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Comparison of Blood Loss in Orthognathic Surgery with Normal and Hypotensive Anaesthesia- Clinical Study.

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Abstract: *Most of the bleeding cannot be controlled by usual surgical techniques employed in soft tissue surgery like identification and ligation of vessels. In this situation induced hypotensive anesthesia appears as an ideal method to decrease the blood loss and amount of transfusions following orthognathic surgery. In this study comparison of blood loss in orthognathic surgery with normal and hypotensive anaesthesia is evaluated.*

Keywords: *Bleeding, Surgical techniques, Hypotensive anesthesia, Orthognathic surgery.*

I. Introduction

Various dentofacial deformities are corrected by orthognathic surgical procedures, which lead to significant blood loss due to soft tissue and intrabony bleeding from medium sized vessels to capillaries. Most of the bleeding cannot be controlled by usual surgical techniques employed in soft tissue surgery like identification and ligation of vessels. In this situation induced hypotensive anesthesia appears as an ideal method to decrease the blood loss and amount of transfusions following orthognathic surgery[1]. The whole blood loss is decreased by more than 40% during hypotensive anesthesia as compared with normotensive anesthesia for similar orthognathic surgical procedures. This clinical study is to determine the efficacy of hypotensive anesthesia in minimizing blood loss during orthognathic surgery[2].

II. Materials And Methods

After obtaining approval from the patient and the parents, 10 patients within the age group of years 21-34 were studied in a prospective, randomized, stratified and single blind fashion.
The patients were randomly allotted to A or B group**.**
A-Group is a normotensive group (normal) on whom a routine anesthetic procedure is to be adopted.
B-Group is a hypotension group on whom hypotensive anesthesia is to be adopted.[3]

The patients selected for study were those requiring orthognathic procedures, for either single or both the jaws. All patients were healthy ASA class I subjects taken in this study

The ASA class includes:
Class I: Healthy patient
Class II: Mild systemic disease – no functional limitation.
Class III: Severe systemic disease [a] – definite functional limitation.
Class IV: Severe systemic disease [a] that is constant threat of life.
Class V:Moribund patient not expected to survive 24 hrs with or without operation.

(a –Whether or not the systemic disease is the disease for which a patient is undergoing surgery.)

Patients belonging to ASA II-IV were not included in the study. In particular asthmatic patients were strictly excluded. Preoperative investigations included hemoglobin percentage, packed cell volume, urine analysis, urea and creatinine[5]. The patient's baseline blood pressure was recorded.

Method of general anesthesia:

Premedication: All the patients included in the study were given the following pre-medications:
8 Hours before surgery. Tab-Diazepam - 10mg, Tab-Ranitidine- 150mg, Tab-Metaclopromide - 10mg, One hour before surgery –Inj- Glycopyrrolate - 0.2mg I.M.

Preparation:

Two good venous accesses one of the infusion of hypotensive agents and the other for the fluid administration were gained. Inj – Cephatxim 1gm and Metronidazole 1gm were given as aroutine prophylactic antibiotic. Inj – Dexamethasone 8mg was given as a routine. Bladder was catheterized with Folley's catheter to monitor hourly urine output. The patients were connected to the monitors like continuous ECG> SpO_2, Pulse rate.Respiratory rate and non-invasive blood pressure. The alarms were selected and entered into the monitor. 250ml of 5% dextrose was infused before induction[4,6,7].

Procedure: The pre-operative blood pressure was recorded before the patient was shifted to the theatre.
Induction: Anesthesia was induced with 5mg/kg of Thiopentone Sodium and Inj- Tramadol 2mg/kg was used as an analgesic agent for both the groups.

Intubation: In patients with a normal predicted airway Vercuronium Bromide 0.05mg/kg were used as a muscle relaxant to facilitate the naso-endotracheal intubation. In patients with a predicted abnormal airway Inj. Succinylcholine was used as a muscle relaxant at 2mg/kg dose. The same method was adopted in both the groups[5,8].

Position: Both the group patients after intubation were positioned in (10^0 Fowler position with a sandbag in the inter-scapular region.

