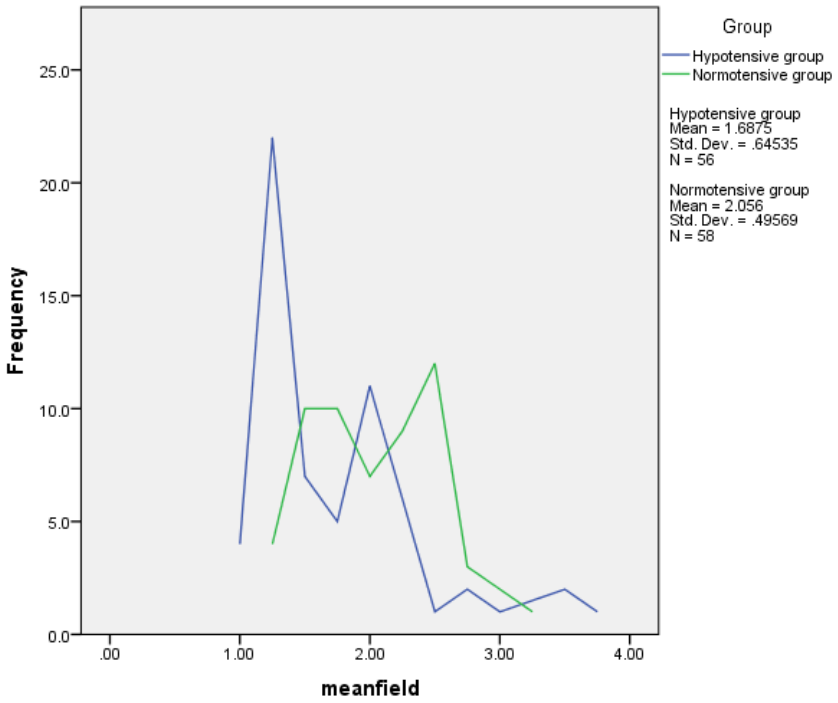


FIGURE 34: Line graph showing difference in quality of surgical field in both groups

14. SURGEON'S SATISFACTION

Based on "t" test analysis

Coefficients [a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.926	.177		33.537	.000
	Group	-.998	.111	-.647	-8.973	0.001*
a. Dependent Variable: surgeon satisfaction (Likert scale)						

TABLE 14: Difference in Surgeon's satisfaction between the two groups

There is statistically significant difference in surgeon's satisfaction on Likert's scale seen in HA (4.93±0.65) and NA (3.93±0.52) groups as evidenced by "t" analysis (p-value= 0.000).

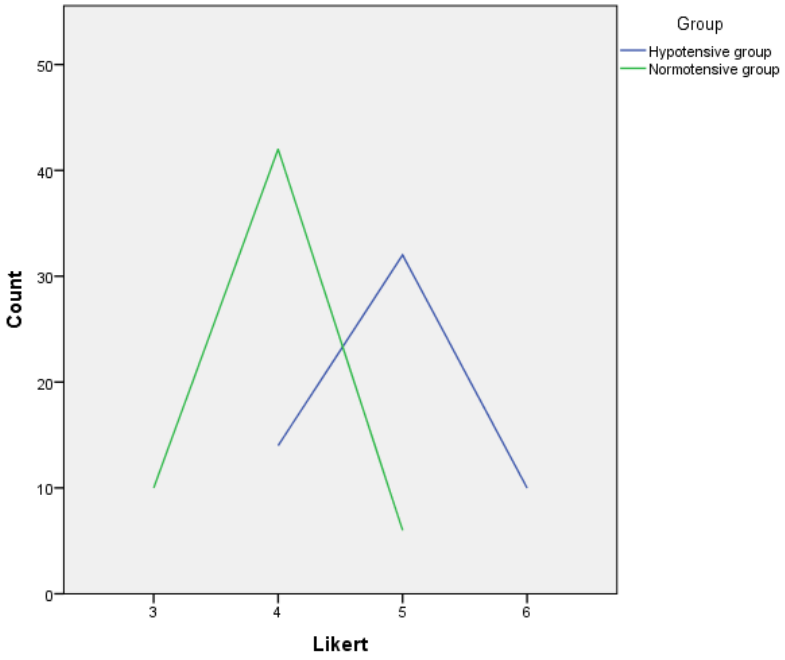


FIGURE 35: Line graph showing difference in surgeon satisfaction score for patients in both groups

15. INTRA-OPERATIVE MAP LEVELS

Based on repeated measure ANOVA tests

Tests of Between-Subjects Effects					
Measure: operative MAP					
Transformed Variable: Average					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Group	13002.746	1	13002.746	24.108	.000
Error	29664.254	55	539.350		

TABLE 15: Difference in intra-operative MAP levels between the two groups

There was a statistically significant difference found in the intra-operative mean arterial blood pressure in both the groups as evidenced by repeated measure ANOVA tests (F=24.108), df(1,55) and p-value=0.000.

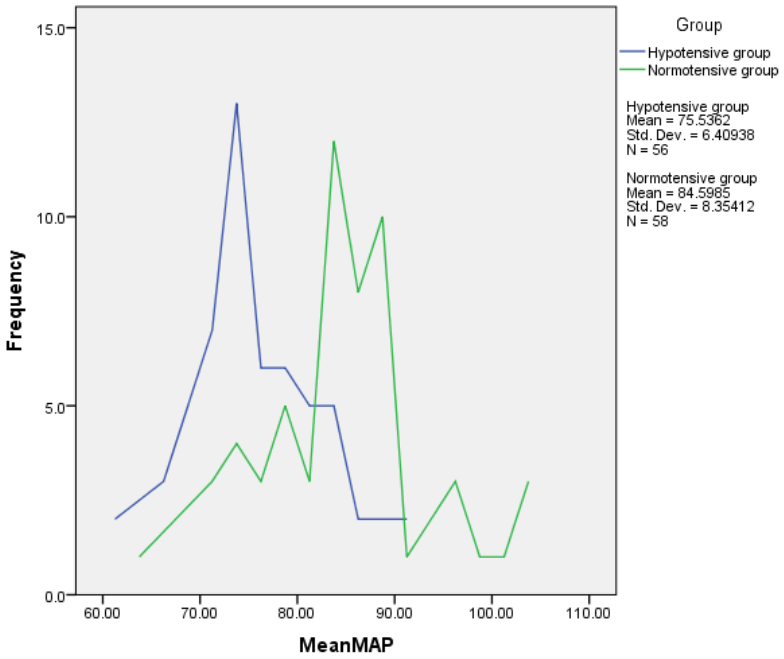


FIGURE 36: Line graph showing difference in intra-operative MAP levels between both groups

16. INTRA-OPERATIVE PULSE RATE LEVELS

Based on repeated measure ANOVA tests

Tests of Between-Subjects Effects					
Measure: operative Pulse					
Transformed Variable: Average					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Group	468.114	1	468.114	.341	.562
Error	74190.429	54	1373.897		

TABLE 16: Difference in intra-operative Pulse rate levels between the two groups

There was no statistically significant difference found in the intra-operative Pulse rate levels in both the groups as evidenced by repeated measure ANOVA tests (F=0.341), df(1,54) and p-value=0.562.

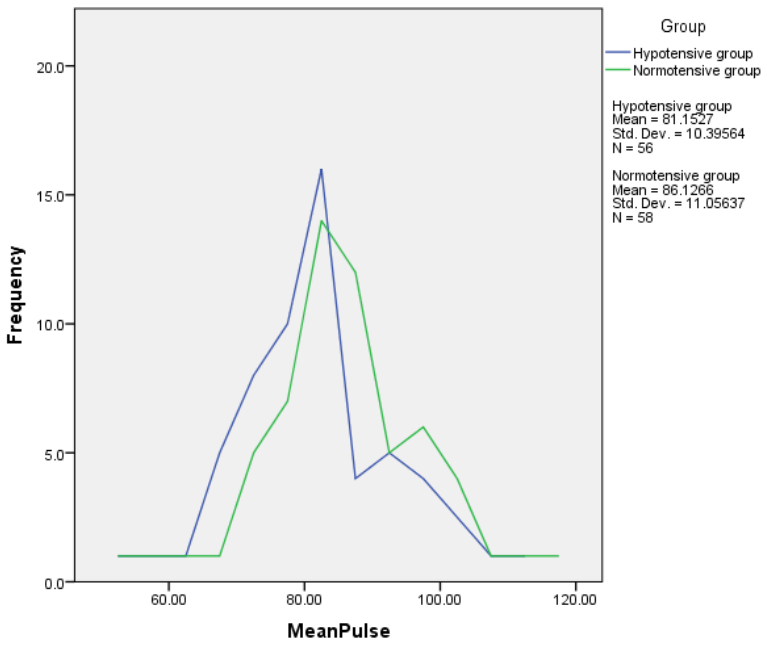


FIGURE 37: Line graph showing difference in intra-operative pulse levels between both groups

17. INTRA-OPERATIVE OXYGEN SATURATION

Based on repeated measure ANOVA tests

Tests of Between-Subjects Effects					
Measure: Oxygen saturation					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Group	.469	1	.469	.076	.784
Error	477.024	77	6.195		

TABLE 17: Difference in intra-operative oxygen saturation levels between the two groups

There was no statistically significant difference found in the intra-operative xygen saturation levels in both the groups as evidenced by repeated measure ANOVA tests (F=0.076), df(1,77) and p-value=0.784.

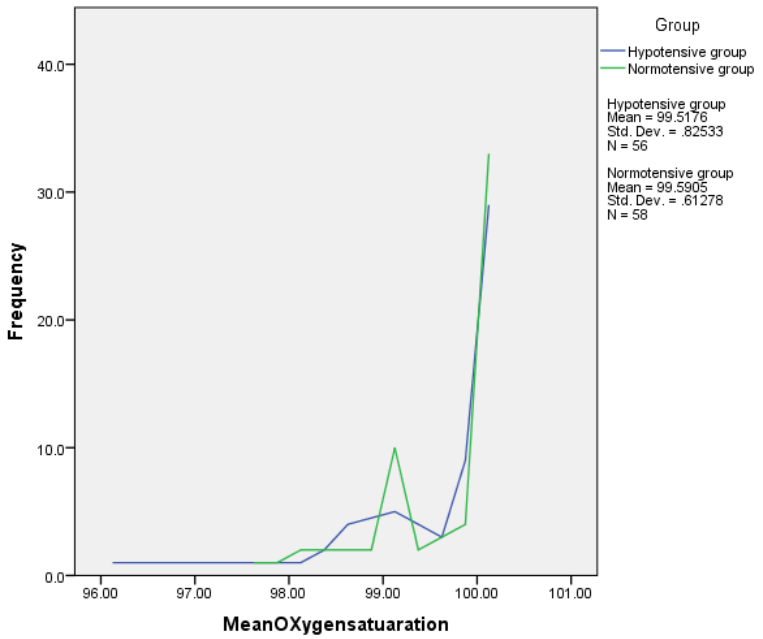


FIGURE 38: Line graph showing difference in intra-operative oxygen saturation values between the two groups

18. INTRA-OPERATIVE EtCO2 LEVELS

Based on repeated measure ANOVA tests

Tests of Between-Subjects Effects					
Measure: ETCo2					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Group	557.145	1	557.145	.713	.402
Error	42199.791	54	781.478		

TABLE 18: Difference in intra-operative EtCO2 levels between the two groups

There was no statistically significant difference found in the intra-operative EtCO2 levels in both the groups as evidenced by repeated measure ANOVA tests (F=0.713), df(1,54) and p-value=0.402.

