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Evaluating The Amount of Hemoglobin Drop in Patients Undergoing Orthognathic Surgery

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Background: Orthognathic surgeries are associated with significant blood loss. Several factors such as duration and method of the surgery, anesthesia technique, hemostasis, and surgeon skill affect the amount of blood loss during surgery. Given the importance of reducing blood loss during surgery and the importance of surgeon awareness of the patient's condition, the present study investigated the amount of hemoglobin loss in patients undergoing orthognathic surgery.

Materials and Methods: In this cross-sectional study, patients over 18 years' old who underwent Bilateral Sagittal Split Osteotomy (BSSO), Le Fort I, or both orthognathic (Bimax) surgeries were studied. The sampling method was convenience sampling. Exclusion criteria included patients with hemophilia, von Willebrand disease, and unpredictable complications during surgery (blood transfusion). The patient's hemoglobin was measured and recorded before and 24 hours after surgery. Also, the amount of blood loss in milliliters was recorded at the end of the surgery. Finally, the data were entered into SPSS 26 software, and Independent sample T-test, ANOVA and Pearson's correlation tests were used. A $p<0.05$ was considered statistically significant.

Results: In this quasi-experimental study, 39 patients with a mean age of 27.54±5.72 years (range 18 to 40 years), 17 of whom (43.59%) were males who were examined. The mean duration of Bimax surgery was significantly longer than Le fort I (P=0.021) and BSSO (P<0.001); The decrease in hemoglobin in Bimax surgery was significantly greater than BSSO (P=0.035); the mean blood loss was also statistically different between BSSO and Bimax surgeries (P=0.041), with Bimax surgery being more significant. The difference in hematocrit (P=0.004) and hemoglobin before and after surgery (P<0.001) was significant between male and female patients (so their mean was higher in males), and the duration of surgery, the rate of hemoglobin loss and the amount of blood loss did not show a statistically significant difference (P>0.05).

***Conclusion*:** The amount of blood loss during Bimax surgery was greater than BSSO, but Le Fort I surgery was not different from the other methods. In general, increasing the surgical time increases the amount of blood loss and hemoglobin loss.

Keywords: Orthognathic surgery, Hemoglobin, Hemorrhage, Osteotomy

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Introduction

Orthognathic surgery is the surgical correction of congenital, developmental, or acquired deformities of the facial bones to restore anatomy and function (1). Although orthognathic surgery is considered relatively safe, more than 65 complications have been reported in one study, ranging from postoperative nausea and vomiting to death (2). Severe bleeding and subsequent prolonged recovery are also reported as common complications of orthognathic surgery (1, 3, 4). The reason for this extensive bleeding is the extensive vascular network of the maxillofacial region and the difficulty of accessing the surgical site for hemostasis (3, 5). Several vessels may be exposed to maxillary osteotomy, leading to severe bleeding. These structures include the descending palatine artery, trigeminal venous network, sphenopalatine artery, and maxillary artery. Also, injury to the inferior alveolar artery, retromandibular vein, masseteric artery, or facial artery can lead to bleeding during mandibular osteotomy (1, 5). Several factors such as the duration of surgery, surgical method, anesthetic technique, hemostasis, and surgeon skill affect the amount of blood loss during surgery (5).

Blood loss in orthognathic surgery is usually calculated after wound closure. This is obtained by subtracting the volume of fluid used for irrigation from the total fluid content of the suction reservoir (6, 7). Other studies have also included the weight of surgical gauze and throat packing (8, 9), although this may underestimate blood loss because intra-tissue and maxillary sinus bleeding is not considered (3, 8). Hemoglobin and hematocrit levels are commonly used as indicators to determine the severity of blood loss and to decide whether to administer blood transfusion. In general, when hemoglobin is less than 6 g/dL or 30–40% of blood volume is lost, blood transfusion is indicated (1). However, blood transfusion can be associated with complications such as infection, prolonged hospital stay, and even death (1, 11). However, the amount of blood loss reported in different studies varies widely (1, 3, 5, 10, 11). Careful planning of this surgery in advance and consideration of various considerations before surgery are essential (1). Accurate estimation and prediction of blood loss during orthognathic surgery is very important. The more accurate this estimation is, the more prepared the surgical team is to deal with potential risks during surgery and provides the surgeon and anesthesiologist with the necessary prognosis for the required treatments. The patient himself is also informed about the possibility of blood transfusion before surgery (12). Given the necessity of knowing the patient's condition during surgery, including the amount of blood loss, the present study investigated the rate of hemoglobin drop in patients undergoing orthognathic surgery.

