Review Article

BLOODLOSS AND TRANSFUSION NEED IN ORTHOGNATHIC SURGERY: REVIEW OF LITERATURE

Constantinus Politis[1a*], Jimoh Olubanwo Agbaje[1b], Ivo Lambrichts[2c]

[1] OMFS-IMPATH Research Group, Department of Imaging and Pathology, Faculty of Medicine, Katholieke Universiteit Leuven, Leuven, Belgium and Department of Oral and Maxillofacial Surgery, University Hospitals Leuven, BE-3000 Leuven, Belgium
[2]Faculty of Medicine, Hasselt University, Diepenbeek, Belgium; Biomedical Research Institute, Laboratory of Morphology, Hasselt University, Campus Diepenbeek, BE-3590 Diepenbeek, Belgium

[a]MD, DDS, MHA, MM, PhD, Professor
[b]BDS, DMD, FMCDS, MMI, PhD
[c]DDS, PhD, Professor

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Background: Blood loss during orthognathic surgery has gained renewed interest due to the omission of surgical final splints in bimaxillary surgery, which increased operative time, while orthognathic surgery is increasingly indicated for the treatment of the obstructive sleep apnea syndrome (OSAS). OSAS subjects are usually older with more medical comorbidity which requires blood transfusion.
Objective: To review (reported) blood loss and transfusion practice in orthognathic surgery in the literature published between 1976 and 2012 and to compare these data with more recent developments. The relationship between the duration of the surgery and the related blood loss and/or transfusion was examined.
Data Sources: The 1976-2012 orthognathic literature was searched to determine the relationship between the duration of the surgery and the related blood loss and/or transfusion.
Study Selection: Articles containing clear information on the operation time, blood loss, transfusion, and orthognathic surgery were included.
Data Extraction: Information on the operation time, blood loss, transfusion, and orthognathic surgery was extracted.
Data Synthesis: Different descriptions of procedures and techniques are grouped together in a concise and coherent way, resulting in a number of categories per label. Using this grouping various targeted questions are exploited and answered.
Keywords: orthognathic surgery, blood loss, operation time, blood transfusion.

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***Corresponding author:** Professor Constantinus Politis, MD, DDS, MHA, MM, PhD, Department of Oral & Maxillofacial Surgery, University Hospitals of Leuven, Kapucijnenvoer 33, 3000 Leuven, Belgium, Telephone: +32 (0) 16.341780, Fax: +32 (0) 16 3 32437, e-mail: c.politis@village.uunet.be

1. Introduction

Blood loss during orthognathic surgery has gained renewed interest for several reasons. A first reason is found in a recent school of thought that advocates the omission of surgical final splints in bimaxillary surgery but insists on the perioperative achievement of an excellent interdigitation, which in many cases can be achieved only by multisegmenting the Le Fort I osteotomy at the cost of increased operative time. Because orthognathic surgery is increasingly used to enhance facial aesthetics, many concomitant procedures have been reported [1], all of them influencing the duration of the operative procedure and blood loss. Orthognathic patients used to be generally young adults without major comorbidities. That scope is changing because orthognathic surgery is increasingly indicated for the treatment of the obstructive sleep apnea syndrome (OSAS). OSAS subjects undergoing maxillomandibular advancement surgery are likely older with more medical comorbidity [2], influencing the limit below which blood transfusion is indicated. Blood loss during surgery requiring blood transfusion is viewed as an important operative complication, designated as a grade II complication in the Clavien-Dindo complication classification system, which is becoming widely accepted for surgical complications, even in oral and maxillofacial surgery [3].

Although a Cochrane review recommends adherence to a restrictive transfusion strategy (7 to 8 g/dL) [4] in hospitalized stable patients, a remarkable tendency to preoperative autologous blood donation is seen even in surgical procedures – such as single-jaw SSO – that nowadays are considered low risk for blood loss [5].
The aim of the present contribution is to review (reported) blood loss and transfusion practice in orthognathic surgery in the literature published between 1976 and 2012. The relationship between the duration of the surgery and the related blood loss and/or transfusion was examined.

