Review Articles

TRANSFUSION NEED IN ORTHOGNATHIC SURGERY - A REVIEW

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Received: April 03, 2017
Revised: May 05, 2017
Accepted: August 14, 2017
Published: August 16, 2017

Academic Editor: Nardi Casap-Caspi, DMD, MD, PhD, Professor and Head, Hebrew University Hadassah Jerusalem, Jerusalem, Israel

Cite this article:
Politis C, Lambrichts I, Agbaje JO. Transfusion need in orthognathic surgery - a review. Stoma Edu J. 2017;4(3):184-199.

ABSTRACT

DOI: 10.25241/stomaeduj.2017.4(3).art.4

Background: Excessive blood loss is the most frequently encountered perioperative problem in maxillary surgery, sometimes necessitating blood transfusion.
Objective: The aim of the present contribution is to review the relationship between different types of orthognathic procedures and the related blood loss in the literature published between 1976 and 2012.
Data Sources: The orthognathic literature was searched from 1976 to 2012 to determine the relationship between different types of orthognathic procedures and the related blood loss, duration of surgery and/or transfusion need.
Study Selection: articles containing clear information on allocation of operation time AND/OR blood loss AND/OR transfusion were included.
Data Extraction: information on 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, this result in number of categories per label, using this grouping various targeted questions are exploited and answered.
Keywords: orthognathic surgery, blood loss, operation time, blood transfusion.

1. Introduction

Excessive blood loss is the most frequently encountered perioperative problem in maxillary surgery, sometimes necessitating blood transfusion according to Mahy et al.[1]
Blood transfusion in itself can lead to complications, such as the transmission of disease or graft-versus-host reactions.
Piñeiro-Aguilar et al. (2011),[2] in a recent systematic review, concluded that intraoperative bleeding observed in patients undergoing Le Fort I and mandibular ramus osteotomies, alone or combined, has generally been less than the limits set to determine the need for a blood transfusion (indicated in healthy adults when hemoglobin is less than 7 g/dL). However, they state bleeding can sometimes reach or surpass the threshold limits for a blood transfusion, and this event should be anticipated by reserving blood at a blood bank or by preparing an autotransfusion. Piñeiro-Aguilar et al's paper was criticised by Dodson (2011)[3] because there was no clear, clinically directed, specific clinical question or challenge to address, resulting in clinically uninformative results. Also, the review of Piñeiro-Aguilar et al. (2011)[2] failed to differentiate among the different orthognathic procedures, and all procedures (single-jaw Bilateral Sagittal Split Osteotomy (BSSO), single-jaw Le Fort I, bimaxillary procedures) were treated in the study as a single entity.
The aim of the present contribution is to review the relationship between different types of orthognathic procedures and the related blood loss in the literature published between 1976 and 2012.

2. Methods

2.1. Literature review: selection criteria

The following entries: Blood loss and orthognathic, Transfusion and orthognathic, Hypotension and orthognathic and Blood transfusion and orthognathic surgery that were introduced in PubMed, Scopus and LIMO.
No limits were set for language, year, field. A manual search for articles containing information on operation time, blood loss, transfusion, and orthognathic surgery was performed in the following journals until 1976:
- British Journal of Oral and Maxillofacial Surgery

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- 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 (Böttger, 2007; Lassacher, 2008),[4,5] both in German.

2.2. Inclusion criteria

The criterion for retention for further processing was a clear allocation of blood loss AND/OR transfusion to one of the following operations:

1) Sagittal Split Osteotomy (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 (eg, 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.

2.3. Exclusion criteria

Exclusion criteria were craniofacial surgery in children; articles where blood loss, or transfusion could not clearly be 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.

3. Results

3.1. Search results

In total, 51 papers and 2 theses were retained for processing. 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

3.1.1. Mandibular surgery and transfusion need

Among the papers that included a subgroup of lower jaw surgery, all but Garg et al. (2010)[6] mentioned the transfusion need (Ash and Mercuri,

Table 1. Transfusion need in Sagittal Split Osteotomy (SSO).

