

## **Concepts, Application, and Efficacy of Hypotensive Anesthesia in Maxillofacial and Orthognathic Surgeries: Review of Literature**

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**Abstract :** *One of the main complications of the orthognathic surgeries of mandible and maxilla is the intraoperative bleeding due to the high blood supply of the region. Severe bleeding increases the possibility of need for blood transfusion. Transfusion increases the risk of transmitting blood-borne diseases and blood mismatch reactions. In order to decrease the incidence of blood transfusion and its complications, various techniques has been used to reduce the amount of bleeding during orthognathic surgeries. One of the most commonly used and effective methods is hypotensive anesthesia. The aim of the present paper was to review the advantages and disadvantages of hypotensive anesthesia and various protocols used to achieve it.*

**Keywords:** *Blood Transfusion, Intraoperative Bleeding, Hypotensive Anesthesia, Orthognathic Surgery.*

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### **I. Introduction**

Maxillofacial and Orthognathic surgeries are implemented to correct dentofacial anomalies and deficiencies. During the orthognathic surgeries, parts of mandibular or maxillary bones are repositioned to achieve an appropriate occlusion. As the oral and maxillofacial regions possess numerous vasculature and blood supply, there is an increased risk of bleeding during the orthognathic surgeries. In case of severe bleeding, there would be a need for blood transfusion which would increase the risk of transmitting bloodborne pathogens and also transfusion reactions [1-3].

Hence various techniques have been used to manage and decrease the amount of bleeding during the surgeries with high risk of intraoperative bleeding including spinal operations, knee arthroplasty, liver resections, craniosynostosis, and maxillofacial surgeries [4-7]. One of the commonly used techniques is hypotensive anesthesia. In this method the risk of bleeding during the surgery is significantly reduced which would decrease the chance of need for blood transfusion [8-10].

The aim of the present paper was to evaluate the role of hypotensive anesthesia in reducing the risk of intraoperative bleeding in patients undergoing orthognathic surgery.

### **II. History**

This technique was first introduced during an intracranial surgery in 1917 by Harvey William Cushing [11]. However, it was introduced to the everyday surgical procedures by Gardner in 1946 [12]. Gardner collected arterial blood prior the surgery to reduce the volume of blood in systemic circulation. The result was hypotension and also vasoconstriction to compensate the blood loss. The final outcome was reduced bleeding in the field of surgery and enhanced surgeon vision during the surgery [12].

Schaberg et al in [13] published the first study on the hypotensive anesthesia in the field of craniofacial surgery in 1976.

### **III. Hypotensive Anesthesia: Technical Definition**

As mentioned before, the main goal of hypotensive anesthesia is to decrease the blood pressure to reduce the amount of bleeding during surgeries. While the general rule in this technique is reducing the mean blood pressure (MAP) by 30%, it should be individualized by taking each patient's MAP into account. Generally, hypotensive anesthesia decreases the systolic blood pressure to less than 90 mmHg and the MAP to less than 65 mmHg [14].

#### **IV. Clinical Advantages of Hypotensive over Normotensive Anesthesia**

Various clinical trials have been published to evaluate the efficacy of hypotensive anesthesia in comparison to normotensive anesthesia in the maxillofacial surgeries. Praveen et al [15] reported that the hypotensive method led to significantly lower intraoperative bleeding when compared with normotensive surgeries. This finding has been supported by the studies performed by Piñeiro-Aguilar et al [6], Dolman et al [16], Ervens et al [17], and Varol et al [18].

The other advantage of hypotensive anesthesia is the quality of surgery field. Dolman et al [16], Precious et al [19], and Carlos et al [20] found that the hypotensive protocol increased the quality of surgery field based on the surgeons' perception. Improved visualization of the surgery field would further decrease the time needed to complete the procedure. The final outcome would be decrease in the length of the surgery which lowers the amount of intraoperative bleeding consequently [20].

While the risk of blood transfusion would be lower in hypotensive anesthesia over the normotensive, the risk of facing possible side effects of transfusion including cross infections and blood-borne diseases, transfusion reactions, and cardiac failures is reduced in hypotensive technique [21].

#### **V. Protocols to Achieve Hypotensive Anesthesia**

##### **A. Mechanical Maneuver: Anti-Trendelenburg Position**

This position may also called Head-up position is commonly used to achieve hypotensive anesthesia. In this method the head is raised by 15 to 25 degrees off the horizontal plane in order to facilitate the drainage of venous blood return from the surgical site. It should be noted that the blood pressure falls 2 mmHg by each 2.5 cm elevation of the surgical site in comparison to the heart level [22,23].

##### **B. Acute Normovolemic Hemodilution**

In this method one or two units of blood is drawn from patient prior the surgery and is replaced with a cell-free fluid [24,25]. This will dilute the blood and lower number of red blood cells in the circulation. As a result, the blood pressure will be decreased and during the intraoperative bleeding fewer numbers of RBCs would be lost. At the end of the surgery the drawn blood unit(s) will be transferred back to the patient's systemic circulation [26-28].