Materials and methods

In this quasi-experimental study, which was approved with the ethics code IR.MUBABOL.REC. 1403.043, patients over 18 years of age who underwent orthognathic surgery (Bilateral Sagittal Split Osteotomy (BSSO), Le Fort I, or both (Bimax) at Shahid Beheshti Hospital in Babol and Dr. Shariati Hospital in Tehran were selected and studied using a simple sampling method. Exclusion criteria included patients with hemophilia, von Willebrand disease, and an unpredictable complication during surgery (need for blood transfusion). In this study, considering a type 1 error of 0.05, a power of 0.8, an acceptable error of 100 ml, and based on the standard deviation of a similar study (12), a sample size of at least 34 people was considered.

Hemoglobin and hematocrit of the patients were measured and recorded before and 24 hours after surgery. Also, after the end of surgery, the amount of blood loss (milliliters) was recorded, which was obtained by subtracting the volume of fluid used for washing from the total fluid content in the suction reservoir. The increase in the weight of blood gases and pharyngeal pack was also added to this amount. The duration of surgery was also recorded.

Finally, the data were recorded in SPSS software (IBM, Armonk, New York) version 26 and, in addition to reporting the data by descriptive statistics indicators, Independent sample T-test and ANOVA tests were used to compare the decrease in hemoglobin and the amount of blood loss between the two genders and based on the type of surgery, and Pearson's correlation test was used to examine their relationship with the duration of surgery. A p-value<0.05 was considered statistically significant.

Results

In this study, 39 patients with a mean age of 27.54 ± 5.72 years (range 18 to 40 years), of whom 17 (43.59%) were males who were studied. 5 of them (1 male and 4 females) underwent BSSO surgery, 4 (1 male and 3 females) underwent Le Fort I, and 30 (15 males and 15 females) underwent Bimax. The frequency of patients in the different groups based on the type of surgery and their gender did not have a statistically significant difference (p-value=0.334). In this study, the duration of surgery, hematocrit, and hemoglobin before and after surgery, the rate of hemoglobin loss, and the amount of blood loss were measured. The mean values of these variables were

examined by type of surgery, which are shown in **Table1**.

As can be seen in **Table 1**, the mean variables of surgical duration (p-value<0.001), hemoglobin drop (p-value<0.001), and blood loss (p-value=0.27) were statistically significantly different based on the type of surgery. In examining the duration of surgery between different groups, it was found that the mean duration of Bimax surgery was significantly longer than Le Fort I (p-value=0.021) and BSSO (p-value<0.001); however, there was no statistically significant difference between the mean duration of Le Fort I and BSSO surgery (p-value=0.175).

In the study of the rate of hemoglobin loss in patients based on the type of surgery, it was also found that the hemoglobin loss in Bimax surgery was significantly higher than BSSO (p-value=0.035); but there was no statistically significant difference between Le Fort I and BSSO surgery (p-value=0.959) and Bimax and Le Fort I (p-value=0.125).

The average amount of blood lost was also statistically different between BSSO and Bimax surgeries (p-value=0.041), which was higher in Bimax surgery, but there was no statistically significant difference between Le Fort I and BSSO (p-value=0.714) and Bimax and Le Fort I (P=0.408).

The relationship between the duration of surgery and the rate of hemoglobin loss and the amount of blood lost is shown in **Table 2**.

As can be seen in Table 2, there was a significant direct relationship between the duration of surgery and the decrease in hemoglobin (p-value<0.001 and r=0.620) and the amount of blood lost (p-value<0.001 and r=0.609).