Year of publication	Reference	n° patients	Blood loss (mL)	Duration (min)	Total transfusions (%)	Number of homologous transfusions	Number of autologous transfusions	Period of data collection	Criteria for transfusion in the paper?
1985	Ash and Mercuri	24	279±100; range 100 - 600	missing	8%	2	0	1981-1983	No
1990	Flood et al	50	missing	missing	4%	2	0	1985-1989	No
1998	Puelacher et al	53	457±299	missing	26.42%	0	14	1993-1995	<8 g/dL hemoglobin
2001	Panula et al advancement	384	341	range (63-255)	0.7%	3	0	1983-1996	No
2001	Panula et al Set-back	50	349	range (70-300)	4%	2	0	1983-1996	No
2005	Teltzrow et al	1264	-	-	missing	7	missing	1982-2002	No

1985; Borstlap et al., 2004; Böttger, 2007; Carry et al., 2001; Dickerson et al., 1993; Flood et al., 1990; Garg et al., 2011; Hegtvedt et al., 1987; Landes et al., 2008; Luz et al., 2004; Martini et al., 2004; Moenning et al., 1995; Panula et al., 2001; Puelacher et al., 1998; Teltzrow et al., 2005; Ueki et al., 2005; Umstadt et al., 2000; Yamashita et al., 2011; Yu et al., 2000).[4,6-8,11-24] These papers were published between1985–2011 and present a total of 9 homologous transfusions and 14 autologous blood transfusions in 1705 BSSO procedures (advancement and set-back). The four papers indicating a transfusion have their data extracted from the period 1981–1996. No patient after 1996 has needed a transfusion for BSSO (Table 1).

In the paper by Ash and Mercuri (1985),[7] no criterion was given for transfusion, but observing the range of blood loss, obviously a maximum loss of 600 mL as the outer limit of blood loss would not qualify for transfusion nowadays.

The paper by Flood et al. (1990)[11] mentions a drop in hemoglobin level from 14.0 (mean) to 12.2 (mean) in this group; the authors state that some patients had higher postoperative hemoglobin after transfusion than preoperative. Again, none of these patients would qualify for transfusion nowadays. Puelacher et al. (1998)[19] reinfused autodonated blood in a high percentage of cases. They do mention that hemoglobin dropped from 12.7±1.4 (preoperative after donation) to 11.3±1.3; "only in 7 cases out of 53, was a blood loss greater than 250 mL documented". Again, a different transfusion policy would apply nowadays.

Panula[18] reported 5 homologous transfusions for 434 bilateral sagittal split procedures. The reasons for the 4 cases are not recounted, but one case of BSSO advancement had an injury in the maxillary artery during instrumentation of the ascending ramus with 4500 mL blood loss, requiring transfusion. Teltzrow et al. (2005)[20] reported 15 bleeding complications in 1264 consecutive BSSOs, 7 requiring a transfusion. Although these authors do not explicitly state whether it concerned homologous or autologous blood transfusion, the answer can be found in the paper by Kramer et al. (2004)[25] from the same department with Teltzrow as co-author, stating that hemorrhage as a severe complication (of Le Fort I osteotomies) was documented when transfusions of erythrocyte

Table 2. Transfusion rate in Le Fort I single jaw osteotomy without concomitant.

Predonation policy	Study	n/N	%	95% CI
No predonation policy	Golia et al. (1985)	0/5	0	(0.0;52.2)
	Ash and Mercuri (1985)	1/20	5	(0.1;24.9)
	Flood et al. (1990)	3/26	11.5	(2.4;30.2)
	Dickerson et al. (1993)	0/12	0	(0.0;26.5)
	Yu et al. (2000)	0/18	0	(0.0;18.5)
	Dolman et al. (2000)	1/23	4.3	(0.1;21.9)
	Umstadt et al. (2000)	2/129	1.6	(0.2;5.5)
	Carry et al. (2001)	0/16	0	(0.0;20.6)
	Panula et al. (2001)	10/65	15.4	(7.6;26.5)
	Zelllin et al. (2004)	2/16	12.5	(1.6;38.3)
	Landes et al. (2008)	0/4	0	(0.0;60.2)
	de Lange et al. (2008)	0/30	0	(0.0;11.6)
	Garg (2011)	0/44	0	(0.0;8.0)
	Total	**19/408**	**4.5**	**(1.8; 9.8)**
Predonation policy	Hegtvedt et al. (1987)	1/25	4	(0.1;20.4)
	Moenning et al. (1995)	0/16	0	(0.0;20.6)
	Puelacher et al. (1998)	13/23	56.5	(34.5;76.8)
	Lenzen et al. (1999)	4/26	15.4	(4.4;34.9)
	Böttger S. (2007)	17/28	60.7	(40.6;78.5)
	Total	**35/118**	**26.3**	**(8.5;54.0)**
Overall total		**54/526**	**10.7**	**(4.6;21.0)**

The total and overall total transfusion rates are estimated using a probit-normal model. Where n is the number of patient and N is the total number of patient.