2. Methods

2.1. Research questions

The relevant clinical questions that should be answered are as follows:

- Is the operation time a predictor for blood loss and/or blood transfusion?
- Are concomitant procedures (segmentation, genioplasty, rhinoplasty, iliac crest grafts) predictors for blood loss and/or blood transfusion?
- Is the practice of preoperative autologous blood donation a predictor for blood loss and/or blood transfusion?
- What are the measures taken to minimise blood

loss during orthognathic surgery?
- Is operating time correlated to blood loss and/or blood transfusion?
- Is blood loss related to blood transfusion?
- Is an evolution in time detectable concerning duration of operations and/or blood loss?
- The methodological questions that need to be answered are as follows:
- How is blood loss defined or measured?
- How is operation time defined?
- How is hypotension/normotension defined?
- How is mean arterial pressure (MAP) measured and reported?

2.2. Literature review: selection criteria
Table 1 summarizes the entries that were introduced in PubMed, Scopus and LIMO.
No limits were set for language, year, field. A manual search for articles containing information on the operation time, blood loss, transfusion, and orthognathic surgery was performed in the following journals until 1976:
- British Journal of Oral and Maxillofacial Surgery
- International Journal of Oral and Maxillofacial Surgery
- Journal of Craniofacial Surgery
- Journal of Cranio-Maxillo-Facial Surgery
- Journal of Oral and Maxillofacial Surgery
- Oral & Maxillofacial Surgery Clinics of North America
- Oral and Maxillofacial Surgery
- Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics
- Plastic and Reconstructive Surgery
- Revue de Stomatologie et de Chirurgie Maxillo-faciale

An additional manual search was done to retrieve theses on the subject of blood transfusion in orthognathic surgery. Two theses were included [6,7], both in German.

2.2.1. Inclusion criteria
The criterion for retention for further processing was a clear allocation of the operation time AND/OR blood loss AND/OR transfusion to one of following operations:
1. SSO (advancement or set-back)
2. Le Fort I osteotomy one-piece without concomitant procedures
3. Le Fort I osteotomy multisegmental or with additional operations
4. Bimaxillary surgery without concomitant procedures
5. Bimaxillary surgery with simultaneous other procedures (e.g., iliac bone graft, cranial bone graft, genioplasty, liposuction, septoplasty, rhinoplasty inferior turbinate reduction, and removal of third molars).

These operations needed to be the predominant operation if a certain group was correlated with the duration of the operation and/or blood loss. If the predominancy of any of these types of operations could not be established, the group was discarded for further analysis.

2.2.2. Exclusion criteria
Exclusion criteria were craniofacial surgery in children; articles where blood loss, operation time, or transfusion could not be clearly attributed to one of the categories mentioned; case reports on syndromes; and case reports or reviews on major postoperative hemorrhagic events. In addition, retrospective reports on large numbers of procedures were often not suitable for inclusion because they did not separate the different categories needed. No minimal number of patients was required to be included.

Table 1. Summary of the entries that were introduced in PubMed, Scopus and LIMO.

Entry	Medline	Scopus	Limo
Blood loss and orthognathic	121	6	80
Transfusion and orthognathic	62	6	26
Operative time and orthognathic	35	10	157
Hypotension and orthognathic	50	5	18
Blood transfusion and orthognathic surgery	62	2	25

3. Results
3.1. Search results
In total, 51 papers and 2 theses were retained that contained valuable subgroups with information. Both retrospective and prospective studies were accepted, no matter if the procedures were done in normotension, mild hypotension, controlled hypotension, or any other tension reported (see Appendix 1)

3.2. Meta-analysis or systematic review
Meta-analysis was not the approach used because there was no control group for comparison. Control groups were used to compare the effect of different medications that influence the depth of controlled hypotension or to compare the effect of certain antifibrinolytic agents such as aprotinin, aminocaproic acid, and tranexamic acid to stabilise clot formation. Because the levels of reduced blood loss of these measures are considered below clinical relevance compared to the type of surgical procedure selected [8], aggregation of data is needed. Therefore, the following differences have been neglected:
- different methods to realise anaesthesia (gas, iv medication);
- different methods to reach mild, moderate, or deep hypotension; and
- different or no use of antifibrinolytic agents.

3.2.1. Aggregation of data
Many different descriptions of procedures and techniques needed to be united in a concise and coherent way, leading to a number of categories per label, allowing focus on the targeted questions. These characteristics were defined as seen in Appendix 2.