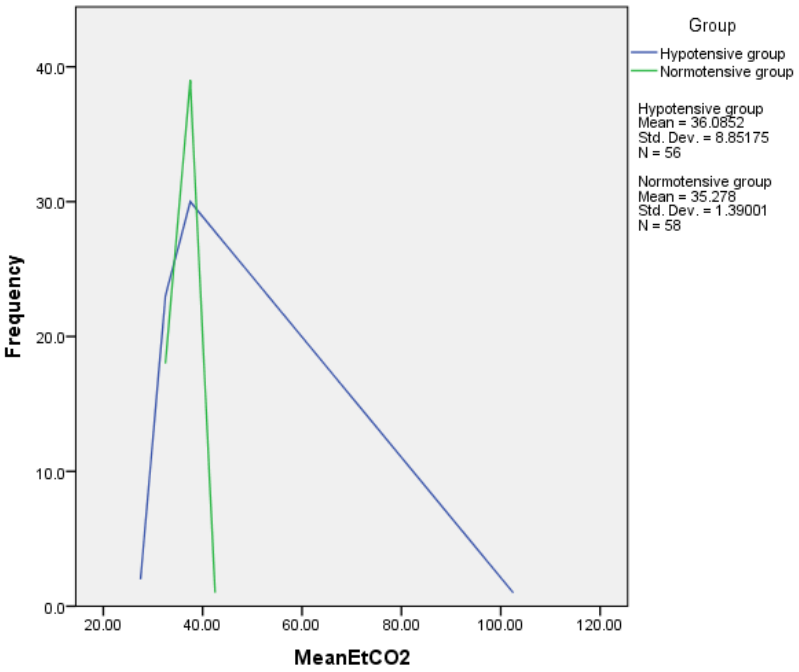


FIGURE 39: Line graph showing difference in intra-operative EtCO2 levels between the two groups

19. VOLUMETRIC BLOOD LOSS

Based on "t" tests of analysis

	Normotensive (n=58)	Hypotensive (n=56)	p-value
Volumetric blood loss (mL) (Mean±SD)	187.67±51.13	153.39±27.48	0.001

TABLE 19: Difference in Volumetric blood loss between the two groups

A mean of 153.39±27.48mL of blood loss was noted during the surgery in hypotensive group as compared to 187.67±51.13mL of blood loss in the NA group. There was statistically significant difference (p value-0.001) in the amount of volumetric blood loss during surgery in both of the groups as evidenced by "t" test analysis.

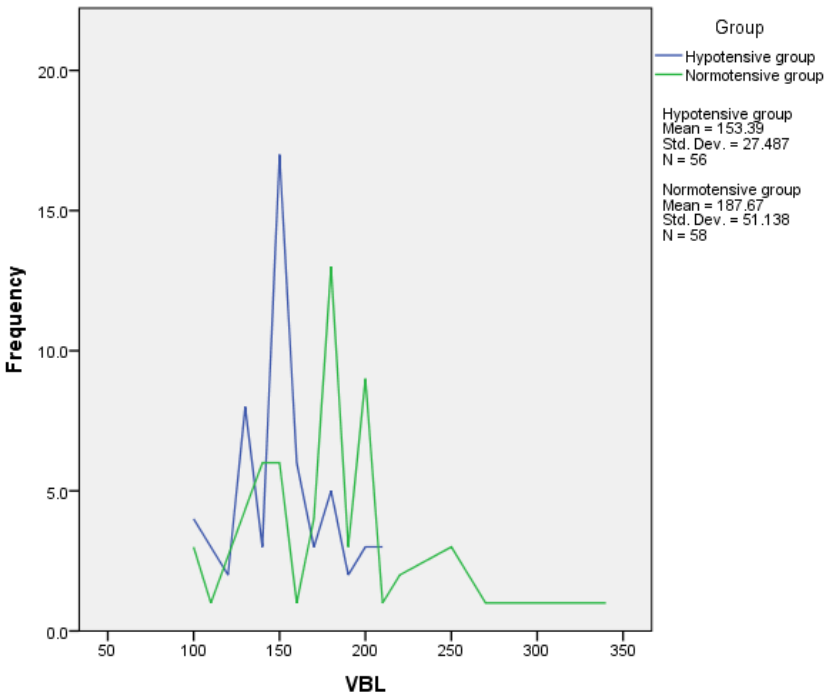


FIGURE 40: Line graph showing difference in volumetric blood loss for patients in both groups

20. INTRA-OPERATIVE NIRS (LEFT) LEVELS

Based on repeated measure ANOVA tests

Tests of Between-Subjects Effects					
Measure: NIRS					
Transformed Variable: Average					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Group	1341.292	1	1341.292	1.633	.206
Error	46809.173	57	821.214		

TABLE 20: Difference in intra-operative NIRS (Left) levels between the two groups

There was no statistically significant difference found in the intra-operative NIRS (Left) levels in both the groups as evidenced by repeated measure ANOVA tests (F=1.633), df(1,57) and p value-0.206.

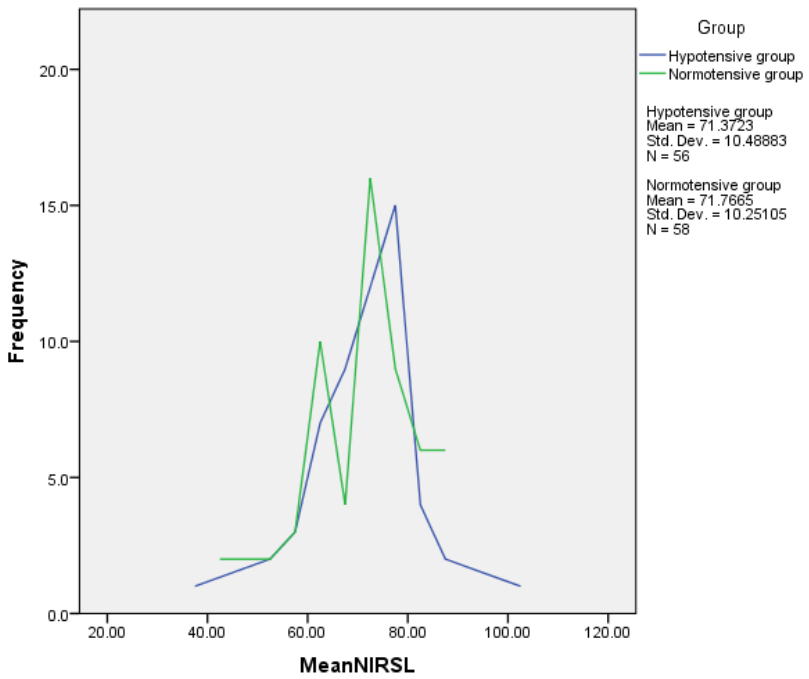


FIGURE 41: Line graph showing difference in NIRS (Left) values between the two groups

21. INTRA-OPERATIVE NIRS (RIGHT) LEVELS

Based on repeated measure ANOVA tests

Tests of Between-Subjects Effects					
Measure: NIRS					
Transformed Variable: Average					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Group	58.917	1	58.917	.068	.796
Error	47904.086	55	870.983		

TABLE 21: Difference in intra-operative NIRS (Right) levels between the two groups

There was no statistically significant difference found in the intra-operative NIRS (Right) levels in both the groups as evidenced by repeated measure ANOVA tests (F=0.068), df(1,55) and p value-0.796.

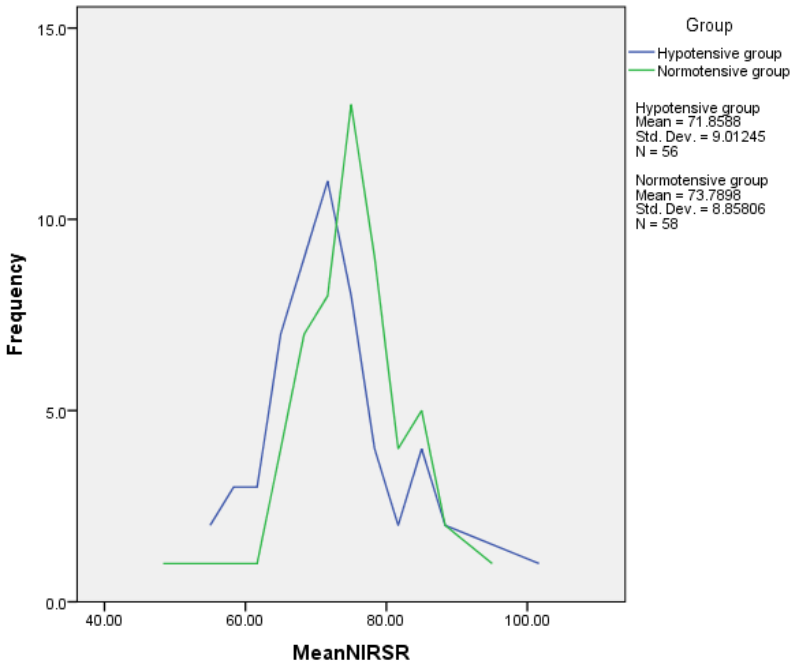


FIGURE 42: Line graph showing difference in NIRS (right) values between the two groups

22. POST-OPERATIVE HEMOGLOBIN LEVELS

Based on "t" test analysis

	Normotensive (n=58)	**Hypotensive (n=56)**	**p-value**
Hb levels (g%) (Mean±SD)	12.51±1.84	12.53±1.66	0.951

TABLE 22: Difference in post-operative hemoglobin levels between the two groups:

In the normotensive group, the mean post-operative Hb levels was 12.51±1.84 g% and in the hypotensive group, the mean post-operative Hb levels was 12.53±±1.66 g%. There was no statistical difference (p value-0.951) between the two groups in relation to post-operative Hb levels at 0.05 level of significance as evidenced by "t" test statistics.

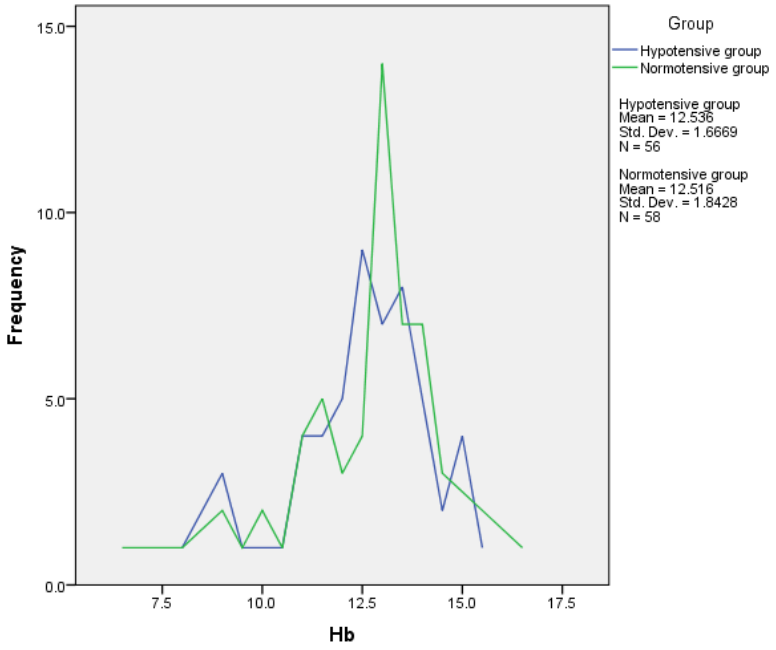


FIGURE 43: Line graph showing difference in post-operative hemoglobin values for patients in both groups.

23. POST-OPERATIVE HCT LEVELS

Based on "t" test analysis

	Normotensive (n=58)	**Hypotensive (n=56)**	**p-value**
HCT levels (%) (Mean±SD)	38.54±5.28	37.51±6.84	0.367

TABLE 23: Difference in post-operative Hematocrit (HCT) levels between the two groups:

In the normotensive group, the mean post-operative HCT levels was 38.54±5.28% and in the hypotensive group, the mean post-operative HCT levels was 37.51±6.84%. There was no statistical significant difference (p value-0.367) between the two groups in relation to post-operative HCT levels at 0.05 level of significance as evidenced by "t" test statistics.