Table 3. Transfusion rate in Le Fort I single jaw osteotomy without concomitant procedures: predonation policy versus no predonation policy.

Le Fort I single-jaw osteotomy without additional complex procedures (segmentation or additional procedures)				
	Patients (n)	**Patients (n) with transfusion**	**Type of blood used in transfusion**	**% transfused patients**
Predonation policy	118	35	Autologous including 1 autologous+ homologous	24%
No predonation policy	408	19	Homologous	6,6%
Total	526	54	-	11,2%

concentrates from foreign donors were required after the autologous blood donation already had been given. In our own series of 1281 consecutive bilateral sagittal split procedures, spanning a period from 1989–2012, no case of transfusion need was seen correlated to the SSO. Except for excessive loss due to unforeseen vascular injury during BSSO, no transfusion need is to be expected in BSSO surgery, even if the surgery is of a long duration. No cross-match or predonation policy is required.

3.1.2. Le Fort I single-jaw surgery without additional complex procedures

Considering single-jaw Le Fort I osteotomies without segmentation or explicit statement of additional procedures, several articles fulfilled this criterion (Ash and Mercuri, 1985; Böttger, 2007; Carry et al., 2001; de Lange et al., 2008; Dickerson et al., 1993; Dolman et al., 2000; Flood et al., 1990; Garg et al., 2011; Golia et al., 1985; Hegtvedt et al., 1987; Kok-Leng Yeow and Por, 2008; Landes et al., 2008; Lenzen et al., 1999; Martini et al., 2004; Moenning et al., 1995; Mohorn et al., 1995; Panula et al., 2001; Praveen et al., 2001; Puelacher et al., 1998; Umstadt et al., 2000; Yu et al., 2000; Zellin et al., 2004)[4,7,9,10-14,16-19,22,24,26-33] (Table 2).

The papers by Kok-Leng Yeow and Por (2008),[29] Praveen et al. (2001),[32] and Martini et al. (2004)[16] did not have a transfusion rate for this subgroup and were discarded. The study by Mohorn et al. (1995)[31] had a defined group of Le Fort I osteotomies, but these were retrieved from other authors, so this report was also discarded. The paper by Umstadt et al. (2000)[22] was classified as a no-predonation policy because not one single patient received any autologous blood. If transfusions were needed, homologous blood was given.

In the paper by Puelacher one patient received both autologous blood and additional homologous units. as seen in Table 3. In all other cases of autologous transfusion in Table 3, the available autologous units were sufficient.

A statistical analysis was done in the SAS program, with 95% exact confidence intervals calculated for the individual studies. The overall transfusion rates and corresponding 95% confidence intervals were statistically estimated using a probit-normal model. A significant difference between predonation and no predonation policy could be shown (p=0.0166). The intra-study correlation was found to be significant. The intra-study correlation in the no predonation policy group was 0.06 (p=0.2896). The intra-study correlation in the predonation policy group was 0.31 (p=0.0662). The statement can be made that when predonation of autologous blood has occurred, the risk of being transfused is higher and does not exclude the need for additional homologous transfusion in case the transfusion need exceeds the available units of autodonated blood.

Figure 1 shows an error-bar chart using the SAS statistical program, and displays the % of transfusion as a dot and its associated confidence interval as a horizontal line. This effectively communicates the precision associated with each effect size and the general pattern of results.

The comparison of the available mean blood losses between the predonation and no-predonation policy groups supports the statement that predonation in single Le Fort I surgery without additional procedures results in more mean blood loss measured in the predonation group than in the other group (Table 4).