3.3. Measurement of blood loss
To compare blood loss in comparable surgical procedures (BSSO, Le Fort I, bimaxillary surgery), measurement of blood loss has to be comparable. In that respect, we found that in 22 out of 51 papers, the method of measuring estimated blood loss was missing [9-30].
In 18 out of 51 papers, the estimated blood loss was measured by deducting the volume of saline used from the total volume in the suction unit and by weighing the sponges [31-48], others 10 mL [43].
In 6 out of 51 papers, losses in sponges were not included

in the estimated blood loss, but the irrigation fluid and the fluid collected in suction devices was [8,49-53].
In 5 papers/theses, the calculation was based on a comparison of preoperative and postoperative hematocrit level [6,42,54,55] or blood volume [56]. The problem with estimation of preoperative and postoperative hemoglobin and/or hematocrit is that the timing between the preoperative and postoperative measurements differed between studies. It varied between 6 hours postoperatively [38] and 1 week postoperatively [46]. Ueki et al [46], however, did include the perioperative blood loss estimation. Hemodilution may be a problem when measuring the postoperative hemoglobin level, and the rise in hemoglobin level will differ according to individual body size.
The postoperative blood loss was not estimated, and the blood lost in drapes and gowns was not measured. The blood lost postoperatively in drains or swallowed by the patient all contribute to the ultimate blood loss that may affect the decision for blood transfusion. Also, blood lost in sinuses or tissue spaces was not accounted for [44].
The intraoperative blood loss estimation is always less than the calculated blood loss [6], but the estimation accuracy worsens with the amount of blood lost. Böttger calculated a linear regression where the estimated blood loss=0.4115 × Calculated blood loss + 406.8. In this calculation, a 1000 mL estimated blood loss appears to correlate with 1462 mL calculated blood loss, and a 2000 mL estimated blood loss appeared to correlate with 4250 mL calculated blood loss [6]. The deviation between estimation and calculation increases as the volume increases. The underestimation between the estimated blood loss and the calculated blood loss also was observed by Schaberg et al [45] in a radioisotope study of red blood cells.

3.4. Measurement of duration of surgery

To know the duration of surgery, all papers that define and measure the duration of surgery in the same manner are valid candidates to be included if the duration can be clearly attributed to a specified orthognathic procedure. The operation time is defined as 'missing' if the starting point of the measurement and the endpoint of the measurement were not defined. In contrast to 'age', 'weight', and 'length', operation time allows variable interpretations.
Out of the 51 papers retained for data acquisition, 44 did not mention at all how the duration of surgery was measured; 2 stated that the duration was recorded or documented; 2 clearly stated that the operating time was calculated from the first incision to the last suture [42,55]; one counted from the beginning of the BSSO incisions to the last suture [29], and one started from the injection of the local anesthetic to the last suture [47]. Clearly, no uniform definition of operation time exists. Using operation time as a predictive variable, in the absence of the knowledge about which two points were used to measure it, creates an important bias when comparing studies.

3.5. Duration of surgery and blood loss

One would assume that the longer the operation lasts, the more blood is lost. In bimaxillary surgery, Böttger [6] indeed found a linear correlation between calculated blood loss and operation time, but this correlation was weak for 82 bimaxillary procedures: Spearman correlation coefficient r = 0.325. Chen et al [31] found a weak Spearman rank correlation between operation time and blood loss in 30 mandibular surgery patients (IVRO set-back and genioplasty). Rummasak et al [43], in a retrospective review of 208 patients with bimaxillary orthognathic surgery, reported the following correlation between blood loss and operative time: blood loss = (2.64 * operative time) + 82.35. They reported a "significant" relationship because the p value was < 0.001 for R2 = 0.15. However, we should be cautious: R2 = 0.15 signifies R = 0.387; when attempting to predict one measure from another, coefficients below 0.40 do not yield a guess even 10% better than chance [57]. Further, the chart seems to include all data points, indicating that the whole population rather than a sample was reported. As a result, p value reporting would not make sense.
A confusing presentation of blood loss versus operative time is found in Ueki et al [46]. In regression analysis, y is what we want to predict or to understand and is sometimes called the dependent variable. X is called the independent variable or a predictor. In the equation, we want to predict blood loss on the basis of operative time. So, operative time needs to be on the x-axis, as most authors have placed it [22,29,31,43,55,58]. Because blood loss is a continuous variable, linear regression was used [59].
Four papers [15,17,20,48] provide data of overall 163 individual patients concerning the peroperative bloodloss and the duration of surgery (Table 2).