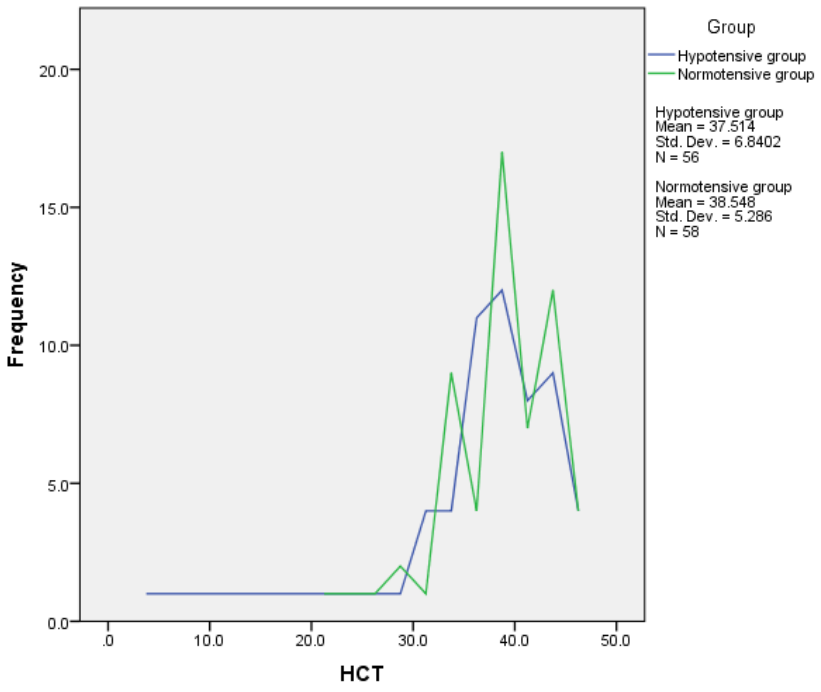


FIGURE 44: Line graph showing difference in post-operative HCT values for patients in both groups

	Dependent t-test statistics					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Preoperative HCT – post-operative HCT (%)	1.6069	4.5800	0.6014	2.8111	0.4026	2.672	57	0.010*

TABLE 24: Difference in pre-operative and post-operative Hematocrit (HCT) levels in normotensive group

There was a statistically significant difference (p value-0.01) found in difference between the pre-operative and post-operative HCT values in normotensive group signifying greater blood loss in this group.

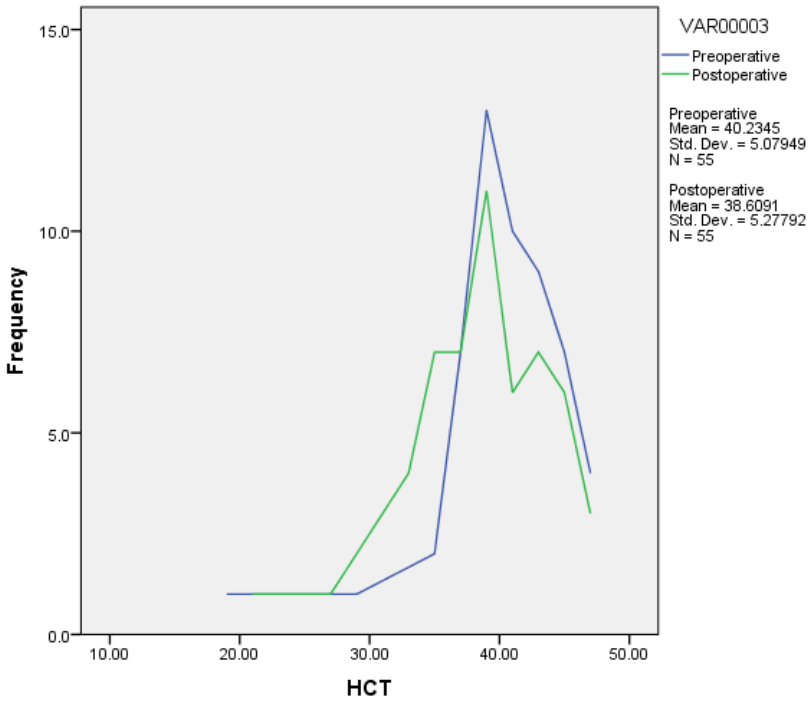


FIGURE 45: Line graph showing difference in* pre-operative *and post-operative HCT values for patients in normotensive group

	Dependent t-test statistics					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Preoperative HCT – post-operative HCT (%)	1.4875	5.8002	0.7751	3.0408	0.0658	1.919	55	0.060

TABLE 25: Difference in pre-operative and post-operative Hematocrit (HCT) levels in hypotensive group

There was no statistically significant difference (p value>0.05) found in difference between the pre-operative and post-operative HCT values in hypotensive group, implying less amount of blood loss which did not decrease HCT value extensively.

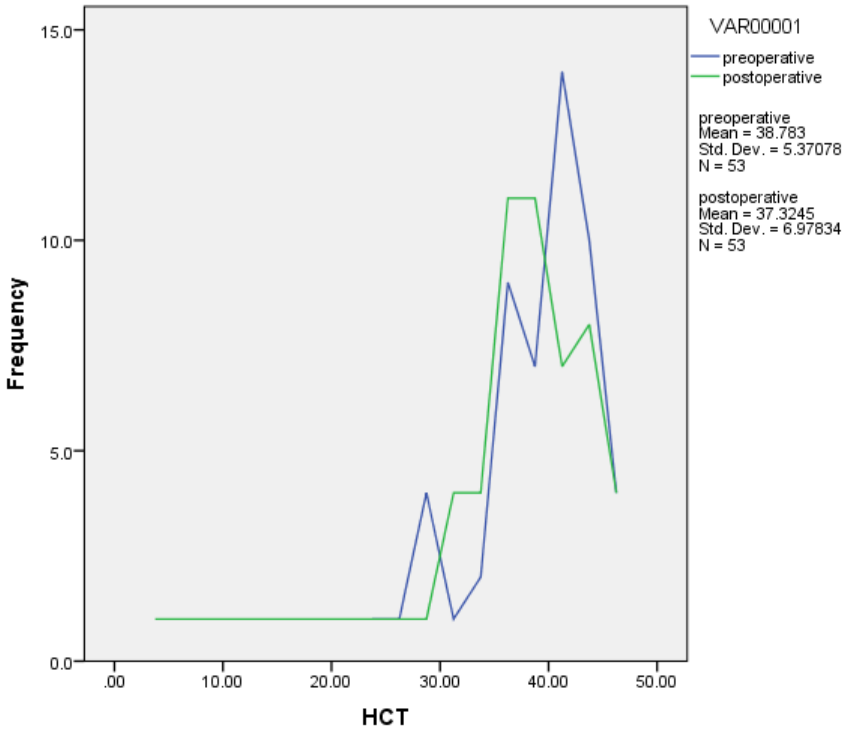


FIGURE 46: Line graph showing difference in* pre-operative *and post-operative HCT values for patients in hypotensive group

24. POST-OPERATIVE PAIN (VAS SCORE)

Based on repeated measure ANOVA tests

Tests of Between-Subjects Effects					
Measure: Pain					
Transformed Variable: Average					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Group	8.910	1	8.910	1.048	.308
Error	952.403	112	8.504		

TABLE 26: Difference in Post-operative Pain levels between the two groups

There is no statistically significant difference in post-operative pain levels between hypotensive and normotensive groups as evidenced by repeated measures ANOVA (F=1.048) df(1,112) and p value 0.308.

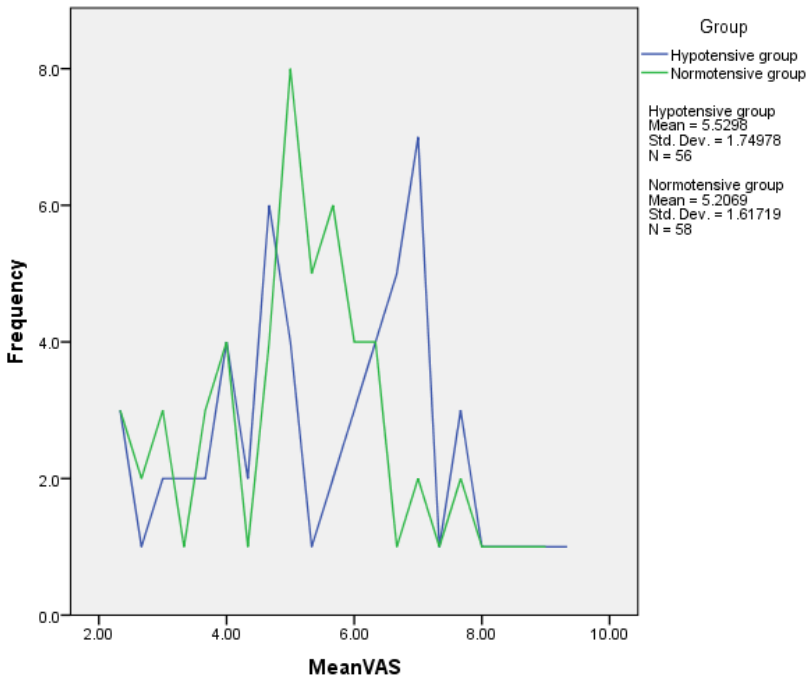


FIGURE 47: Line graph showing difference in post-operative pain levels for patients in both groups

DISCUSSION

Trauma is considered as one of the main causes of death among the population below 40 years of age (24). Among trauma, road traffic accident (RTA) (73.8%) has been the most common cause in the developing countries, followed by falls (18%), assaults (6.7%) and sports injury (1.5%) (25). The global burden of non-fatal injuries due to trauma is between 20-50 million people every year according to WHO news report. The maxillofacial region in the body is the most vulnerable part to be affected by trauma. As high as 20-25% of the polytrauma patients have maxillofacial injuries (26). Most of the times, maxillofacial injuries are associated with other systemic injuries like cervical spine, head injury, thoracic, abdominal, orthopedic, which increases the morbidity and mortality of these patients. Severity of injury have also found to be greater in MFT positive patients.

Majorly in trauma cases, bleeding occurs at multiple levels depending on the number of sites involved. It has been found that 1.9% of MFT positive polytrauma patients have "relevant blood loss i.e. >20% of total blood loss."(1) There is enough literature evidence where blood loss in the form of acute hemorrhage due to trauma accounts for 30-40% of mortality, out of which 33-56% occur during the pre-hospital period (27). This blood loss at the primary site i.e. at place of impact of trauma is inevitable. Further, a multitude of traumatic injuries would further compound the blood loss of highly vascular maxillofacial region, as these patients require multiple surgeries and debridement during their hospital stay. Besides, most of the MFT patients have limited mouth opening and difficulty in eating food, which further compromises their nutritional status, thus hampering the heme buildup (4).

The associated morbidity of acute blood loss may affect the patient hemodynamically, negatively impacting their healing, overall wellbeing, day to day activities, social interactions drastically effecting their physical, socio-economical and psychological wellbeing (28)(29). However, trauma victims have set defined protocols for reducing blood loss at varied levels of care, for example, at the site of trauma, prehospital period and during the surgery. Various methods like application of digital pressure, tourniquets, local hemostatic agents, manual reduction of fracture and stabilization can be employed to control the bleeding during prehospital settings.

Whereas, in hospital, early exploration and clamping if needed, and pressure packing with balloon tamponade, intravenous tranexamic acid, desmopressin, patient positioning, suturing of the tissues, electrocauterization devices have been used to control the bleeding either in emergency or during surgery. In severe bleeding cases, angiography followed by trans-arterial embolization or external carotid artery ligation and controlled hypotension in GA are also indicated (30)(31).