As far as hypotension is concerned, the entire range of blood pressure control is found without relation to blood loss (normotension, mild controlled hypotension, moderate controlled hypotension, deep controlled hypotension). The liberal reinfusion of autologous blood in these series needs to be met with skepticism. However, a need remains of about 4.5 % requiring a blood transfusion in single-jaw Le Fort I procedures without additional complex procedures in the no-predonation policy group, according to a probit-normal statistical model.

One should be careful with percent values of blood transfusion in the literature. Kramer et al. (2004)[32] indicate a transfusion need of 1.1% in 1000 Le Fort I operations (11 patients transfused), prospectively studied. It should be noted that the 1.1% occurred in bimaxillary operations; the authors explicitly state that hemorrhage after Le Fort I osteotomy was documented only when transfusions of erythrocyte concentrates from foreign donors were required after autologous blood donation already had been given. The total transfusion need in this large series of Le Fort I cannot be recovered.

3.1.3. Le Fort I single-jaw surgery with additional procedures

A total of 211 Le Fort I single-jaw surgical cases qualify as 'complex', either because they concerned cleft patients or because of multi-piece segmentation with an additional bone-grafting, mostly an iliac crest graft. Of interest, the recent literature does not provide many papers describing performance of Le Fort I single-jaw surgery: Schaberg et al., 1976;[34] Ash

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Table 4. Mean blood loss for Le Fort I single-jaw osteotomies without concomitant surgery, sorted according to mean blood loss reported per author.

Le Fort I single-jaw osteotomy without segmentation or additional procedures			
Author	**Mean blood loss**	**Number of patients**	**Predonation policy (1=yes, 0=no)**
Dolman et al. (2000)	120	11	0
de Lange et al. (2008)	144	15	0
Moenning et al. (1995)	231	16	0
Yu et al. (2000)	266	8	0
Dolman et al. (2000)	270	12	0
Ash and Mercuri (1985)	327	20	0
de Lange et al. (2008)	346	15	0
Yu et al. (2000)	348	10	0
Puelacher et al. (1998)	410	23	1
Dickerson et al. (1993)	421	12	0
Golia et al. (1985)	480	5	0
Zellin et al. (2004)	530	16	0
Lenzen et al. (1999)	670	26	1
Panula et al. (2001)	697	65	0
Böttger (2000)	850	28	1

and Mercuri, 1985;[7] Flood et al., 1990[11] Hegtvedt et al., 1987;[13] Moenning et al., 1995;[17] Samman et al., 1996;[35] Yu et al., 2000;[24] Zellin et al., 2004;[33] and Landes et al., 2008.[14] The figures in parentheses give the number of patients concerned.

In the paper by Flood et al. (1990),[11] 38 Le Fort I procedures were completed with an additional genioplasty. Preoperative hemoglobin level dropped from 14.2 g/dL to 12.4 g/dL. None of these patients would nowadays qualify for blood transfusion. These data can be qualified as outliers.

The paper by Schaberg et al. (1976)[34] does not give a figure of transfusion, 14 patients. The resulting 159 patients are listed in Table 5.

In these 159 patients, 3 autologous transfusions were reported and 8 homologous blood transfusions for a total of 11 transfusions on 159 patients, or 6.9% in a numerical analysis. The estimated transfusion rates according to the logistic regression model are 7.6 % in the no-predonation policy group and 5.6 % in the predonation policy group (Table 6).

This compares favourably with single-jaw Le Fort I procedures of less complex nature, even though the mean blood loss of complex Le Fort I surgery is significantly different from single piece Le Fort I surgery. Because of the lack of reliable data, no duration of operation can be compared between single Le Fort I procedures with or without additional complex procedures.

A number of comments need to be made concerning the two studies with a predonation policy (Hegtvedt et al., 1987;[13] Moenning et al., 1995[17]). Hegtvedt et al. (1987)[13] stated that no patient who predonated blood received any homologous transfusion. A conservative approach towards transfusion was