Comparison of the mean values of the variables based on the gender of the patients is given in **Table 3**. In this study, the difference in hematocrit (p-value=0.004) and hemoglobin before and after surgery (p-value<0.001) was significant between male and female patients (so that their mean was higher in male patients) and the rest of the cases did not show a statistically significant difference (p-value>0.05).

Table 1. Mean values and standard deviations of the studied variables by type of surgery.

Type of surgery	Bimax (Number=30)	The fort I (Number=4)	BSSO (Number=5)	P-value*
Surgery duration (hours)	5.27 ± 1.01	3.75 ± 0.96	2.50 ± 0.61	<0.001
Hematocrit (percentage)	41.80 ± 5.57	42.50 ± 16.53	40.12 ± 5.41	0.861
Hemoglobin before surgery (g/dL)	13.90 ± 1.83	13.10 ± 1.24	13.28 ± 1.83	0.587
Hemoglobin after surgery (g/dL)	12.00 ± 2.07	12.23 ± 1.16	12.58 ± 1.58	0.822
Decrease in hemoglobin (g/dL)	1.88 ± 0.97	0.87 ± 0.17	0.70 ± 0.17	0.010
Amount of blood lost ((mL)	301.67 ± 153.96	200.00 ± 81.65	122.00 ± 43.82	0.027

Table 2. Relationship between surgical duration, blood loss and hemoglobin drop.

Duration of surgery	Lost blood	Decrease in hemoglobin
Correlation (r)	0.609	0.620
P-value	<0.001	<0.001

Table 3. Mean values and standard deviations of the studied variables by gender of patients

Gender	Female (Number=22)	Male (Number=17)	P-value
Surgery duration (hours)	4.70 ± 1.40	4.82 ± 1.37	0.792
Hematocrit (percentage)	38.91 ± 6.18	45.22 ± 6.46	0.004
Hemoglobin before surgery (g/dL)	12.73 ± 1.39	15.05 ± 1.30	<0.001
Hemoglobin after surgery (g/dL)	11.06 ± 1.37	13.44 ± 1.70	<0.001
Decrease in hemoglobin (g/dL)	1.64 ± 1.04	1.61 ± 0.97	0.929
Amount of blood lost (mL)	272.73 ± 175.07	262.73 ± 175.07	0.835

Discussion

Orthognathic surgery is generally considered a major surgery that requires hospitalization, close monitoring, and various interventions related to the patient's blood parameters. Severe bleeding followed by a long recovery period is a common side effect of orthognathic surgery, due to the extensive vascular network in the head and neck region. The results of a study conducted by Salma et al. in 2017 showed that 9% of patients undergoing orthognathic surgery required intraoperative blood transfusion, with 74% requiring 1 RBC unit and the rest requiring 2 RBC units (1).

According to the results of this study, the mean age of the subjects was 27.54 ± 7.52 (range 18–40 years), of which 17 (43.59%) were males. In the present study, the analysis of information such as hematocrit, hemoglobin before and after surgery, hemoglobin loss, and blood loss between the two sexes showed that women and men had significant differences in hematocrit and hemoglobin before and after surgery; these were significantly lower in women than in men. Ueki et al. conducted a study in 2005 to investigate effective ways to reduce bleeding during orthognathic surgery. During the stages of this study, RBC, hemoglobin, and hematocrit were examined by gender, before and after surgery, and the results showed that these were significantly lower in women before and after surgery than in men (8). This could be due to the different physiology of women compared to men. In this study, there was no significant difference between the two sexes in terms of blood loss and hemoglobin loss. A study conducted by Salma et al. in 2017 to investigate the timing of surgical blood loss, hemoglobin drop, blood transfusion, and length of hospital stay in orthognathic surgery showed that the amount of blood loss in men was significantly higher than in women, which was inconsistent with the results of the present study (1); because men underwent more severe surgeries than women in that study. A study conducted by Thesum et al. in 2016 stated that there was no significant difference between males and females in terms of blood loss, which was consistent with the results of our study (6).