Table 2. Summary of the entries that were introduced in PubMed, Scopus and LIMO.

Study	Estimate	Standard Error
Golia et al [15]	-0.37310	0.3161034
Kasahara et al [17]	3.65315	0.7732564
Landes et al [20]	1.46156	0.6044895
Zellin et al [48]	4.43946	1.1349279

Based on these studies it was possible to estimate the amount of bloodloss for every minute of surgery: per minute of operation time the estimated bloodloss is 2.151 mL (= SE 1.124 mL; p = 0.056) (Table 3).

Table 3. Relation bloodloss versus duration of surgery.

Evaluation between-study heterogeneity				Random Effects Analysis		
I^2	Q	Df	P-value	Estimate	SE	p-value
92.210	38.510	3	<.0001	2.151	1.124	0.056

I^2 = percentage of variation in study estimates due to heterogeneity; Q = Cochrans Q statistic. If Q is smaller than the number of degrees of freedom, then the estimated heterogeneity equals zero (I^2 = 0%); Df = Degrees of Freedom for heterogeneity test; Random Effects Analysis: DerSimonian and Laird method; SE = standard error

Several articles [6,22,29,31,43,46,58] do find a linear correlation between blood loss and the duration of surgery but these data could not be integrated due to the lack of necessary information. Besides the linear regression coefficient, both the standard error of the alfa- and beta-coefficient should be known as well as the total number of patients.

3.6. Hypotension

There is no accepted single definition for intraoperative hypotension. Bijker et al [60] in a literature review found more than 50 different definitions of intraoperative hypotension used in the recent anaesthesia literature. When it comes to controlled hypotension in the orthognathic literature, again no consensus is found as to what constitutes controlled hypotension and how it would differ from intraoperative hypotension. Bijker et al [61] found that patient and surgical characteristics, notably age and duration of surgery and duration of low blood pressure, influence the relationship between intraoperative hypotension and adverse outcome. Controlled hypotension is an anesthesiological technique to lower the mean arterial blood pressure of the patient in orthognathic surgery on the presumption that a lower blood pressure correlates with less blood loss and a better quality of the operation field. In the orthognathic literature, hypotension has not been related to adverse effects except for patients with pre-existing hypofunction. In these cases, cerebral damage or neurological deficit, stroke, dysrhythmia, cardiac arrest, or even death have been reported [32].

The absence of a common definition of hypotension, the different ways of measurement of arterial pressure, the different attitudes towards the intraoperative duration of hypotension, the timing to reverse hypotensive anaesthesia to discover and address undetected arterial hemorrhage [29], and the different means to achieve hypotension render comparisons between study groups difficult. An entire range encompassing aggressive attitudes (MAP 50–55 mm Hg), cautious attitudes (blood pressure 20%– 30% below mean preoperative level), and no deliberate hypotension is reported with orthognathic surgery.

Measurement of mean arterial pressure was mostly done with the aid of measurements from a radial artery catheter. [45] calculated mean arterial pressure with the formula: systolic pressure × 2/5 + diastolic pressure × 3/5. No other mean arterial pressure measurement formula was found in the 50 other retained articles. Contemporary monitors measuring mean arterial pressure use the following formula: (diastolic pressure × 2) + systolic pressure) / 3.

3.6.1. Advantages of controlled hypotension

Controlled hypotension has advocates and opponents. Arguments raised in favour of controlled hypotension are a shorter operation time, a better quality of the operation field, diminished blood loss, and lower blood transfusion. Others question the advantages of controlled hypotension [6]. Choi and Samman [32] studied that controversy with a systematic review and concluded in support of hypotensive anaesthesia, with three studies reporting a significant decrease of blood loss in patients receiving hypotensive anaesthesia, two studies reporting a significant decrease in transfusion rate, and two other studies demonstrating an improved surgical field and significant reduction in operation time. Their conclusion was that hypotensive anaesthesia is most valuable in operations of long duration when a large amount of blood loss and consequent blood transfusion are to be expected.