Maintenance of Anesthesia:

In 'B' group patients, anesthesia was maintained with 70% of nitrous oxide, 30% of oxygen and 1% of halothane. Halothane was slowly weaned off and stopped.
In 'A' group – normotensive group of patients Halothane of 0.5% was used for the initial hour and stopped.

A) **Hypotensive agents:** Used on B group – hypotensive patients. Nitroglycerine - 50mg in 500ml normal saline was infused through a volumetric infusion pump (Figure-1) just before theInduction and this NTG was titrated to keep the mean arterial pressures in between 60 -65mm.

Figure -1 Volumetric infusion pump

Esmolol was used to prevent the tachycardia response by the nitroglycerine[9]. Esmolol was started at 300 micrograms/kg as a bolus followed by an infusion rate to keep the heart rate less than 100 / min. This esmolol was infused in a syringe infusion pump (Figure-2)

Figure – 2Syringe infusion pump

B) Anesthetic agents:

In patients of both the groups Vercuronium Bromide a non-depolarizing muscle relaxant was used to maintain the muscle relaxation and Tramadol was toped up at 1mg/kg dose if the surgery was prolonged for more than three hours.

C) Hypotensive level

The mean arterial pressure was maintained in between 60-65mm of Hg throughout the procedure until the surgeon fixed up the osteotomy segments. In case of reduced urine output of less than 0.5ml/kg/hr in spite of adequate fluid replacement, the mean arterial pressure was slowly raised roughly by around 10mm of Hg to retain the urine output[10]. At the end of the segmental fixation, by reducing the NTG infusion rate to the pre operative value, the mean arterial pressure was slowly raised and the hemostasis is checked.

D) Fluid management:

A strict fluid replacement protocol was followed. Ringer's lactate was infused intra-operatively at the rate of 6ml/kg/hr, with a volumetric pump to maintain routine intra-operative fluid requirements. Allowable blood loss (ABL) was defined as 20% of estimated blood volume (male 80ml/Kg, female 70ml/Kg). Blood loss up to the ABL replaced with 3ml of Ringer's lactate for each milliliter of blood loss[11]. When blood losses reached the ABL, one unit of blood was transfused and then additional unit for every 400 ml of blood loss.

Monitoring:

It includes a non-invasive blood pressure monitor (Figure-3), E.C.G., Pulse oximeter and urinary output. Blood pressure both systolic, diastolic and mean arterial pressure, heart rate, SpO_2 were checked and recorded every fifteen minutes. Urine output was measured every hour.

Figure – 3 Blood pressure monitor

Before the incision, the surgeon infiltrated the oral mucosa with 2% lignocaine with adrenaline 1:80000. The duration of the anesthesia, from anesthetic induction to the reversal of muscle relaxant's effect was recorded. The time from first incision to the completion of the last suture placement was recorded as the surgical time[13]. During the procedure, the amount of irrigation fluid was precisely measured.

Pharmacokinetics and Pharmacodynamics

Pharmacology of the hypotensive anesthetic drugs:

The drugs, used in deliberate hypotension, are:

1. Inhaled anesthetics - Halothane
2. Intravenous anesthetics - Nitroglycerine
   - Esmolol

The signs of depth of anesthesia with halothane that are most practical value are the blood pressure, which is progressively depressed, and the response to surgical stimulation. The concentration of anesthetic agent that is necessary in the inspired gas mixture for induction of anesthesia must be appropriately reduced as an alveolar concentration increases during maintenance if progressive increase in depth of anesthesia and decrease in blood pressure are to be avoided.

Circulation: Administration of halothane is characterized by a dose dependent reduction of arterial blood pressure. Hypotension results from two main effects. First, the myocardium is depressed directly and cardiac

output is decreased; second, the normal baroreceptor-mediated tachycardia in response to hypotension is obtunded.
Heart: Both increased concentrations of halothane and reduced arterial carbon dioxide tension (hyperventilation) accentuate the reduction in cardiac output.
Cardiac rhythm: The heart rate is slow during anesthesia with halothane. Halothane may also increase the automaticity of the myocardium
Baroreceptor control. In addition, halothane has little effect on the response of preganglionic symphathetic neurons to stimulation of baroreceptors

Organ Blood Flow: Halothane influences the blood flow to every organ by both direct and indirect actions. The coronary circulation remains responsive to myocardial needs for oxygen. In an individual patient, pH and carbon dioxide tension, posture, temperature, age, disease, and the administration of other drugs can influence blood flow to each of these organs.