While this technique decreases the amount of blood loss during the surgery, one should take into account that the lower amount of RBCs in systemic circulation increases the risk of hemodynamic changes including decreased cardiac output [29,30]. On the other hand, Ervens et al [17] compared three different anesthetic protocols (normotensive, hypotensive, and hypotensive plus acute normovolemic hemodilution) in patients undergoing Le Fort I osteotomy or bimaxillary surgery. They found the amount of blood loss was significantly lower in hypotensive anesthesia in comparison to the normotensive protocol. However, no additional benefit was found in accompanying hypotensive anesthesia with acute normovolemic hemodilution regarding the quality of surgical field and amount of blood loss [17].

##### **C. Pharmacological Methods**

Various drugs and pharmacological agents are available to induce hypotensive anesthesia for orthognathic and maxillofacial surgeries. It should be noted that an ideal drug must have a rapid onset with easy administration, rapid recovery after surgery, rapid elimination from circulation, no toxic metabolites, and very few side effects with limited effect on body organs [15]. In the following lines we will discuss various drugs used to achieve hypotensive anesthesia.

##### **Volatile Anesthetic Drugs**

Volatile agents lead to vasodilation and mostly used to induce hypotension during the general anesthesia. These agents include halothane, enflurane, isoflurane, desflurane, and sevoflurane [31].

The mechanism of action of halothane is within myocardial depression. However, enflurane decreases the blood pressure by myocardial depression in addition to decreasing peripheral vascular resistance. Isoflurane, desflurane, and sevoflurane has the same efficacy to reduce the blood pressure [32,33].

One of the main disadvantages of volatile drugs is the need to use high concentrations of these drugs to induce hypotensive anesthesia when used alone. The result would be renal or hepatic injuries. As a result, volatile drugs are mostly used in combination with other anesthetic agents. In addition, when using sevoflurane, isoflurane, or desflurane, non-thermoregulatory shivering and headaches are common in the recovery phase [32,33].

### **Propofol**

Propofol is a widely used anesthetic drug with rapid onset and potent capability of inducing hypotensive anesthesia. One of the disadvantages in using propofol is the limitation in the duration of use; in another word, when using propofol it should be used for short-term. Long-term use of this agent has the potential to induce propofol infusion syndrome in children [34,35].

Ankichetty et al [31] reported no significant difference in the amount of bleeding between isoflurane and propofol for hypotensive anesthesia exhibits there is no significant difference. In addition, Tabrizi et al [36] found no significant advantage in using propofol over isoflurane regarding early postoperative complications including nausea, shivering, agitation, pain, and vomiting.

### **Opioids**

Synthetic opioids include morphine, sufentanil, alfentanil, and remifentanil. In comparison to morphine, these opioids have advantages according to maintaining hemodynamics during maxillofacial surgeries [37,38]. Washburn et al [39] reported that using opioids to achieve hypotensive anesthesia led to decreased amount of bleeding and diminished the risk of blood transfusion during orthognathic surgery.

Remifentanil is commonly used in various surgeries in combination with propofol to reduce the dose of propofol and further postoperative complications. Remifentanil acts through mu receptors. One of the main advantages of this drug is its rapid removal from systemic circulation as it is metabolized by nonspecific esterases present in either blood or tissues. As a result, the recovery time is very short and the recovery complications are very rare [40,41].

### **Nitrates**

These drugs include sodium nitroprusside and nitroglycerine. They are very common for the induction phase of the anesthesia. They lead to hypotensive anesthesia with acting directly on smooth muscles of vessels and decreasing venous return and cardiac output [36].

One of the main disadvantages of nitrous drugs is the reflex tachycardia which could be prohibited by introducing small amount of beta adrenoceptor antagonist [36].

### **Beta Adrenoceptor Blockers**

In order to induce hypotensive anesthesia, these agents are used alone or in combination with nitrous agents. One of the main drugs in this category is Labetalol which is also act as an antihypertensive drug. It usually injected in small bolus doses [42]. The half life of this agent is 4 hours which is long and is a main disadvantage of this agent. However, McNulty et al [42] found that labetalol is a safe and effective alternative to induce hypotension during maxillofacial surgeries.

### **Calcium Channel Blockers**

This drug category includes nifedipine, verapamil, nicardipine, and diltiazem. It has been reported that continuous infusion of calcium channel blockers such as nicardipine can be used to prevent the renal injuries caused by hypotensive anesthesia [43].

## **VI. Contraindications of Hypotensive Anesthesia**

While there are numerous advantages in using hypotensive anesthesia during surgeries, it should be noted that this protocol could be contraindicated in some patients. Systemic conditions that disable the use of hypotensive anesthesia include cardiac disorders, ischemic heart failure, hypertension, hepatic and renal diseases, diabetes mellitus, polycythemia, anemia, hemoglobinopathies, and respiratory insufficiencies [44]. In these situations the side effects would be life threatening and other approaches to reduce the intraoperative bleeding such as tranexamic acid could be implemented [45].

## **VII. Conclusion**

There is a high risk of intraoperative bleeding and further need for blood transfusion in surgeries of high blood supply regions especially maxillofacial surgeries. Hypotensive anesthesia provides an effective and relatively safe mean to reduce the amount of bleeding during the surgery and reduce the need for blood transfusion and its side effects. However, there is a risk of insufficient perfusion of vital organs and also renal and hepatic injuries in using hypotensive anesthesia. It should also be noted that this technique is prohibited in some patients with specific systemic conditions.

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