3.6.2. Minimizing perioperative bleeding

Both surgeon and anesthesiologist have means at their disposal to affect coagulation, blood loss, and the quality of the surgical field.

- Anesthesiologist:

- normovolemic hemodilution
- application of Cell Saver Systems
- carefully controlled body temperature
- use of tranexamic acid (antifibrinolytic agent) as a clot stabiliser
- use of aprotinin (serine protease inhibitor)
- use of desmopressin, increasing coagulant activity
- hypotensive anesthetic techniques
- optimised tissue perfusion by administration of 500 mL of hydroxyethyl starch 6%/200/0.5 before segmentation of the maxilla [55]
- atraumatic nasal intubation with heated nasal tubes
- avoidance of trauma at adenoid fossa during intubation
- preoperative injection of human recombinant erythropoietin (not routine in OMFS)
- preoperative exclusion of bleeding disorders
- maintaining hypocapnia

- Surgeon:

- avoiding perioperative vascular injury
- bipolar electrocoagulation; cutting diathermy
- use of an electrocautery unit to make incisions
- skilled surgeons to perform the operation instead of residents
- surgical vigilance
- administration of local anaesthesia with vasoconstrictor immediately after intubation
- timely administration of local anaesthesia in Le Fort I
- fluid injection with vasoconstrictor subperiosteally at nasal floor
- cocainisation of the nasal mucosa prior to maxillary surgery
- vasoconstriction of intranasal lining with cottonoid sponges soaked in nasal decongestant
- placement of the patient in a reverse Trendelenburg position
- incisions that are cleanly made through the periosteum
- packing of open surgical sites with gauze
- local hemostatics like oxidised regenerated cellulose (Surgicel®, Ethicon Inc, Johnson&Johnson Company, Somerville, NJ, USA)
- piezosurgical osteotome
- endoscopic assistance for a controlled dissection of nasal mucosa [62]
- hemostats and hemoclips
- short duration of operation
- instrumentation that allows suction with built-in light system
- avoiding venous obstruction

3.7. Excessive blood loss

Reports concerning the need for blood transfusion also give some insight into the occurrence of excessive blood loss, either directly by explicit mention or by observation of the range of blood loss. Kok-Leng Yeow and Por [19] report 3 excessive bleedings in 102 orthognathic patients, occurring from the facial artery, maxillary artery, and pterygoid plexus separately in three patients. When we observe the reported ranges of the subgroups, we see an upper limit of the range at 3000 mL and one upper limit of 6000 mL of perioperative blood loss. Martini et al [22], in a graph depicting the linear correlation between

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blood loss and operation time, show two outliers of blood loss, one close to 2900 mL and one at 5000 mL, in an orthognathic surgery group containing 27 Le Fort I operations and 52 bimaxillary cases. Choi et al [58], in a reported graph with the relationship between total blood loss and operation time in 61 patients, show 4 cases of blood loss in excess of 3000 mL. The mean blood loss in 11 patients who received blood transfusion included one group of 7 patients (2,291±831.7 mL) and one group of 4 patients (1,732±856.8 mL). Rummasak et al [43] reported retrospectively on 208 bimaxillary orthognathic osteotomies, and their graph depicting the regression analysis between blood loss and operative time shows one case with 2750 mL and one case with 3400 mL of estimated blood loss. Samman et al [44] reported on 291 bimaxillary and 69 single-jaw surgical cases with a range of blood loss between 50 mL and 5000 mL and 5 hemorrhagic perioperative incidents. They reported that 4% of the 291 bimaxillary surgical cases required a transfusion greater than 2 units of blood. In the range of blood loss reported by Ash [9], we find a value of 3400 mL, which occurred in a bimaxillary osteotomy case. In the series of Böttger [6], an upper limit of 3400 mL is reported.