Hypotensive anesthesia is one of the effective modalities commonly used in various cardiac, orthopedics, spinal and maxillofacial surgeries to reduce the intra-operative blood loss (32)(33)(34)(12). With the advent of using arteriotomy procedure, hypotensive anesthesia was invented by Harvey William Cushing during an intracranial surgery in 1917, to provide a blood less field (3). In 1962, sodium nitroprusside was first drug used to induce hypotension during anesthesia (35).

In normotensive anaesthesia, the patients MAP is kept at levels that are within the range of blood pressure that were measured in pre-operative period. In hypotensive anaesthesia, patients MAP is reduced by 30%, which usually brings the SBP under 90 mmHg and the MAP below 65 mmHg. With this study, we intended to determine the benefits of hypotensive anaesthesia in MFT patients while keeping a close watch on cerebral oxygenation as a marker of adversity.

Several agents can be used either alone or in combination with others, to induce controlled hypotension such as inhalational anaesthetics, sodium nitroprusside, nitro-glycerine, trimethaphan, calcium channel blockers (e.g. nicardipine), adreno receptors antagonists (e.g. propranolol and esmolol), ACE inhibitors, alpha2-adrenoreceptor agonists (e.g. clonidine, dexmedetomidine). In our study, we have used dexmedetomidine as the drug of choice for intervention. It is known to reduce BP, PR, cardiac output and norepinephrine release.

Hypotensive anesthesia lowers the intra-operative MAP of the patients and therefore reduce the blood loss intra-operatively and prevents the requirement for blood transfusions. It enhances the quality of surgical field by reducing the volume of blood in the field during the dissection of tissues and provides a cleaner field to the surgeon for more accurate surgery. With this, it also shortens the surgical time. While the evidence showed benefit of HA, the possible complications of using this technique need to be looked upon. It has been seen as a possible cause of damage to vital organs because

of hypoperfusion, especially the brain, heart, kidneys and liver. In few studies, major complications like cerebral damage, stroke, dysrhythmia, cardiac arrest or even death have been reported following hypotensive anesthesia in the patients who suffered previously from diseases like cerebrovascular diseases, coronary artery disease or uncontrolled hypertension (4)(36)(37).

Therefore, RCT was conducted so as to evaluate and compare the effects of hypotensive anesthesia with dexmedetomidine (0.2-0.7 mcg/kg/hour after a bolus dose of 1mcg/hour over 10 mins) in MFT patients in terms of surgical field, intra-operative blood loss and effect on cerebral perfusion using NIRS monitoring.

In our study, maxillofacial trauma cases have been seen most commonly in the young adults in the range of 25-40 years of age (36.8%). Our study sample's mean age was 32.3$\pm$12.07 years. Furthermore, the mean age of patients in NA group was 31.60$\pm$11.54 years in comparison to 33.16$\pm$12.64 years in HA group and the difference in age distribution was found to be statistically insignificant. This can be attributed to the fact that this division of population is mostly moving outdoors, is socially more interactive and is the earning set of people in western Rajasthan. Similar findings of younger population being involved have also been reported in the literature in respect to maxillofacial trauma in Indian studies (38)(39) as well as international studies (40).

The number of male patients in NA group were 56 (96.6%) and 2 (3.4%) patients were females. In the HA group, 51 patients were male (91.1%) and 5 patients were females (8.9%) and this difference was found to be statistically insignificant. The predominance of male gender getting affected by MFT (93.9%) in comparison to females (6.1%) in our study is ascribed to the fact that the males are the primary earning members of families in an Indian society as compared to women who are considered to be responsible for household work. Further, the ratio of male drivers on road to females is more, exposing men to trauma. These results are in concurrence with other studies by Gandhi *et al.* and Subhas raj *et al.* (41)(38).

The highest number of our patients had midfacial fractures (45.6%) followed by mandibular fractures (32.5%). Only 21.9% of patients had fractured the entire facial skeleton i.e., pan-facial fractures. The reason of midfacial region getting more affected can be due to the most projecting out bony and soft tissue skeleton over the middle third of face. The results are similar in the study conducted by Agarwal P *et al.* who reported

55.5% of midface fractures and 44.5% of mandibular fractures. However, few studies have reported mandible bone as the most common site of maxillofacial trauma (42)(43). Among 58 patients in NA group, 53.4% of patients (n=31) had midface fracture, 25.9% of patients (n=15) had mandibular fractures, 20.7% of patients (n=12) were having pan-facial fractures. However, in 56 patients in HA group, 37.5% of patients (n=21) had midface fracture, 39.3% of patients (n=22) had mandibular fractures, 23.2% of patients (n=13) were having pan-facial fractures. It was found that fracture pattern distribution in both the study groups was statistically insignificant.

All the MFT patients underwent complete hemogram profile as a pre-operative investigation which showed mean of 40.15±5.00 hematocrit (HCT) levels and mean of 13.58±1.43g% hemoglobin (Hb) levels in NA group. A mean of 39.0±5.30 HCT values and mean of 13.12±1.74g% Hb values were observed in HA group. This difference was found to be insignificant, signifying that there was normal distribution of patients in both of the groups.

All patients had coagulation profile tests done pre-operatively which included platelet count (PLT), prothrombin time (PT), INR (International normalized ratio), Activated partial thromboplastin time (APTT) and fibrinogen. The normotensive anesthesia group had mean of 254.21± 95.08/cu-mm PLT, mean of 14.72±1.86 seconds PT, mean of 1.09±0.78 INR values, mean of 27.393±34 seconds APTT and mean of 352.48±117.42g/L fibrinogen values. The hypotensive group had mean of 255.70±89.17/cu-mm PLT, mean of 14.40±1.83 seconds PT, mean of 1.07±0.09 INR, mean of 27.39±5.33 seconds APTT and 354.53±115.41g/l fibrinogen. This difference in relation to coagulation profile was found to be statistically insignificant indicating homogenous distribution between the two groups.

As a part of pre-operative parameters, the average of 3 readings of Mean arterial blood pressure and pulse rates of all the patients were noted. The mean of pre-operative MAP levels was 92.15±7.57mmHg in NA group and 89.67±6.98mmHg in HA group which showed no statistical significant difference between the two groups in relation to MAP levels. A mean of 77.05±7.95 beats/min of pre-operative pulse levels was found in normotensive group and mean of 76.91±8.53 beats/min was found in hypotensive group with no statistical significant difference between the two groups. This implies that the patients were normally distributed in both the groups in relation to pre-operative

MAP levels and Pulse rates. All the patients had 100% oxygen saturation in pre-operative period as per the standard pulse-oximeter device used.

Statistically insignificant difference in distribution of patient's sociodemographic characteristics (in the form of age, gender), trauma characteristics (for example, type of fractures and number of fracture sites), hematological parameters (like hematocrit, hemoglobin and coagulation profile) and hemodynamic parameters (in the form of MAP and pulse rate) was seen in both the groups. This statistically insignificant distribution signifies that the patients in both the study groups had a homogenous distribution. Thus, all the patients and injury related confounding factors have been adequately balanced by randomization.

All the patients in the study were treated with ORIF as per AO trauma protocol under GA in operation room under adequate coverage of antibiotics and analgesics. Study patients were randomly distributed. The patients in normotensive group were treated with standard anesthesia protocol (propofol, fentanyl for induction and inhalation drug like sevoflurane for maintenance anesthesia). The patients under hypotensive group were treated with an additional drug, dexmedetomidine (0.2-0.7 mcg/kg/hour after a bolus dose of 1mcg/hour over 10 mins) with an aim to provide controlled hypotension. After patient preparation and draping under aseptic conditions was done, LA with adrenaline was injected along the planned incision sites. As needed, intraoral or extraoral approaches were used to expose the fracture sites. Anatomic reduction of fracture segments was done. After achieving the occlusion, wire IMF was done, followed by fixation of fracture with miniplates and screws. The surgical site was irrigated with normal saline. After achieving hemostasis, closure was done in layers with sutures and finally, all the patients were uneventfully extubated.

All the patients in both the study groups showed statistically insignificant difference for the intubation and extubation time. NA group had a mean of 2.33$\pm$1.2 number of fracture sites approached for ORIF and mean of 2.09$\pm$0.99 number in HA group. No statistically significant difference (p value-0.253) between the groups was found implying that the number of fracture sites exposed and plated also, had homogenous distribution in both the groups.

MFT patients due to their extensive vascularity, experience greater blood loss at the site of injury and during surgery. Hypotensive anesthesia (i.e. 30% reduction of

MAP) as an intervention aimed to reduce the surgical blood loss was successfully achieved and maintained in all the HA group patients as shown by strict surveillance of the intra-operative MAP values taken every 15 minutes. However, there was one patient in our study who was allocated in hypotensive group (intervention) but due to the pre-operative low pulse rate levels (<65beats/min) restricted him for hypotensive anesthesia intra-operatively. Similarly, one patient who had pan facial fracture was allocated in normotensive group (control) but he was shifted to hypotensive group due to massive bleeding intra-operatively.

Intraoperative blood loss during surgery can be calculated by various methods, for example, hematocrit method (the ratio of difference in pre-operative and post-operative HCT divided by mean of both HCT values) (28), gravimetric technique (calculating difference in weight of soaked and dry gauze sponges, each gram considered as 1mL) (44). The most frequently used standard volumetric method (Aliabadi *et al*. (39) and Dolman *et al*.(10)) is used in our study. Here, volume of blood and fluid collected in suction bottle and, blood and fluid soaked by all the used gauze pieces was subtracted with the volume of irrigation fluid used, giving the approximated blood loss. A standard small gauze piece (approximately size of 5 X 5cm) when completely wet soaks 5mL of fluid and the large gauze mop (approximately 25 X 25cm) soaks 10mL of fluid. Statistically significant less blood loss was found in HA (153.39$\pm$27.48mL) than NA group (187.67$\pm$51.13mL). This finding has multiple literature support in which statistically significant reduced blood loss in found in various orthognathic surgeries, head and neck surgeries, orthopedics surgery (12)(10)(5)(45). Hypotensive anesthesia lowers the mean arterial pressure and thus reduces the volume of blood loss during surgery.

All patients in both the groups had maintained 100% oxygen saturation throughout the surgery. No intra-operative arterial blood gases analysis was done as all the patients were hemodynamically stable throughout the surgery and were continuously monitored with vitals, ECG and EtCo2 with the help of multi Para monitor in operating room.

None of our patients required intra-or post-operative blood transfusions. This is observed similarly in study by Ehsan Aliabadi *et al*.(39) This could be explained as all included patients were in ASA 1 and 2 category with no systemic disease, blood

dyscrasias or pre-operative anemia. Secondly, blood loss during our surgery ranged from 100 to 340 mL with a mean of 170.83mL was within the normal range. Further, continuous monitoring of the patients showed them to be hemodynamically stable both intra and post operatively ruling out any need of blood transfusion.

Although assessment of surgical field by surgeon is highly subjective but the standard Fromme *et al.* ordinal scale was used every 30 minutes intra-operatively to objectify. A statistically significant better surgical field as per Fromme's scale was found in the HA group (1.68±0.64) when compared with NA group (2.05±0.49). This is in accordance with observations of Lin *et al*. and Ehsan Aliabadi *et al.* in their RCTs (39).

Further, surgeon satisfaction with regard to surgical field was assessed using 6 point Likert scale from 1 as extremely dissatisfied to 6 as highest score for extremely satisfied. Likert scale was given by a psychologist Rensis Likert, is most widely used psychometric scale which employs questionnaire to scale the responses in a research or survey, used in various studies (21). A statistically significant better surgeon's satisfaction on Likert's scale was found in hypotensive group (4.93±0.65) than in normotensive group (3.93±0.52).

Reduced bleeding in hypotensive group patients gives a better visualization of the surgical field which is absolutely essential for accurate dissection, better identification and protection of vital structures. It further increases surgeon's efficiency and has been proved to lower the intra-operative and post-operative complications (17). In a nutshell, a successful attempt to reduce the blood loss in HA group resulted in improved surgical field and greater surgeon's satisfaction benefiting both the surgeon and patient.