Respiration: If the patient anesthetized with halothane is allowed to breathe spontaneously. Halothane thus influences both ventilatory control and the efficiency of oxygen transfer.
Ventilatory Control: Characteristically respirations are rapid and shallow during halothane anesthesia
Pulmonary Oxygen Transfer: Efficient transfer of oxygen from the alveolar gas to hemoglobin in the alveolar capillary red blood cell depends on a proper balance between alveolar ventilation and perfusion.

Nervous System: Electrical activity of the cerebral cortex recorded by a frontooccipital EEG shows progressive replacement of fast, low voltage activity by slow waves of greater amplitude as halothane anesthesia is deepened Since cerebral blood flow generally increases during halothane anesthesia, cerebrospinal fluid pressure increases. Shivering during recovery is common and probably represents both a response to heat loss and an ill-defined expression of neurological recovery[12].

Muscle: Relaxation of skeletal muscle is desirable or necessary for many surgical procedures. Anesthesia with halothane causes some relaxation by central depression; in addition, the duration and magnitude of the muscular relaxation induced by non-depolarizing skeletal muscle relaxants such as tubocurarine or pancuronium are increased.

Kidney: Halothane causes dose dependent reductions of renal blood flow and the rate of glomerular filteration; these parameters may be 40 to 50% of normal. Preoperative hydration and prevention of hypontension can attenuate these effects. Halothane does not interfere greatly with autoregulation of renal blood flow nor, in the normotensive state.
Liver and Gastrointestinal Tract: Splanchnic and hepatic blood flow is reduced by halothane as a passive consequence of reduced perfusion pressure, but there is no evidence of overt ischemia.
Bio-transformation: Approximately 60 to 80% of absorbed halothane is eliminated unchanged in the exhaled gas in the first 24 hours after its administration.

Advantages: Halothane is non inflammable and does not irritate the respiratory Passage. It has a fruity odour and is not unpleasant for induction. Induction of anesthesia and recovery are reasonably quick. The incidence of postoperative vomiting is low. Halothane inhibits laryngeal and pharyngeal reflexes in upper planes of surgical anesthesia to a considerable extent. It also relaxes the masseter muscles and inhibits salivation; hence tracheal intubation is much easier with this agent. It does not cause laryngospasm, bronchospasm, coughing, but produces bronchodilation by a direct relaxation of the bronchial smooth muscle. Hence it is preferred in-patients with history of bronchial asthma. Halothane may be employed to induce control hypotension to provide a "bloodless" field during surgery but is safe in expert hands with Boyles anesthetic apparatus (Figure-IV).

Figure – 4 Boyles anesthetic apparatus

Disadvantages: Muscular relaxation with halothane alone is inadequate to permit the surgical procedures; however, it potentiates the actions of d-tubocurarine, including its ganglionic blocking effect and this may lead to profound hypotension during anesthesia.It depresses respiration if its concentration in the anesthetic vapour is allowed to exceed 2%. It causes cardiovascular depression and hence, hypotension is a major drawback with halothane anesthesia. It exerts direct depressant action on the heart, decreases the cardiac output, reduces the sympathetic outflow and increases the parasympathetic tone. The total peripheral resistance changes very little even when hypotension occurs. With increased concentration it causes bradycardia. With rapid inhalation or a sudden increase in the concentration of halothane, the blood pressure may decrease suddenly and cardiac arrest may supervene.

Intravenous Anesthetics:
The intravenous anesthetics are:
1. Nitroglycerine 2. Esmolol

1.Nitroglycerine:

The drug has been used for years to treat patient's coronary artery spasm or with myocardial infractions and to control periods of hypertension in-patients with known coronary artery disease.
Chemical name of nitroglycerine is 1.2.3 propanetriol trinitrate.