3.8. Criteria for transfusion

The updated Cochrane review on transfusion thresholds [4] concludes that, for most patients, giving less blood is safe and blood transfusion is probably not essential until hemoglobin levels drop below 7.0 to 8.0 g/dL. In the orthognathic literature, no consensus exists regarding what constitutes a blood transfusion 'trigger'. Fenner et al [13] performed 105 consecutive bimaxillary osteotomies without any need for transfusion and argued that in young healthy adults, hemoglobin concentrations as low as 50 g/L can be sustained. In contrast, Zellin et al [4] gave blood transfusion when arterial hemoglobin was below 100 g/L. Flood et al [63] reported overtransfusion in bimaxillary osteotomies where the postoperative hemoglobin increased after homologous transfusion. Obviously, the high rate of blood transfusion in the series of Flood et al [63] could have been avoided by more strict criteria for transfusion. The general condition of the patient and underlying diseases are taken into account when deciding on the need for blood cell transfusion, and hemoglobin concentration is one of the criteria [39,64] used the criterion of allowable blood loss. The allowable blood loss was defined as 20% of the estimated blood volume (male 70 mL/kg, female 65 mL/kg), and once this was reached, a unit of packed red cells was transfused.

3.9. Risk of transfusion

The authors report that the risk for viral transmission is very low in developed countries. An example is Canada, where the residual risk of transmission through transfusion of HIV, HCV, and HBV is estimated to be 1 per 7.8 million donations, 1 per 2.3 million donations, and 1 per 153,000 donations, respectively [4]. This reduction in risk should lead to the abandonment of the practice of autologous blood transfusion because the most important reason for an autologous blood donation is the greatly reduced risk of disease transmission. It has been reported that the availability of autologous blood increased the rate of autologous blood transfusion [22,37]. In case strict criteria are used to 'trigger' blood transfusion, the availability of autologous blood did not seem to increase the rate of blood transfusion [25].

4. Preoperative donation of autologous blood

Preoperative autologous blood donation has several disadvantages. It is not risk free, and human error and the administration of the wrong unit of blood still can occur. It leads to anemia and hypovolemia [6] and is more expensive than homologous blood donation. Patients waste time from work to donate. Autologous blood that is not used is discarded and constitutes waste [26]. Iwase et al [5] further reported increased intraoperative blood loss to be associated with total withdrawn blood before the operation. Retransfused autologous blood has a lower hemoglobin concentration and the erythrocyte function diminishes by 10% per week in unused autologous blood [22].

While avoiding the risk of transfusion of homologous blood is an advantage of transfusion of autologous blood, Moennig et al [51] reported that 3 out of 4 patients needing a transfusion received the available units of autologous and additional units of homologous blood to compensate the loss. These four patients had an average estimated blood loss of 975 mL [51]. Thus, the donation of autologous blood does not entirely exclude the risk of needing a homologous blood transfusion.

Meta-analyses on preoperative autologous blood donation have shown that this practice indeed reduces the use of allogeneic blood transfusion by 63%, but at the same time increases overall red blood cell transfusions (ie, allogeneic and autologous red blood cell units) by 30% and causes a decline in patient hemoglobin concentration by more than 1 g/dL from before commencing preoperative autologous blood donation to immediately prior to surgery [65].

The German recommendation for autologous blood donation states: "The so-called 'liberal' transfusion indication for autologous blood products stands in contrast to the strict indication parameters for the therapeutic use of blood products laid down in the present guidelines and should be rejected because it is for all practical purposes equivalent to a blood transfusion without indication" [66].

Donors of autologous blood will more likely receive a transfusion because their initial hemoglobin value has been lowered by the autologous blood donation and because the availability of autologous blood influences the decision of transfusion. Puelacher [26] reports that the mean hemoglobin level of 121 patients prior to donation was 14.2 g/dL and fell to 12.7 g/dL after a mean donation of 2.3 units per patient. If then the criterion for transfusion is a certain hemoglobin level, patients with autodonation will sooner reach that level than patients without donation.

Nath and Pogrel [24] report on 260 orthognathic surgery cases in which 126 patients chose autodonation and 134 patients preferred no autodonation. The transfusion rate was respectively 26/126 and 3/134 patients, indicating that the availability of autologous blood influenced the decision to use it. Obviously, 'a perceived benefit' must accompany this decision, which probably is influenced by the information given to the patient. Puelacher et al

[26] evaluated 127 questionnaires about autologous donation of blood in patients who underwent orthognathic surgery; 65 patients (51%) reported that autologous blood donation was decisive for the agreement to operate and that 12 patients (9%) would have refused the operation without the possibility of autologous blood donation.