A better surgical field due to decreased blood loss in hypotensive group should have resulted in lesser surgical time in hypotensive anesthesia group. But in our study, no statistically significant difference in the surgical duration was found. Duration of surgery was calculated in hours from incision to final suture placement. This came out to be 2.3±1 hours in normotensive group and 2.4±0.95 hours in hypotensive group. The reason could be due to the complexity of fracture, number of incisions taken to approach fracture or accessibility to fracture site. However, similar results of no difference in surgical duration have been reported by Praveen *et al.* and Prasant *et al*.(12)(5), Dolman

et al. and Precious *et al*.(45)(10). There were no inadvertent pauses in between the surgeries in both the group patients.

Hypotensive anesthesia is being used extensively with an aim to have numerous benefits of reduced intra-operative blood loss, better surgical field, other intra-operative and post-operative complications and less chances of blood transfusion. However, even with controlled hypotension, few reports of cerebral ischemia, dysrrythmias, cardiac arrest have been reported which may be probably due to compromised vital organ perfusion (46)(4)(47). Thus in principle, it would be great if this perfusion of vital organ is determined before taking controlled hypotension as a choice of anesthesia.

NIRS was pioneered by Karl Norris in 1980s for quality of assessment of agricultural products (48). After that it was used in biomedical sciences. Jobsis was the first to introduce the concept of measurement of cerebral oxygenation by near infrared spectroscopy (NIRS) (49). This has been extensively used in cardiac surgeries to reassure cerebral oxygenation in hypotensive state (13)(32). Further, in field of orthopaedics, oncology and spinal surgeries, NIRS has been used to measure real time cerebral perfusion (50)(16). The principle behind NIRS monitoring is that the blood which is oxygenated appears red whereas, de-oxygenated blood appears blue or black. This difference occurs due to the fact that oxygenated Hb varies in parts of its absorption pattern from de-oxygenated Hb and therefore in its apparent optical spectrum. NIRS has two parts i.e., a light source and a photoelectric detector. A light source generates Near Infra-Red light that is directed to the tissues and is reflected back to the photoelectric detector which measures emergent light intensity and gives information regarding the amount of oxygenation. Thus, gives real time assessment of organ perfusion. NIRS sensors were applied on both sides of forehead of the patient intra-operatively and readings were taken every 15 minutes, separately for both sides for checking cerebral perfusion by reassuring cerebral oxygenation (rSO2). No statistically significant difference in cerebral oxygenation was found in both HA (71.61 ± 8.83) and NA group (72.77 ± 8.58). This signifies that cerebral perfusion is similar in both the groups and has not been compromised by inducing hypotension.

All the patients were monitored for intra and post-operative complications. Bradycardia which was defined as pulse rate below 60 beats/mins, reflex tachycardia is pulse above 100 beats/min, arrythmias or desaturation (oxygen saturation of <95% for

>10 seconds) were not found in the entire study. In post-operative period of 24 hours, the complications ranging from PONV (post-operative Nausea and vomiting), fever, shivering, hypertension to myocardial infarction, renal infarct and cardiovascular events were absent.

The hematocrit (HCT) values were taken in post-operative period in order to assess the extent of blood loss after surgery. HCT reflects % of blood volume i.e. composed of RBC's. It, unlike Hb, is unaffected by heme dilution or heme concentration that may occur due to intravenous infusions during surgery. No statistically significant difference was found in the difference between pre-operative and post-operative HCT values in HA group (p value>0.05) as compared to normotensive group (p value<0.01). This may be due to the significantly greater blood loss occurring in normotensive anesthesia group patients when compared to hypotensive anesthesia group patients.

There are numerous scales that have been introduced in the clinical practice to objectify the subjective assessment of pain. In literature, Visual analogue scale (VAS), McGill pain scale, Comfort scale, Numeric rating scale (NRS),Wong baker faces pain scale and Color analog scale are mentioned (51)(52). Most of which are difficult to understand. Faces pain scale is chosen in young children, which shows facial expressions ranging from state of wellbeing to worst pain possible. VAS scale was developed by Freyd in 1923 (53). There are two types of this scale, a 10 point and a 100 point scale. 10 point VAS scale is one of the most commonly used scale because of its simplicity, easy comprehensibility and reproducibility. It measures pain from not at all (zero) to worst terrible pain (ten). Since our study population has different cultural background, VAS scale was augmented with pictographic representation for better comprehension by the patients. In our study, the patients in post-operative period were monitored for pain levels for 24 hours using the VAS scale at interval of 6, 12 and 24 hours. No statistically significant difference was found in relation to post-operative pain levels in between HA group (5.5 ± 1.74) and NA group (5.20 ± 1.61). This is not in accordance with low post operative pain levels reported by the studies using hypotensive anesthesia (8)(54).

STRENGTH OF STUDY

1. IEC was obtained before commencement of the study and the study was conducted strictly adhering to methodology as per protocol.
2. The paramount strength of the study is the robust study design. The present study is a double arm, double blinded RCT. Every single effort was made to minimize all the possible risk of biases.
3. Randomization, allocation concealment, and allotment of participants were done by a person unrelated to the trial. Block randomization using a table of random numbers and allocation concealment with standard SNOE minimized the selection bias.
4. Additionally, a statistically insignificant distribution of patients in the form of sociodemographic parameters (in the form of age, sex), trauma characteristics (for example, type of fractures and number of fracture sites), hematological parameters (like hematocrit, hemoglobin and coagulation profile) and hemodynamic parameters (in the form of mean arterial blood pressure and pulse) was achieved. This signifies that our randomization was successful in obtaining homogenous distribution of patients in both the groups thus minisculising the selection bias. This homogenous distribution further signifies that patient related confounding factors have also been balanced in both the groups.
5. All the allocated patients have completed the follow up period of 24 hours and thus, there was no sample attrition.
6. Investigator was the person unrelated to the trial who was supervising randomization, allocation concealment, patient allocation and data recording thus minimizing the reporting bias.
7. As the intervention was given during GA, there is no role of performance bias on patient's behalf. Furthermore, surgeon's blinding curtailed the performance bias on behalf of the surgeon.
8. The homogenous patient distribution in both the groups and further non-significant difference in trauma characteristics in the form of type of fractures and site of fracture plating indicates that the results produced arise as a result of intervention rather than patient's factors.

9. Every effort has been made to either use the standard objective parameters (Pulse rates, MAP, Oxygen saturation, NIRS, volumetric blood loss) for evaluation. But, wherein subjective parameters (like surgical field assessment, surgeon satisfaction, pain score) were assessed, every effort was made to use standard scales (Fromme *et al.* ordinal scale, Likert scale and VAS pain score) to objectify the subjective parameters as an effort to reduce the detection bias.

10. NIRS monitoring used in the study is a powerful tool as it detects the cerebral blood oxygen saturation in the form of real time continuous monitoring. It has an edge over other methods because of its non-invasiveness, low cost and simplicity of the technique.(23) Although, techniques using jugular venous oxygen saturation ($SjvO_2$), thermal gradient blood flow meter, electroencephalogram (EEG), event-related potentials (ERPs) can be used and are considered to be accurate, but these methods are invasive and pose potential risks of hematoma and venous thrombosis.

LIMITATIONS

1. Hypotensive anesthesia as a mode of intervention can only be used in patients with stable vitals wherein the patients usually maintain above 65beats/min of pulse rates and more than 110/70mmhg of blood pressure in pre-operative time. But in our study, there was one patient who was allocated in hypotensive group (intervention) due to the low pre-operative Pulse rate levels (<65beats/min) which restricted him for hypotensive anesthesia intra-operatively.
2. Similarly, one patient who had pan facial fracture was allocated in normotensive group (control) but he was shifted to hypotensive group due to massive bleeding intra-operatively.
3. The exact calculation of blood loss on the surgical drapes and blood staining over surgeon's gowns could not be accurately calculated and was missed in volumetric blood loss calculation.
4. As the NIRS monitor is to be placed on forehead of the patients for the readings of cerebral oxygenation, this could not be placed in majority of our pan-facial fracture or comminuted zygomatic arch fracture cases requiring coronal approach and therefore these patients could not be enrolled in the study.
5. Majority of the patients in MFT cases have associated head injuries which already predispose these patients to give altered cerebral perfusion and thereby would be some important candidates for NIRS readings. This 14.2% of trauma patients with head injury were excluded from our study as a part of the study design. NIRS recording in head injury patients would have been more contributary for cerebral hypoperfusion related to hypotensive anesthesia. Studies have used NIRS monitoring as a useful tool for cerebral oximetry in traumatic brain injury patients. (55)

Implication and Future Recommendation

- There is enough literature evidence reporting the role of HA on intra-operative blood loss, quality of surgical field and duration of operation in major maxillofacial surgeries like orthognathic surgeries, cleft lip and palate surgeries and head and neck tumor resection surgeries. The studies have proved the benefit of controlled hypotension in GA in respect to reduced blood loss, better quality of surgical field and reduced duration of operation. But there is a lack of investigation on vital organ perfusion objectively during the hypotensive anesthesia intra-operatively in maxillofacial surgeries. More clinical trials are needed for verifying the safety of using this technique in view of vital organ perfusion to finally establish the complete safety of hypotensive anesthesia.

- Most importantly there is a need for a multicentric study with greater sample size. Extending the sample population to medically compromised MFT patients in terms of concomitant head injury, anemias would help to gauze cerebral perfusion better in hypotensive state. This would help in achieving generalizability and external validity of our study for larger population.

- In our study, we have investigated only cerebral blood oxygenation using Near Infrared Spectroscopy, but the effects of hypotensive anesthesia on other vital organs like liver, kidneys and heart were not evaluated. Very few studies have evaluated these effects as a marker of adversity. (4) Therefore, it is suggested to more extensively research the hepatic, renal and cardiac effects of hypotensive anesthesia.

- The impact of hypotensive anesthesia on cerebral blood flow and oxygenation can be assessed using other advanced and reliable methods like jugular venous oxygen saturation ($SjvO_2$) transcranial doppler ultrasonography, thermal gradient blood flow meter, (23) electroencephalogram (EEG), event-related potentials (ERPs). But they fail to reflect oxygenation as a real time measurement. Non-invasive methods for example, positron emission tomography (PET), functional magnetic resonance imaging (fMRI) can also be used.

- Although, dexmedetomidine is a relatively safe drug with potent analgesia, sympatholytic and cardiovascular stabilizing properties. But the adverse effects of

dexmedetomidine include hypotension, hypertension, bradycardia, arrythmias, AV Block, tachycardia, respiratory depression, dry mouth, nausea, fever, rigors and muscle weakness. Other alternative drugs that can be used are propofol, midazolam and fentanyl. Further studies for the drug of choice for hypotensive anesthesia in field of maxillofacial area are also recommended.

CONCLUSION

Although there is plethora of researches on the benefits of hypotensive anesthesia in various surgical procedures pertaining to head and neck, orthopedics, spinal and orthognathic surgeries describing its technique, benefits and complications. There is a lack of evidence in the effect of hypotensive anesthesia in vital organ perfusion especially in maxillofacial specialty, it is actually absent. Thus, we planned a double blinded RCT to compare the effect of controlled hypotension in general anesthesia in maxillofacial trauma patients with an evaluation of cerebral oxygenation using NIRS monitor as a marker of adversity of hypotensive anesthesia.

This is first of its kind study that has evaluated effect of hypotensive anesthesia in maxillofacial trauma patients with a record of vital organ (cerebral) perfusion. This study has focused on comparison between the two groups, normotensive and hypotensive group on the grounds of proposed benefits of hypotensive anesthesia.