Precautions:
1. Nitroglycerine injection should be used with caution in-patients with severe hepatic or renal disease.
2. Excessive fall in blood pressure, especially for prolonged periods of time, must be avoided because of possible deleterious effects on the brain, heart, liver and kidney from poor perfusion and the attendant risks of ischaemia, thrombosis and altered functions of these organs. Patients with normal or low pulmonary capillary wedge pressure are especially sensitive to the hypotensive effects of nitroglycerine injection. It is advisable to monitor the pulmonary
capillary wedge pressure to titrate the dosage of the drug and as it generally precedes the occurrence of arterial hypotension.
3. Use during pregnancy: The safety of the use of nitroglycerine injection during pregnancy has not been established, therefore it should be given to pregnant women only if clearly needed.

2. Esmolol:

Esmolol is selective β_1 antagonist with a very short duration of action. It has little if any intrinsic sympathomimetic activity and it lacks membrane stabilizing actions. Esmolol is administered intravenously and is used when β blockade of short duration is desired or in critically ill patients in whom adverse effects of bradycardia, heart failure, or hypotension may necessitate rapid withdrawal of drug.

III. Data Collection

Preoperatively the gauze was cut into pieces of 4X6 inches and the weight of each gauze was determined (Fig.5). The length and weight of throat pack gauze (Roller gauze) was measured. The number of gauzes used for the surgery and the total weight of the gauze was determined, by using the common balance. All the gauzes were sterilized after measuring.

Figure – 5

A total number of 40 gauzes were prepared for every surgery and the weight of 40 gauze were noted. For every 15 minutes the surgeon Fromme's ordinal scale assessed the surgical field as the scale as follows.
5-Massive uncontrollable bleeding
4-Bleeding, heavy but controllable, that significantly interfered with the dissection.
3-Moderate bleeding that moderately compromised surgical dissection.
2-Moderate bleeding, a nuisance but without interference with accurate dissection.
1-Bleeding, so mild that it was not even a surgical nuisance.
0-No bleeding, virtually bloodless field.

All these readings were recorded for every 15 minutes. After the surgery was completed, the volume of fluid in the suction apparatus was measured (Fig.VI). The number and the weight of the used gauze were measured postoperatively using common balance and also the weight of unused gauze was measured.

Figure – 6

The blood loss was assessed by
a) Calculating the difference in weight of the gauze, both pre and Post-operatively.
b) Suction bottle volume minus irrigation fluid volume.

At the end of the surgery, all the patients were kept in the recovery room until fully awake and then shifted to the ward. Postoperative I V fluids were given depending upon the patient's weight and requirement. Urea, Creatinine, serum Bilirubin, Hb% and packed cell volume were done on the Ist postoperative day to know about the organ function.

IV. Blood Loss Assessment

Amount of saline used (Total for irrigation), Volume collected in the suction apparatus:
No.of small gauze used:No. of large gauze used (Throat pack):Fluids given intra-venously at O.T:Estimation of blood loss by surgeon: Estimation of blood loss by anesthetist.

V. Results

Table I Normal Group

S.No.	AGE	SEX	LENGTH OF SURGERY	LENGTH OFANESTHESIA	EBL BY SURGEON	EBL BY ANESTHETIST
1	24	Female	2Hrs.	2Hrs 15 mts.	900ml	1000ml
2	21	Female	2Hrs. 30 mts.	2Hrs 45 mts.	700ml	800ml
3	34	Female	2Hrs. 20 mts.	2Hrs 40 mts.	700ml	800ml
4	29	Female	2 Hrs.25 mts	2Hrs 40 mts	700 ml	800 ml
5	27	Female	2 Hrs.30mts	2Hrs. 45 mts	700ml	800 ml

Table – 1 showing age, sex, length of surgery, length of anesthesia, estimated blood loss by surgeon and anesthetist in control group