In this study, orthognathic surgery techniques (BSSO, Le Fort I, or Bimax) were also compared in terms of surgical time, hematocrit, and hemoglobin levels before and after surgery, hemoglobin loss, and blood loss. The results of the present study showed that the duration of Bimax surgery was significantly longer than BSSO and Le Fort I surgeries, but there was no significant difference between the durations of BSSO and Le Fort I surgeries. The results of a study conducted by Bowe et al. in 2021 showed that Bimax surgery had the longest duration, which was consistent with the results of our study. Also, the duration of Le Fort I surgery was slightly longer than BSSO, and it can be said that there was no significant difference and was consistent with the results of our study (13). Considering that simultaneous correction of the upper and lower jaws (Le Fort I, BSSO) is performed in Bimax surgery, it is expected that it will take longer than surgery on each jaw alone. Also, due to the greater complexity of maxillary surgery due to proximity to anatomical structures such as paranasal sinuses and nerves, this surgery (Le Fort I) requires more precision and time. On the other hand, the surgeon's skill and the use of more advanced techniques also affect the surgical time, and the lack of significant difference in this method in the present study may be due to this. According to the present study, the amount of blood loss and hemoglobin drop in Bimax surgery was significantly higher than in BSSO surgery. However, there was no significant difference between BSSO and Le Fort I surgeries, as well as between Bimax and Le Fort I surgeries. The results of a study conducted by Salma et al. in 2017 to investigate the surgical time of blood loss, hemoglobin drop, blood transfusion, and length of hospital stay in orthognathic surgery showed that patients undergoing Le Fort I surgery lost more blood than patients undergoing BSSO surgery, which was inconsistent with the results of our study. This discrepancy could be due to the larger sample size of their study. Factors such as the skill of the surgeon, preoperative precautions, and medications used to reduce bleeding may also explain this difference. In general, the amount of bleeding in Le Fort I surgery may be higher than in BSSO because the maxillary bone is usually spongier and has more blood vessels. This study also showed that patients undergoing combined surgery (BSSO + LI + GP) had more bleeding, which was consistent with the results of our study (1). Thesum et al. (2016) conducted a study to investigate the factors affecting the amount of blood loss during orthognathic surgery. In this study, the three-piece Le Fort I osteotomy, BSSO, and combined surgery were examined. The results showed that the treatment method had a significant effect on the amount of blood loss, and there was a significant difference between the two methods, which was different from our study, which only reported a difference in the amount of bleeding between the two surgical methods, Bimax and BSSO (6). The reason for the difference in results can be attributed to the difference in sample size, surgeon skill, and instruments used.

According to the present study, the duration of surgery was significantly associated with the amount of blood loss and hemoglobin loss, and these two factors increased with increasing surgical duration. A study by

Salma et al. on patients who underwent BSSO, Le Fort I, or any combination of the two also showed that there was a significant relationship between the duration of surgery and the amount of blood loss, which was consistent with the results of the present study (1).

Therefore, factors affecting the amount of blood loss during maxillofacial surgeries, such as gender, surgical duration, and surgical technique, should be specifically considered and investigated by surgeons to control the intraoperative and postoperative complications in patients and provide them with a better treatment experience.

Conclusion

Comparison of orthognathic surgery techniques showed that Bimax surgery duration was longer than BSSO and Le Fort I, but there was no significant difference between BSSO and Le Fort I. The amount of blood lost during Bimax surgery was also greater than BSSO, but Le Fort I surgery was not different from the other methods. In general, increasing the surgical time increased the amount of blood lost and decreased hemoglobin. The results of this study can be used in clinical planning of orthognathic surgery, and with optimal time management and preoperative prophylaxis and preparation for blood transfusion, especially in individuals and techniques with a higher risk of bleeding, it can lead to improved surgical outcomes and reduced complications due to decreased hemoglobin.

Declaration

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Conflict of interest

The authors reported no conflicts of interest.

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