Study	**n/N**	**%(95% CI)**
Predonation policy		
Hegtvedt et al. (1987)	1/25	4.0 (0.1;20.4)
Moenning et al. (1995)	0/16	0.0 (0.0;20.6)
Puelacher et al. (1998)	13/23	56.5 (34.5;76.8)
Lenzen et al. (1999)	4/26	15.4 (4.4;34.9)
Botger S. (2007)	17/28	60.7 (40.6;78.5)
Total	35/118	26.3 (8.5;54.0)
No predonation policy		
Golia et al. (1985)	0/5	0.0 (0.0;52.2)
Ash and Mercuri (1985)	1/20	5.0 (0.1;24.9)
Flood et al. (1990)	3/26	11.5 (2.4;30.2)
Dickerson et al. (1993)	0/12	0.0 (0.0;26.5)
Yu et al. (2000)	0/18	0.0 (0.0;18.5)
Dolman et al. (2000)	1/23	4.3 (0.1;21.9)
Umstadt et al. (2000)	2/129	1.6 (0.2;5.5)
Carry et al. (2001)	0/16	0.0 (0.0;20.6)
Panula et al. (2001)	10/65	15.4 (7.6;26.5)
Zelllin et al. (2004)	2/16	12.5 (1.6;38.3)
Landes et al. (2008)	0/4	0.0 (0.0;60.2)
de Lange et al. (2008)	0/30	0.0 (0.0;11.6)
Garg (2011)	0/44	0.0 (0.0;8.0)
Total	19/408	4.5 (1.8;9.8)
Overall total	54/526	10.7 (4.6;21.0)

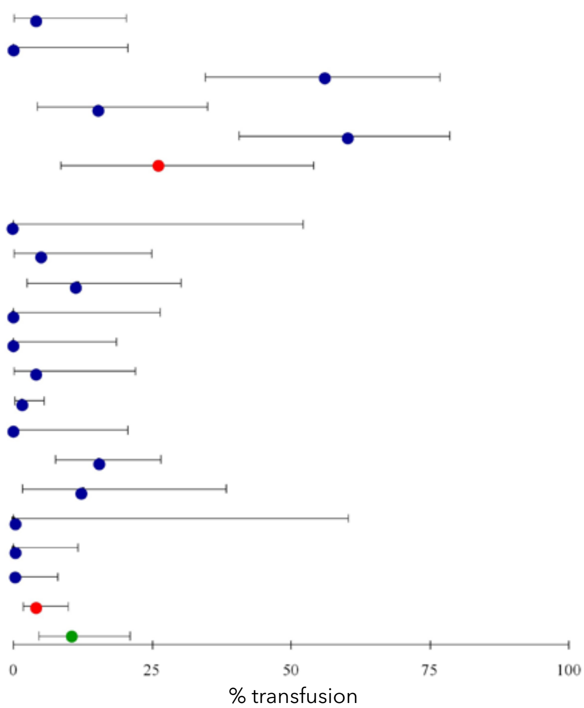

Figure 1. Error-bar chart, dots representing % of transfusion, blue dots represent study total, red dots represent group total, green dot represents overall total, horizontal lines representing 95% confidence interval, Le Fort I single-jaw osteotomy without additional complex procedures: transfusion policy.

Table 5. Transfusion rate for Le Fort I single jaw surgery with additional procedures.

Predonation policy	Study	n/N	%	95% CI
No predonation policy	Ash and Mercuri (1985)	2/6	33.3	(4.3;77.7)
	Samman et al. (1996)	6/69	8.7	(3.3;18.0)
	Yu et al. (2000)	0/12	0	(0.0;26.5)
	Zelllin et al. (2004)	0/14	0	(0.0;23.2)
	Landes et al. (2008)	0/4	0	(0.0;60.2)
	Total	**8/105**	**7.6**	**(3.9;14.5)**
Predonation policy	Hegtvedt et al. (1987)	3/34	8.8	(1.9;23.7)
	Moenning et al. (1995)	0/20	0	(0.0;16.8)
	Total	**3/54**	**5.6**	**(1.8;15.9)**
Overall total		**11/159**	**6.9**	**(3.9;12.1)**

The overall transfusion rates are estimated using a logistic regression model. Where n is the number of patient and N is the total number of patient.

favoured because blood losses over 1000 mL and hematocrits of 26% and 29% were not transfused because of a stable clinical condition. Moenning et al. (1995)[14] used a strict transfusion trigger, even for autologous blood, and stated that the hemoglobin level must be below 7 g/dL and the hematocrit below 21% before transfusions were indicated for a symptomatic patient requiring autologous blood. It is obvious that predonation does not preclude the use of strict transfusion criteria. If these are met, no clinically significant difference in transfusion rate is observed between a predonation and no-predonation policy.