Table II HYPOTENSION GROUP

S.No.	AGE	SEX	LENGTH OFSURGERY	LENGTH OFANESTHESIA	EBL BY SURGEON	EBL BY ANESTHETIST
1	22	Male	3 Hrs. 30 mts.	3Hrs. 40 mts.	600 ml	575ml
2	22	Female	2 Hrs. 30 mts.	2Hrs. 40 mts.	200 ml	150ml
3	25	Female	2 Hrs. 45 mts.	3Hrs.	500 ml	545ml
4	22	Male	2 Hrs, 30mts	2 Hrs. 40mts	200 ml	150 ml
5	22	male	2 Hrs 30 mts	2 hrs. 40 mts	200 ml	150ml

Table – II showing age, sex, length of surgery, length of anesthesia, estimated blood loss by surgeon and anesthetist in hypertension group

Table III NORMAL GROUP

S.no.	15 min	30 min	45 min	1 hr	1hr 15min	1hr 30 min	1 hr 45 min	2 hrs	2hr15m	2hr30m
1	1	1	2	1	1	3	1	0		
2	1	1	2	3	2	1	1	1	1	0
3	1	1	3	2	1	1	1	1	0	
4	1	1	3	2	1	1	1	1	0	
5	1	1	3	2	1	1	1	1	0	

Table – III showing the scoring of the surgical field according to Fromme's ordinal scale in the control group.

Table IV HYPOTENSION GROUP

S.No.	15 Min	30 min	45 min	1 hr	1hr 15min	1hr 30 min	1 hr 45 min	2 hrs	2hr 15m	2hr 30m	2hr 45m	3 hrs	3hr 15m	3hr 30m	3hr 45m
1	1	1	0	0	1	0	0	1	0	0	0	0	0	1	
2	1	1	0	0	0	1	0	0	0	1					
3	1	1	0	0	0	0	1	0	0	0	1				
4	1	1	0	0	0	0	1	0	0	0	1				
5	1	1	0	0	0	0	1	0	0	0	1				

Table – IV showing the scoring of the surgical field according to Fromme's ordinal scale in the Hypotensive group

TABLE – V

VARIABLES	**AGE**	
CONTROL	MEAN	S.D
	26.3	5.26
HYPOTENSION	23.30	1.552

Table – V shows that the age distribution among the patients it reveals that the mean age is 26.30 with a standard deviation of 5.26 in the control group. In the hypotension group the mean age is 23.3 with a standard deviation of 1.55. This figure explains there is no difference between the ages for the control and hypotension group.

TABLE VI:

SEX	**CONTROL**		**HYPOTENSION**	
	No	**%**	**No**	**%**
Male	7	100	1	33
Female	3	100	2	66

Table VI shows that sex distribution among the patients.

The Chi-SquaredValue is 0.22. There is no association between the control and hypotension group with their sex.

TABLE VII:

VARIABLES	CONTROL		HYPOTENSION		t-VAUE
	MEAN	S.D	MEAN	S.D	(P-VALUE)
EBL bySurgeon	733	57.37	433.3	207.99	t.2.406p<0.07
EBL by Anesthetist	866	122.61	423	427.87	t.1.74p<0.16

Table VII shows a comparison of estimated blood loss (EBL) by the surgeon and anesthetist between control and hypotension group. The statistical analysis of the data by student t-test explained that there is a significant difference of EBL by surgeon and anesthetist between hypotension and control group at P<0.16 level. The mean values of EBL by surgeon and EBL by anesthetist in hypotension group were then compared with control group.