It should be recommended that the decision to offer the possibility of preoperative autologous blood donation should not be done as a gain-framed or loss-framed persuasive message. A loss-framed persuasive appeal emphasises the disadvantages of failing to comply with the communicator's recommendation; in contrast, the gain-framed appeal will emphasise the advantages of compliance. Both are well-known techniques in patient communication [67]. Obviously, legal recommendations [66] and court rules in Germany [22] and in the United States [24] do not facilitate the information task towards the patient [26], because the patients need to be informed about the risks of homologous transfusion and the possibility of autologous blood transfusion as an alternative. Blau et al [49] reported that based on the perceived safety of reinfusion of autologous blood, the transfusion decision was made even before knowledge of the postoperative hemoglobin level.

5. Discussion and Conclusions

Considering the risk factors for blood transfusion after orthognathic surgery, a great deal of attention has been focused in the past both on the relationship with the duration of the surgery and the blood loss during surgery and in the postoperative period. Blood loss and duration of surgery are only weakly related to each other. The most significant factor in deciding when to transfuse is one's attitude towards transfusion and the related 'trigger' criterion for transfusion. Although the contemporary limit of 7 g/dL is a safe margin for healthy persons, the measurable increase in cardiac output needs to be observed.

It is important to know that Hb drop could be overestimated due to hemodilution, which in return may influence the decision of blood transfusion [68]. The estimated blood loss might be a good guide, especially in cases that received large amounts of i.v. fluids. According to Al-Sebaei et al [69], blood loss does not consistently increase over time. The majority of intra-operative blood loss is expected to occur in the beginning of the procedure during the performance of the osteotomies [69].

On the other hand, it has been shown that predonation of autologous blood both increases the necessity and the opportunity to use it. Nevertheless, any blood transfusion is graded as a grade II complication in the Clavien-Dindo complication classification system.

Minimising perioperative blood loss seems to be a multidisciplinary task in which both the anesthesiologist and the surgeon share a common responsibility. The timely adaptation of legal guidelines to adopting a nontransfusion default position when there is no evidence for potential benefit is the wise approach.

Author contributions

CP was the principle investigator who initiated, designed and prepared the protocol. CP, JOA and IL were involved in the analysis of data and the writing of the manuscript. All authors read and approved the final manuscript.

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Constantinus POLITIS

MD, DDS, MM, MHA, PhD Professor & Chairperson
Oral and Maxillofacial Surgery Department
University Hospitals Leuven, KU Leuven
Leuven, Belgium

CV

Dr. Politis is an Oral and Maxillo-Facial Surgeon. He is currently a Professor and Chairperson of the Department of OMFS at Leuven University Belgium. He is an invited Lecturer at EHSAL in Brussels. He graduated from the Catholic University of Leuven in medicine (MD) and dentistry (DDS), also specializing in oral and maxillofacial surgery at the same university. There followed additional postgraduate training in Arnhem (Stoelinga), Aachen (Koberg), Copenhagen (Pindborg), Göteborg (Bränemark) and San Francisco (Marx). He also holds a master degree in management (MM) and a master degree in Hospital Management (MHM). He is Secretary General of the Professional Union of Belgian Oral and Maxillofacial Surgeons.

Questions

1. The relation between the duration of orthognathic surgery and bloodloss is:

❑a. Linear;
❑b. Exponential;
❑c. Asymptote function;
❑d. Depends on type of surgical procedure.

2. Which of following measures does not help in minimizing peri-operative bleeding:

❑a. Anti-Trendelenburg position of the patient;
❑b. Timely administration of local anaesthesia in Le Fort I;
❑c. Replacing the saw by piezo-tome;
❑d. Control of body temperature.

3. The overestimation of the hemoglobin drop measured after orthognathic surgery can be due to:

❑a. Hemodilution;
❑b. Weight of the patient;
❑c. Body temperature;
❑d. Hypertension.

4. The risk of blood transfusion includes transmission of all of following agents but one:

❑a. Hepatitis B;
❑b. Hepatitis C;
❑c. HIV;
❑d. Syphilis.