Statistically significant difference was found in relation to reduction in intra-operative blood loss, improvement in quality of surgical field and hence, increased surgeon satisfaction at the end of the surgery in hypotensive anesthesia group when compared with normotensive anesthesia. However, no statistically significant difference in surgical duration was detected in both the groups. Further, no statistically significant difference of cerebral oxygenation as measured by NIRS recording was found in both the groups. None of the patients in the study had intra-operative or post-operative complications in the form of bradycardia, tachycardia, arrythmias or desaturation. Hence concluding, that MFT patients can be safely administered hypotensive anesthesia although a large multicentric study with more laxed inclusion criterias of including patients in ASA III, head injury, anemias would give external validity and generalizability to our results.

BIBLIOGRAPHY

1. Pietzka S, Kämmerer PW, Pietzka S, Schramm A, Lampl L, Lefering R, et al. Maxillofacial injuries in severely injured patients after road traffic accidents—a retrospective evaluation of the TraumaRegister DGU® 1993–2014. Clin Oral Invest. 2020 Jan;24(1):503–13.
2. Dhanush C V, Azeez MI, Menon S, Sham E, Vishwas MK, Kumar V. Estimation of blood loss in maxillofacial surgery. JOOO. 2022 Sep 28;8(3):144–9.
3. Shaban B, Attar AS, Eshghpour M. Concepts, Application, and Efficacy of Hypotensive Anesthesia in Maxillofacial and Orthognathic Surgeries: Review of Literature.
4. Choi WS, Samman N. Risks and benefits of deliberate hypotension in anaesthesia: a systematic review. International Journal of Oral and Maxillofacial Surgery. 2008 Aug;37(8):687–703.
5. Prasant MC, Kar S, Rastogi S, Hada P, Ali FM, Mudhol A. Comparative Study of Blood Loss, Quality of Surgical Field and Duration of Surgery in Maxillofacial Cases with and without Hypotensive Anesthesia. Journal of International Oral Health. :4.
6. Tewari A, Singh G, Mishra M, Gaur A, Mallan D. Comparative Evaluation of Hypotensive and Normotensive Anesthesia on LeFort I Osteotomies: A Randomized, Double-Blind, Prospective Clinical Study. J Maxillofac Oral Surg. 2020 Jun;19(2):240–5.
7. Ervens J, Marks C, Hechler M, Plath T, Hansen D, Hoffmeister B. Effect of induced hypotensive anaesthesia vs isovolaemic haemodilution on blood loss and transfusion requirements in orthognathic surgery: a prospective, single-blinded, randomized, controlled clinical study. International Journal of Oral and Maxillofacial Surgery. 2010 Dec;39(12):1168–74.
8. Venn RM, Bradshaw CJ, Spencer R, Brealey D, Caudwell E, Naughton C, et al. Preliminary UK experience of dexmedetomidine, a novel agent for postoperative sedation in the intensive care unit. Anaesthesia. 1999 Dec;54(12):1136–42.
9. Naaz S. Dexmedetomidine in Current Anaesthesia Practice- A Review. JCDR

[Internet]. 2014 [cited 2023 Jan 11]; Available from: http://jcdr.net/article_fulltext.asp?issn=0973-709x&year=2014&volume=8&issue=10&page=GE01&issn=0973-709x&id=4946

10. Dolman RM, Bentley KC, Head TW, English M. The effect of hypotensive anesthesia on blood loss and operative time during Le Fort I osteotomies. Journal of Oral and Maxillofacial Surgery. 2000 Aug;58(8):834–9.

11. Felfernig-Boehm D, Salat A, Kinstner C, Fleck T, Felfernig M, Kimberger O, et al. Influence of Hypotensive and Normotensive Anesthesia on Platelet Aggregability and Hemostatic Markers in Orthognathic Surgery. Thrombosis Research. 2001 Aug;103(3):185–92.

12. Praveen K, Narayanan V, Muthusekhar MR, Baig MF. Hypotensive anaesthesia and blood loss in orthognathic surgery: a clinical study. British Journal of Oral and Maxillofacial Surgery. 2001 Apr;39(2):138–40.

13. Scheeren TWL, Schober P, Schwarte LA. Monitoring tissue oxygenation by near infrared spectroscopy (NIRS): background and current applications. J Clin Monit Comput. 2012 Aug;26(4):279–87.

14. Abel Rahman NI, Fouad EA, Ahmed A, Youness AR, Wahib M. Efficacy of different dexmedetomidine regimens in producing controlled hypotensive anesthesia during functional endoscopic sinus surgery. Egyptian Journal of Anaesthesia. 2014 Oct;30(4):339–45.

15. Daki A. Efficacy of Tranexamic acid in Reducing Blood Loss During Maxillofacial Trauma Surgery–A Pilot Study. JCDR [Internet]. 2014 [cited 2022 Dec 30];

16. Maghawry KM, El-Agamy AES, Tahir WI, Zein AF. Cerebral oxygen saturation monitoring during hypotensive anesthesia in shoulder arthroscopy: A comparative study between dexmedetomidine and esmolol. Egyptian Journal of Anaesthesia. 2015 Jan;31(1):43–52.

17. Barak M, Yoav L, Abu el-Naaj I. Hypotensive Anesthesia versus Normotensive Anesthesia during Major Maxillofacial Surgery: A Review of the Literature. The Scientific World Journal. 2015;2015:1–7.

18. Ettinger KS, Yildirim Y, Weingarten TN, Van Ess JM, Viozzi CF, Arce K. Hypotensive Anesthesia Is Associated With Shortened Length of Hospital Stay

Following Orthognathic Surgery. Journal of Oral and Maxillofacial Surgery. 2016 Jan;74(1):130–8.

19. Lin S, McKenna SJ, Yao CF, Chen YR, Chen C. Effects of Hypotensive Anesthesia on Reducing Intraoperative Blood Loss, Duration of Operation, and Quality of Surgical Field During Orthognathic Surgery: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Journal of Oral and Maxillofacial Surgery. 2017 Jan;75(1):73–86.
20. Dharmendra Patel D, Singh A, Upadhyay M. Dexmedetomidine versus Nitroglycerin for Controlled Hypotensive Anaesthesia in Functional Endoscopic Sinus Surgery. J Anesth Clin Res [Internet]. 2018 [cited 2022 Dec 30];09(05). Available from: https://www.omicsonline.org/open-access/dexmedetomidine-versus-nitroglycerin-for-controlled-hypotensive-anaesthesia-in-functional-endoscopic-sinus-surgery-2155-6148-1000822-101717.html
21. Sharma H, Arora S, Bhatia N, Rattan V, Sethi S. Tranexamic Acid Is Associated With Improved Operative Field in Orthognathic Surgery. Journal of Oral and Maxillofacial Surgery. 2020 Sep;78(9):1509–17.
22. Tegegne SS, Gebregzi AH, Arefayne NR. Deliberate hypotension as a mechanism to decrease intraoperative surgical site blood loss in resource limited setting: A systematic review and guideline. International Journal of Surgery Open. 2021 Feb;29:55–65.
23. Zhong W, Ji Z, Sun C. A Review of Monitoring Methods for Cerebral Blood Oxygen Saturation. Healthcare. 2021 Aug 26;9(9):1104.
24. Gassner R, Tuli T, Hächl O, Rudisch A, Ulmer H. Cranio-maxillofacial trauma: a 10 year review of 9543 cases with 21067 injuries. Journal of Cranio-Maxillofacial Surgery. 2003 Feb;31(1):51–61.
25. Shaban B, Attar AS, Eshghpour M. Concepts, Application, and Efficacy of Hypotensive Anesthesia in Maxillofacial and Orthognathic Surgeries: Review of Literature.
26. das TraumaRegister DGU®, Esmer E, Delank KS, Siekmann H, Schulz M, Derst P. Gesichtsverletzungen bei Polytrauma − Mit welchen Verletzungen ist zu rechnen?: Eine retrospektive Auswertung aus dem TraumaRegister DGU®. Notfall

Rettungsmed. 2016 Mar;19(2):92–8.

27. Kauvar DS, Lefering R, Wade CE. Impact of Hemorrhage on Trauma Outcome: An Overview of Epidemiology, Clinical Presentations, and Therapeutic Considerations. Journal of Trauma: Injury, Infection & Critical Care. 2006 Jun;60(6):S3–11.
28. Akinbami BO, Onajin-Obembe B. Assessment of Intraoperative Blood Loss during Oral and Maxillofacial Surgical Procedures in a Nigerian Tertiary Health Care Center. Journal of Blood Transfusion. 2014 Sep 2;2014:1–8.
29. Conforte JJ, Alves CP, Sánchez M delP. R, Ponzoni D. Impact of trauma and surgical treatment on the quality of life of patients with facial fractures. International Journal of Oral and Maxillofacial Surgery. 2016 May;45(5):575–81.
30. Schulman S. Pharmacologic tools to reduce bleeding in surgery. Hematology. 2012 Dec 8;2012(1):517–21.
31. Rossaint R, Bouillon B, Cerny V, Coats TJ, Duranteau J, Fernández-Mondéjar E, et al. Management of bleeding following major trauma: an updated European guideline. Crit Care. 2010;14(2):R52.
32. von Knobelsdorff G, Höppner RM, Tonner PH, Paris A, Nienaber CA, Scholz J, et al. Induced arterial hypotension for interventional thoracic aortic stent-graft placement: impact on intracranial haemodynamics and cognitive function. Eur J Anaesthesiol. 2005 Jun 2;20(2):134–40.
33. Juelsgaard P. Hypotensive epidural anesthesia in total knee replacement without tourniquet: Reduced blood loss and transfusion. Regional Anesthesia and Pain Medicine. 2001 Mar;26(2):105–10.
34. Dutton RP. Controlled hypotension for spinal surgery. Eur Spine J. 2004 Oct;13(S01):S66–71.
35. Drover DR, Hammer GB, Barrett JS, Cohane CA, Reece T, Zajicek A, et al. Evaluation of sodium nitroprusside for controlled hypotension in children during surgery. Front Pharmacol [Internet]. 2015 Jul 6 [cited 2023 Jan 12];6. Available from: http://journal.frontiersin.org/Article/10.3389/fphar.2015.00136/abstract
36. McLeod ME, Creighton RE, Humphreys RP. Anaesthetic management of arteriovenous malformations of the vein of galen. Can Anaesth Soc J. 1982 Jul;29(4):307–12.

37. Jones TH, Chiappa KH, Young RR, Ojemann RG, Crowell RM. EEG monitoring for induced hypotension for surgery of intracranial aneurysms. Stroke. 1979 May;10(3):292–4.

38. Gandhi S, Ranganathan LK, Solanki M, Mathew GC, Singh I, Bither S. Pattern of maxillofacial fractures at a tertiary hospital in northern India: a 4-year retrospective study of 718 patients: Pattern of maxillofacial fractures in northern India. Dental Traumatology. 2011 Aug;27(4):257–62.

39. Aliabadi E, Malekpour B, Tavanafar S, Karimpour H, Parvan M. Intraoperative blood loss in maxillofacial trauma surgery. Ann Maxillofac Surg. 2020;10(1):164.

40. Lee JH, Cho BK, Park WJ. A 4-year retrospective study of facial fractures on Jeju, Korea. Journal of Cranio-Maxillofacial Surgery. 2010 Apr;38(3):192–6.

41. Subhashraj K, Nandakumar N, Ravindran C. Review of maxillofacial injuries in Chennai, India: A study of 2748 cases. British Journal of Oral and Maxillofacial Surgery. 2007 Dec;45(8):637–9.

42. Bakardjiev A, Pechalova P. Maxillofacial fractures in Southern Bulgaria – A retrospective study of 1706 cases. Journal of Cranio-Maxillofacial Surgery. 2007 Apr;35(3):147–50.

43. Kieser J, Stephenson S, Liston PN, Tong DC, Langley JD. Serious facial fractures in New Zealand from 1979 to 1998. International Journal of Oral and Maxillofacial Surgery. 2002 Apr;31(2):206–9.