A statistical analysis of this group was done in SAS; 95% exact confidence intervals were calculated for the individual studies. The overall transfusion rates and corresponding 95% confidence intervals were estimated using a logistic regression model. No significant difference between predonation and no-predonation policy could be shown. (p=0.6288) The intra-study correlation was not estimable using a beta-binomial model and hence set to zero. For this reason no probit-model was used and a logistic regression model was chosen (Fig. 2).

The transfusion rate for Le Fort I single-jaw osteotomy without additional complex procedures is 4.5% according to the statistical model in the no-predonation policy group, whereas the addition of complex procedures to a Le Fort I single-jaw osteotomy increases the transfusion rate up to 7.6% in the no-predonation policy group.

Complex Le Fort I surgery should not be underestimated. It usually is more difficult to advance a maxilla to an extent that a bone graft is needed. Certainly, complex isolated Le Fort I surgery with multiple segments and additional bone graft–harvesting procedures may be more challenging and time consuming than straightforward bimaxillary procedures where the magnitude of movements is smaller, often to overcome the difficulty of a large single-jaw movement, which in addition is less stable. In this series of 211 complex single Le Fort I osteotomies, 181 were performed before the year 2000 and 30 after. None of these 30 required a blood transfusion.

3.1.4. Bimaxillary surgery without additional complex procedures

The aggregation of data allowed inclusion in this category of the normal Le Fort I one piece with BSSO (advancement, rotation, or set-back). If an author stated that a two-piece or a straightforward genioplasty was considered in this group because of the ease of the routine not adding much to the duration of the surgery, this was accepted in this category. If any additional procedure was not accounted for by the author when discussing 'bimaxillary osteotomies', these were accommodated in this category.

The group with predonation consisted of the following papers (numbers of patients in

Table 6. Transfusion rate in Le Fort I single jaw osteotomy with additional surgery: predonation policy versus no-predonation policy.

Le Fort I single-jaw surgery with additional complex procedures				
	n° patients	n° patients transfused	Autologous/ homologous	%
Predonation policy	54	3	Autologous	5.6%
No predonation policy	105	8	Homologous	7,6%
	159	3		6.9%

Study	n/N	%(95% CI)
Predonation policy		
Hegtvedt et al. (1987)	3/34	8.8 (1.9;23.7)
Moenning et al. (1995)	0/20	0.0 (0.0;16.8)
Total	3/54	5.6 (1.8;15.9)
No predonation policy		
Ash and Mercuri (1985)	2/6	33.3 (4.3;77.7)
Samman et al. (1996)	6/69	8.7 (3.3;18.0)
Yu et al. (2000)	0/12	0.0 (0.0;26.5)
Zellin et al. (2004)	0/14	0.0 (0.0;23.2)
Landes et al. (2008)	0/4	0.0 (0.0;60.2)
Total	8/105	7.6 (3.9;14.5)
Overall total	11/159	6.9 (3.9;12.1)

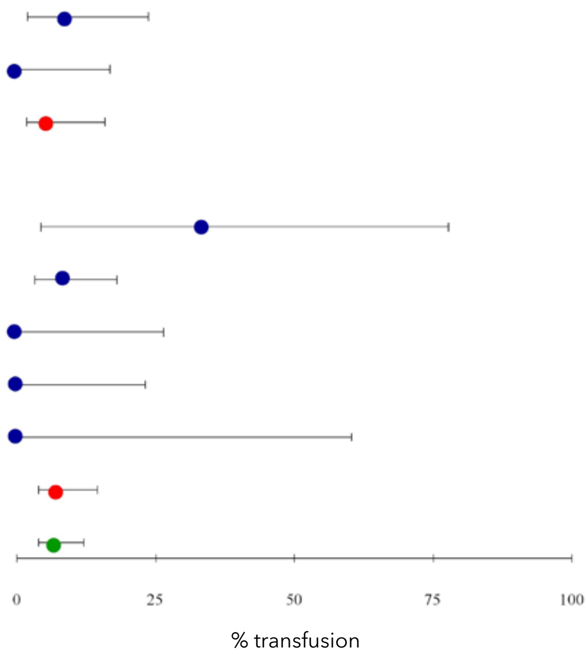

Figure 2. Error-bar chart, Le Fort I single jaw osteotomy with additional surgery; dots representing % of transfusion, blue dots represent study total, red dots represent group total, green dot represents overall total, horizontal lines representing 95% confidence interval.