Fig 7: Comparison of estimated blood loss by surgeon and anesthetist between hypotension and control group

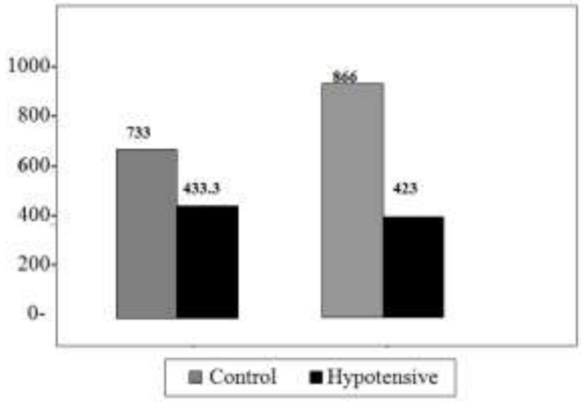

Fig-7 explains that the estimated blood loss by surgeon and Anesthetist shows the better values in hypotension anesthesia

TABLE VIII:

GROUP	MEAN	S.D
Control	1.25	0.04
Hypotension	0.37	0.02
t- Value	32.869 (p<0.001)	

Table VIII shows that the assessment of hypotension and control Group, the student t-test value is 32.869. It reveals that there is statistically Significant difference between hypotension and control group at p<0.001 Level. The assessment of the surgical field by surgeon reveals that the hypotension group is better than the control group.

Photograph of one case

Le Fort I Osteotomy

PREOPERATIVE POSTOPERATIVE

Discussion:

This investigation demonstrated that induced hypotension anesthesia patients in our group did result in reduced blood loss (as measured by the three methods).

1. Estimated blood loss by surgeon
2. Estimated blood loss by anesthetist.'
3. Fromme's ordinal scale for assessment of surgical field and improved surgeon's assessment of the surgical field.

One might question, the use and accuracy of the non-invasive blood pressure monitor (NIBP) for a study of this nature. Certainly, the "gold standard" of blood pressure measurement is an intra-arterial catheter transducer system. These are however, not without risk. The accuracy of automatic non-invasive blood pressure monitors has been questioned. The unit used in our study was Hewlett Packard M3046A monitor cycling every 10 minutes. In our study, blood pressure was lowered to a level significantly different from that of the control group.

In our study 10 Orthognathic surgery patients were studied to compare blood loss, surgical field quality and procedure duration with and without induced hypotension anesthesia. Our study revealed that induced hypotensive anesthesia, resulted in reduced blood loss and improvement in surgical field which was similar to Precious et al but the time of surgical procedure showed a statistical difference between the two groups and the mean time of surgery in the induced hypotension anesthesia group was less when compared to the normotensive control group. This could be due to less surgical field and better visualization to work faster.

Summary:

A study was concluded on 6 patients undergoing osteotomy procedures for facial correction. The study population consisted of two groups. One group of 3 patients (normotensive anesthesia group) and the other group of 3 patients (hypotension anesthesia group), a comparative study on blood loss intra-operatively in these two groups were studied by assessing and comparing the blood loss estimated by the surgeon, anesthetist and surgical field[2]. The drugs used for anesthesia for the normotensive groups were nitrous oxide and halothane and for the hypotensive group the addition of nitroglycerine and esmolol. Blood loss was evaluated by the surgeon,[4] anesthetist and according to Fromme's scale of surgical grading at intervals of 15 minutes from the onset of procedure to the end of the procedure[7].

Our study showed that there is a significant difference between the blood loss in both the groups, and induced hypotension anesthesia group showed reduced blood loss as assessed by the surgeon, anesthetist and according to Fromme's scale[5]. There was neither any organ dysfunction due to tissue hypoxia in any one of the subjects nor any complications.

VI. Conclusion

Technique for minimizing blood loss are important for reducing the need for transfusion and the potential risk of a transfusion reaction or the transmission of blood borne pathogens. This is especially relevant when considering the elective nature of orthognathic surgery. Induced hypotensive anesthesia is a useful and safe technique in the orthognathic population when properly applied and executed[8].

Further well-designed, prospective investigations are needed to define, which agents are most efficient and safe; the recommended parameters of induced hypotensive anesthesia with respect to blood pressure reduction; and effect on blood loss using most accurately available qualifying technique.[6] Induced hypotension anesthesia not only reduced the blood loss, but also provides a blood loss field helping the surgeon to work more effectively and minimize the time of surgery Hence, induced hypotensive anesthesia should routinely be applied especially in elective surgeries like orthognathic surgeries, which is of high beneficial value.[9]

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