44. Dhanush C V, Azeez MI, Menon S, Sham E, Vishwas MK, Kumar V. Estimation of blood loss in maxillofacial surgery. JOOO. 2022 Sep 28;8(3):144–9.

45. Precious DS, Splinter W, Bosco D. Hypo tensive Anesthesia for Orthogna thic Surgery Patients. :4.

46. Jones TH, Chiappa KH, Young RR, Ojemann RG, Crowell RM. EEG monitoring for induced hypotension for surgery of intracranial aneurysms. Stroke. 1979 May;10(3):292–4.

47. Hogue CW, Levine A, Hudson A, Lewis C. Clinical Applications of Near-infrared Spectroscopy Monitoring in Cardiovascular Surgery. Anesthesiology. 2021 May 1;134(5):784–91.

48. Pasquini C. Near Infrared Spectroscopy: fundamentals, practical aspects and analytical applications. J Braz Chem Soc. 2003 Apr;14(2):198–219.

49. Tobias JD. Cerebral oxygenation monitoring: near-infrared spectroscopy. Expert Review of Medical Devices. 2006 Mar;3(2):235–43.

50. Murphy GS, Szokol JW, Marymont JH, Greenberg SB, Avram MJ, Vender JS, et al. Cerebral Oxygen Desaturation Events Assessed by Near-Infrared Spectroscopy During Shoulder Arthroscopy in the Beach Chair and Lateral Decubitus Positions. Anesthesia & Analgesia. 2010 Aug;111(2):496–505.

51. Ho K, Spence J, Murphy MF. Review of Pain-Measurement Tools☆☆☆★. Annals of Emergency Medicine. 1996 Apr;27(4):427–32.

52. Tripathi L, Kumar P. Challenges in pain assessment: Pain intensity scales. Indian J Pain. 2014;28(2):61.

53. Freyd M. The Graphic Rating Scale. Journal of Educational Psychology. 1923 Feb;14(2):83–102.

54. Mohamed Amin S, Elmawy MG. Controlled Hypotensive Anesthesia in Children Undergoing Nasal Surgery. J Anesth Clin Res [Internet]. 2016 [cited 2022 Dec 30];7(8).

55. Barud M, Dabrowski W, Siwicka-Gieroba D, Robba C, Bielacz M, Badenes R. Usefulness of Cerebral Oximetry in TBI by NIRS. JCM. 2021 Jun 30;10(13):2938.

ANNEXURES

Annexure I: Institutional Ethical Clearance Certificate

अखिल भारतीय आयुर्विज्ञान संस्थान, जोधपुर
All India Institute of Medical Sciences, Jodhpur
संस्थागत नैतिकता समिति
Institutional Ethics Committee

No. AIIMS/IEC/2021/3536 Date: 12/03/2021

ETHICAL CLEARANCE CERTIFICATE

Certificate Reference Number: **AIIMS/IEC/2021/3365**

Project title: **"A randomized controlled trial on the role of intraoperative controlled hypotension in maxillofacial trauma patients"**

Nature of Project:	**Research Project Submitted for Expedited Review**
Submitted as:	**M.D.S. Dissertation**
Student Name:	**Dr. Tanya Batra**
Guide:	**Dr. Kirti Chaudhry**
Co-Guide:	**Dr. Ankita Chugh, Dr. Pradeep Kumar Bhatia & Dr. Pravin Kumar**

Institutional Ethics Committee after thorough consideration accorded its approval on above project.

The investigator may therefore commence the research from the date of this certificate, using the reference number indicated above.

Please note that the AIIMS IEC must be informed immediately of:

- Any material change in the conditions or undertakings mentioned in the document.
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research.
- In case of any issue related to compensation, the responsibility lies with the Investigator and Co-Investigators.

The Principal Investigator must report to the AIIMS IEC in the prescribed format, where applicable, bi-annually, and at the end of the project, in respect of ethical compliance.

AIIMS IEC retains the right to withdraw or amend this if:

- Any unethical principle or practices are revealed or suspected
- Relevant information has been withheld or misrepresented

AIIMS IEC shall have an access to any information or data at any time during the course or after completion of the project.

Please Note that this approval will be rectified whenever it is possible to hold a meeting in person of the Institutional Ethics Committee. It is possible that the PI may be asked to give more clarifications or the Institutional Ethics Committee may withhold the project. The Institutional Ethics Committee is adopting this procedure due to COVID-19 (Corona Virus) situation.

If the Institutional Ethics Committee does not get back to you, this means your project has been cleared by the IEC.

On behalf of Ethics Committee, I wish you success in your research.

Dr. Praveen Sharma
Member Secretary

Member secretary
Institutional Ethics Committee
AIIMS Jodhpur

Basni Phase-2, Jodhpur, Rajasthan-342005; **Website:** www.aiimsjodhpur.edu.in; **Phone:** 0291-2740741 Extn. 3109
E-mail : ethicscommittee@aiimsjodhpur.edu.in; ethicscommitteeaiimsjdh@gmail.com

Annexure II: Patient Information Sheet [English]

Department of Oral and Maxillofacial Surgery

All India Institute of Medical Sciences, Jodhpur

TITLE: **"A Randomized Controlled Trial on the role of Intraoperative Controlled Hypotension in Maxillofacial Trauma Patients".**

As you know that you/your ward has been diagnosed with Maxillofacial fracture, the treatment of fracture would be putting up plates and screws for stabilization under General Anesthesia as a part of standard treatment protocol. You/your ward are requested to take part in the research/ study being conducted with title "A Randomized Controlled Trial on the role of Intraoperative Controlled Hypotension in Maxillofacial Trauma Patients".

You/your wards face is a very vascular area and may bleed extensively during surgery to add on to the blood loss that must have occurred at the accident site. To control the amount of blood loss, dexmedetomidine is a drug that would be used as a hypotensive anesthetic agent as a part of this research. It is a very common drug used in other surgeries like hip, shoulder, brain surgeries with minimal side effects. Following minor side effects of nausea, vomiting, hypotension, bradycardia or tachycardia can be encountered and would be efficiently dealt with. As a part of your normal treatment protocol, the surgery will be for 3 hours' duration on an average. Post operatively, drugs would be administered for control of pain and infection. Hospital stay would be for minimum 5-7 days post surgery. You/your ward may have normal surgical and general anesthetic complications which are not related to the research being done. Fractures usually take 6-8 months to heal and you/your ward will be kept under a regular monthly follow up. This study requires us to collect your/your wards detailed history, records and clinical examination according to the given proforma prior to surgery. Confidentiality of all the documents would be strictly maintained.

For further queries, please contact:

Dr Tanya Batra
Post Graduate Student
Oral and Maxillofacial Surgery
Department of Dentistry
All India Institute of Medical Sciences, Jodhpur
Mobile No. – +916376504412

Annexure III: Patient Information Sheet [Hindi]

ओरल और मैक्सिलोफेशियल सर्जरी विभाग

अखिल भारतीय आयुर्विज्ञान संस्थान, जोधपुर

रोगी सूचना पत्रक

शीर्षक: "मैक्सिलोफेशियल ट्रॉमा के मरीजों में इंट्राऑपरेटिव नियंत्रित हाइपोटेंशन की भूमिका पर एक यादृच्छिक नियंत्रित परीक्षण"।

जैसा कि आप जानते है कि आप आपके बच्चे को मैक्सिलोफेशियल फ्रैक्चर का निदान किया गया है, फ्रैक्चर के उपचार में मानक उपचार प्रोटोकॉल के एक भाग के रूप में जनरल एनेस्थेसिया के तहत स्थिरीकरण के लिए प्लेट और स्क्रू लगाए जाएंगे। आपसे आपके बच्चे से अनुरोध किया जाता है कि वे शीर्षकः– ''**मैक्सिलोफेशियल ट्रॉमा मरीजों में अंतः क्रियात्मक नियंत्रित हाइपोटेंशन की भूमिका पर एक यादृच्छिक नियंत्रित परीक्षण**'' के साथ किए जा रहे अनुसंधान/अध्ययन में भाग लें।

आपका आपके बच्चे का चेहरा एक बहुत ही संवहनी क्षेत्र है और सर्जरी के दौरान बड़े पैमाने पर खून बह सकता है जो कि दुर्घटना स्थल पर हुए रक्त की हानि में वृद्धि करेगा। रक्त की हानि की मात्रा को नियंत्रित करने के लिए डेक्समेडिटोमिडाइन एक दवा है जिसे इस शोध के एक भाग के रूप में हाइपोटेंशियल ऐनेस्थेटिक एजेंट के रूप में इस्तेमाल किया जाएगा। यह एक बहुत ही सामान्य दवा है जिसका उपयोग अन्य सर्जरी जैसे कूल्हे, कंधे, मस्तिष्क की सर्जरी में कम से कम दुष्प्रभाव सामने आ सकते है और उनसे कुशलता से निपटा जाएगा। आपके सामान्य उपचार प्रोटोकॉल के रूपमें, सर्जरी औसतन 3 घंटे की अवधि के लिए होगी। पोस्ट ऑपरेटिव रूप से, दवाओं को दर्द और संक्रमण के नियंत्रण के लिए दिया जायेगा। न्यूनतम 5–7 दिनों के पोस्ट सर्जरी के लिए अस्पताल में रहना होगा। रोगी को सामान्य सर्जिकल ओर सामान्य संवेदनाहारी जटिलताएं हो सकती हैं जो अनुसंधान से संबंधित नहीं है। फ्रैक्चर को ठीक होने में आमतौर पर 6–8 महिने लगते हैं ओर आपको नियमित मासिक अनुवर्ती के तहत रखा जाएगा। इस अध्ययन में हमें सर्जरी से पहले दिए गए प्रोफार्मा के अनुसार आपके विस्तृत इतिहास, रिकॉर्ड, और नैदानिक परीक्षा को एकत्र करने की आवश्यकता है। सभी दस्तावेजों की गोपनीयता को कडाई से बनाए रखा जाएगा।

अधिक प्रश्नों के लिए, कृपया संपर्क करेः

डॉ. तान्या बत्रा
पोस्ट–ग्रेजुएट स्टूडेंट
ओरल और मैक्सिलोफेशियल सर्जरी
दंत चिकित्सा विभाग
अखिल भारतीय आयुर्विज्ञान संस्थान, जोधपुर
मो. नं. : +916376504412

Annexure IV: Informed Consent Form (English)

Serial no: ----------

INFORMED CONSENT FORM

All India Institute of Medical Sciences, Jodhpur

The attached information sheet dated_____has elaborate details in the language that I can fully comprehend. I have read the said contents in detail and have fully understood the same. I also confirm that I was provided the requisite opportunity to ask questions for better conception.

The nature and purpose of the study and the relevant risks/benefits attached, the duration and all other necessary information has been clearly put forth. I declare that my participation is purely voluntary and that I am free to withdraw at any time without assigning any reason and that my medical care or legal rights shall not be affected in any way.

I am aware that information collected about me upon my participation in this research and the relevant section of medical notes shall be looked at by any responsible individual from AIIMS, Jodhpur.

I hereby accord my permission for the undersigned individuals to access my records. I hereby give my consent to take part in the study.

Signature/Left Thumb Impression: _____

Name of the Participant: _____

Son/Daughter/Spouse of:_____

Postal Address: _____

Date: _____

Place: _____

This is to certify that the above consent has been obtained in my presence.

Signature of Principal Investigator Date:
Place:

Witness 1:	Witness 2:
Signature/Left Thumb Impression:	Signature/Left Thumb Impression:
_____	_____
Name: _____	Name: _____
Postal Address: _____	Postal Address: _____
_____	_____

Annexure V: Informed Consent Form (Hindi)

सीरीयल नम्बरः .....

सूचित सहमति प्रपत्र

अखिल भारतीय आयुर्विज्ञान संस्थान, जोधपुर

संलग्न जानकारी पत्र में भाषा में विस्तृत विवरण है कि मैं पूरी तरह से समझ सकता हूं। मैने उक्त सामग्री को विस्तार से पढा है और इसे पूरी तरह से समझा है। मैं यह भी पुष्टि करता हूं कि मुझे बेहतर समझने के लिए प्रश्न पूछने का अपेक्षित अवसर प्रदान किया गया था।

अध्ययन की प्रकृति, उद्देश्य और संबंधित जोखिम/लाभ, अवधि और अन्य सभी आवश्यक जानकारी स्पष्ट रूप से सामने रखी गई है। मैं घोषणा करता हू कि मेरी भागीदारी विशुद्ध रूप से स्वैच्छिक है ओर मैं बिना किसी कारण बताए किसी भी समय अपनी भागीदारी लेने के लिए स्वतंत्र हूं और मेरी चिकित्सा देखभाल अधिकारी किसी भी तरह से प्रभावित नहीं होंगे।

मुझे पता है कि इस शोध में मेरी भागीदारी और चिकित्सा नोटों से संबंधित खंड पर मुझसे एकत्रित जानकारी को एम्स जोधपुर के किसी भी जिम्मेदार व्यक्ति द्वारा देखा जाएगा।

मैं अपने रिकॉर्ड को एक्सेस करने के लिए अधोहस्ताक्षरी व्यक्तियों को अपनी अनुमति देता हूं। मैं इस अध्ययन में भाग लेने के लिए अपनी सहमति देता हूं।

हस्ताक्षर/बांए अंगूठे का निशानः
प्रतिभागी का नामः
पुत्र/पुत्री/पति/पत्नी :
डाक पताः
दिनांकः
स्थानः

गवाह 1:	गवाह 1:
हस्ताक्षर/बांए अंगूठे का निशानः	हस्ताक्षर/बांए अंगूठे का निशानः
नामः	नामः
डाक पताः	डाक पताः

Annexure VI: Case Record Form

NAME:

SERIAL NO:

AGE/SEX:

OCCUPATION:

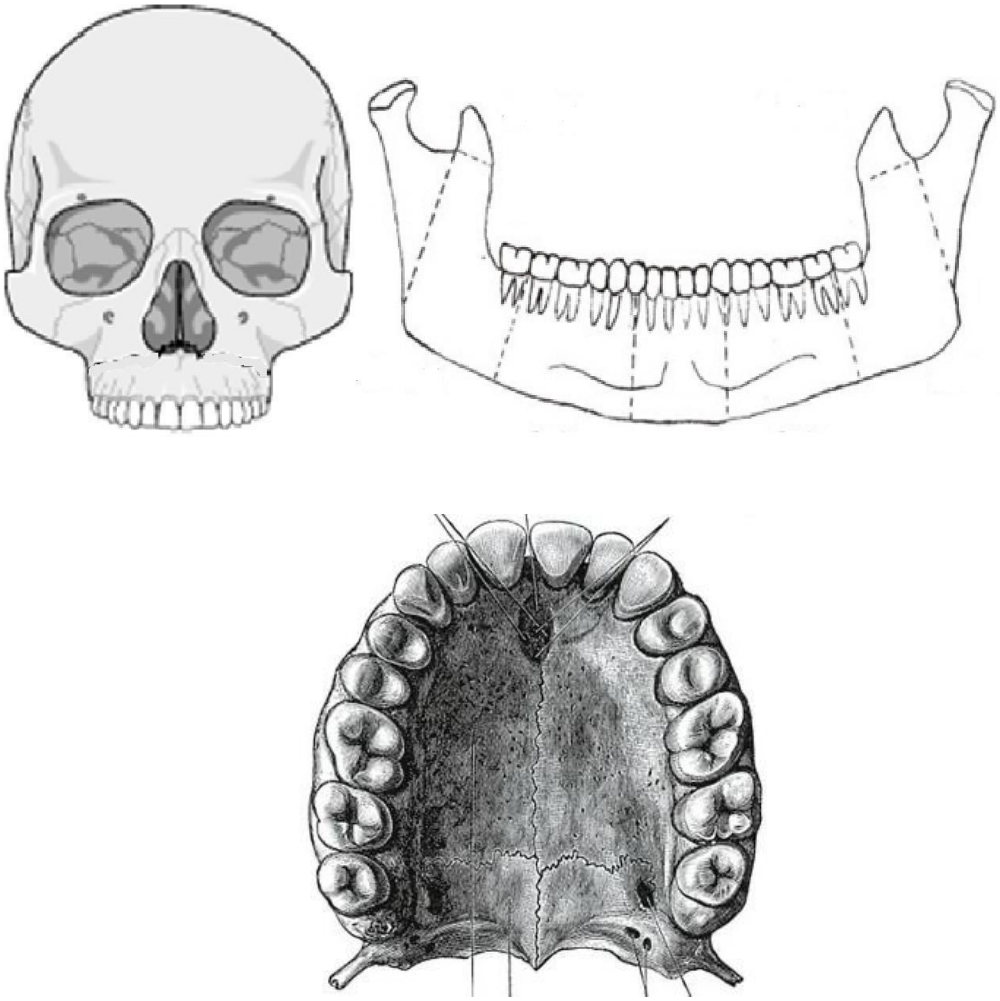
AIIMS REGISTRATION ID:

CONTACT NUMBER:

INCLUSION CRITERIA:	**YES**	**NO**
▪ Patients who have given written informed consent to be a part of the study		
▪ Patients posted for ORIF for maxillofacial trauma		
▪ Patients in the age group between 16 to 65 years, of either sex		
▪ Patients with minimal comorbidities- ASA I,II		
▪ Absence of pre-existing maxillofacial pathologies especially any odontogenic tumor, cyst, neuralgias, TMDs and MPDS		

EXCLUSION CRITERIA:	**YES**	**NO**
▪ Patient in age range <16 years and >65 Years		
▪ Patients with severe debilitating conditions such as uncontrolled diabetes mellitus, uncontrolled hypertension, cardio respiratory conditions, previous history of cerebrovascular accidents, myocardial infarction, coronary artery disease		
▪ All pregnant and lactating females		
▪ Patients on antiplatelet/anticoagulant therapy		
▪ Patients with concomitant head injuries, cervical spine injuries or debilitating thoracic or abdominal trauma		

Maxillofacial fractures



Provisional diagnosis

Randomization Code No. –

I. Preoperative parameters-

1. Hemoglobin (g%):
2. Coagulogram including-
   a) Platelet count (/cu-mm):
   b) Prothrombin time (seconds):
   c) Fibrinogen (g/L):
   d) anti-thrombin (%):
   e) aPTT (seconds):
3. Mean Arterial Blood Pressure (mm of Hg):

T1	T2	T3	Average

4. Pulse Rate (per minute):

T1	T2	T3	Average

5. Oxygen saturation (%):

T1	T2	T3	Average

II. Intraoperative parameters-

1. Anesthetist's Perspective-
   a) Anesthetic agent used:

   b) Dosage:

   c) Time taken for intubation:

d) Time taken for extubation:

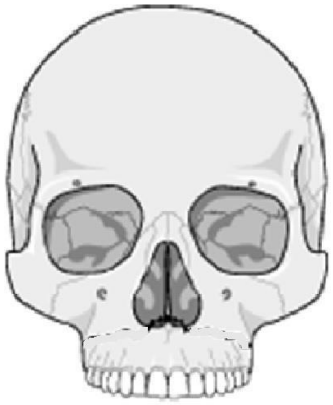
e) Total duration of anesthesia:

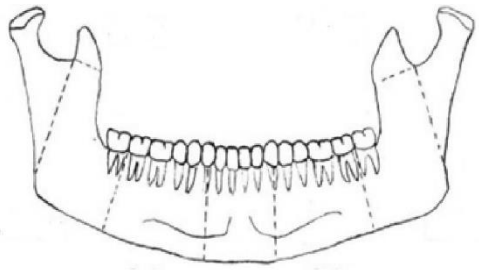
f) Any special comments:

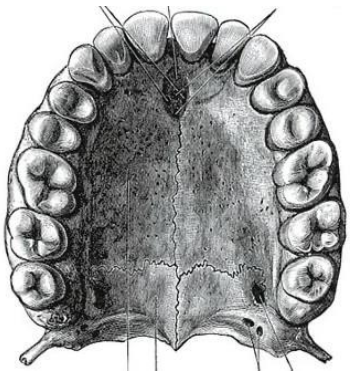
2. Surgery done-
   a) Duration from incision to closure:

   b) Incisions taken:

   c) Open reduction and internal fixation done at







3. Surgical field (Fromme's ordinal scale)

Time (minutes)	Surgical field (ordinal scale)
30	
60	
90	
120	

5	Massive uncontrollable bleeding
4	Bleeding, heavy but controllable, that significantly interferes with dissection
3	Moderate bleeding that moderately compromises surgical dissection
2	Moderate bleeding, a nuisance but without interfering with accurate dissection
1	Bleeding so mild it is not even a surgical nuisance
0	No bleeding, virtually bloodless field.

4. Surgeons satisfaction using 6 point Likert scale:

Extremely dissatisfied 1	Very dissatisfied 2	Somewhat dissatisfied 3	Somewhat satisfied 4	Very satisfied 5	Extremely satisfied 6

5. Any inadvertent pauses during surgery: Yes/No-

   If yes, cause:

6. Any special comments:

7. Blood loss-

   Volumetric blood loss would be calculated

   Number of small gauge pieces used=

   Number of large gauge pieces used=

   Number of suction canister (500mL) used=

   Total volume of fluid in the suction=

Calculation of blood loss taken as average of:

Volumetric blood loss calculation	
calculating (preop Hb(%)- postop Hb(%))/ preop Hb(%)	
Average	

8. Blood transfusion: Yes/No

   If yes, details:

9. Patient's Vitals and NIRS monitoring:

Para-meter/ every 15mins	Base line	15	30	45	60	75	90	105	120	135	150	175	190	210	225	240	Post Intubation
a)Pulse rate																	
b)Blood Pressure																	
c)Mean arterial pressure																	
d)Oxy-gen saturat-ion																	
e)End Tidal CO2																	
f)NIRS (rSO_2)																	

10. Any alternate intervention, if required:

11. Intraoperative complications-

    a) Bradycardia:

    b) Reflex tachycardia:

    c) Hypotension:

    d) Desaturation:

    e) Arrythmias:

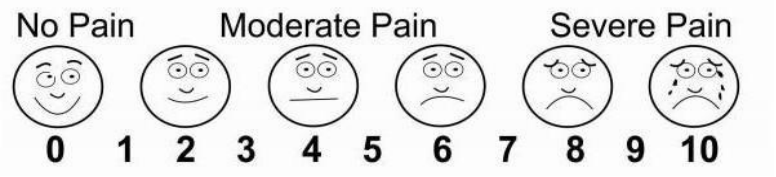
    f) Any other:

III. Postoperative parameters-

1. Hemoglobin (g%):
2. Hematocrit (%):
3. Complications till 24 hours-
    a) Nausea/vomiting:
    b) Reflex tachycardia:
    c) Hypotension:
    d) Desaturation:
    e) Any other:

4. Visual Analogue Scale (VAS) for Pain assessment till 24 hours

6 hours	
12 hours	
24 hours	



Annexure VII: Plagiarism Score Certificate

ORIGINALITY REPORT

11%
SIMILARITY INDEX

PRIMARY SOURCES

1	"42 Annual Congress of AOMSI Nagpur 16-18 Nov 2017", Journal of Maxillofacial and Oral Surgery, 2017 Crossref	132 words – 1%
2	hdl.handle.net Internet	126 words – 1%
3	worldwidescience.org Internet	79 words – 1%
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7	"EUROANAESTHESIA 2005: Annual Meeting of the European Society of Anaesthesiology Vienna, Austria, May 28-31, 2005", European Journal of Anaesthesiology, 09/14/2005 Crossref	42 words – < 1%
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