parentheses): Böttger, 2007[4] (82 patients); Felfernig-Boehm et al., 2001[36] (30 patients); Gong et al., 2002[37] (83 patients); Guyuron et al., 1996[38] (20 patients); Hegtvedt et al., 1987[13] (96 patients); Kessler et al., 2006[39] (65 patients); Lassacher, 2008[5] (55 patients); Lenzen et al., 1999[30] (69 patients); Moenning et al., 1995[17] (33 patients); Nkeke et al., 2005[40] (56 patients); Puelacher et al., 1998[19] (45 patients); Rohling et al., 1999[41] (127 patients); and Rummasak et al., 2011[42] (208 patients), for a total of 969 patients. (Table 7)

The group without predonation policy consisted of 1331 patients: Ash and Mercuri, 1985[7] (20 patients); Carry et al., 2001[9] (24 patients); Dhariwal et al., 2004[43] (115 patients); Fenner et al., 2009[44] (105 patients); Flood et al., 1990[11] (67 patients); Fromme et al., 1986[45] (56 patients); Garg et al., 2011[12] (125 patients); Golia et al., 1985[28] (4 patients); Karimi et al., 2012[46] (32 patients); Kretschmer et al., 2008[47] (91 patients); Landes et al., 2008[14] (70 patients); Lessard et al., 1989[48] (52 patients); Panula et al., 2001[18] (91 patients); Samman et al., 1996[35] (291 patients); Stewart et al., 2001[49] (27 patients); Ueki et al., 2005[21] (29 patients); Umstadt et al., 2000[22] (66 patients); Varol et al., 2009[50] (45 patients); and Yu et al., 2000[24] (21 patients). Including Flood et al. (1990),[11] we get 1331 patients. When excluding Flood et al. (1990)[11] as an outlier, 1264 patients remain in the group without predonation. (Table 8)

The overall total consisted of 1264 + 969=2233 patients. This was defined as the study group.

A statistical analysis was done in the SAS program and 95% exact confidence intervals were calculated for the individual studies. The overall transfusion rates and corresponding 95% confidence intervals were estimated using a probit-normal model. A significant difference between the predonation and the no-predonation policy could be shown (p=0.0099). The intra-study correlation in the no-predonation policy group was 0.32 (p=0.0004). The intra-study correlation in the predonation policy group was 0.42 (p=<.0001). A significant year effect could be shown in the no-predonation policy group (p=0.0154). No significant year effect could be shown in the predonation policy group (p=0.4574). No significant difference in year effect could be shown between the predonation and the no-predonation policy group (p=0.4334). (Table 5; Table 6; Fig. 3)

In total, there were 3 overlapping patients who received both autologous and homologous blood. For the statistical analysis we viewed these as separate patients, resulting in 342 patients in the statistical analysis. (Table 9)

When these figures are expressed as % , we find a discrepancy between the transfusion rate in centres with or without a predonation policy of autologous blood (Table 10).

These figures need to be put into perspective.

Obviously, there is a discrepancy between the transfusion rate in centres with (39%) or without (12,5 %) a predonation policy of autologous blood (Table 7; Table 8; Fig. 3).

This discrepancy between these centers is even sharper when the evolution in time is entered as a variable (Table 11).

Looking at the data for centers where only homologous transfusion is given, a sharp decline in the number of transfusions is seen in the papers after 2006. A representative paper that reflects the contemporary attitude is found in Fenner et al. (2009).[44] In 105 consecutive bimaxillary surgeries, none of their patients received allogeneic blood, and no autologous blood was donated presurgery. They allowed a reduction in hemoglobin to 60 g/L as long as the ASA I patient remained hemodynamically

Table 7. Transfusion rate after bimaxillary surgery without additional procedures, predonation policy.

Predonation policy	Study	n/N	%	95% CI
Predonation policy	Hegtvedt et al. (1987)	41/96	42.7	(32.7;53.2)
	Moenning et al. (1995)	1/33	3	(0.1;15.8)
	Guyuron et al. (1996)	12/20	60	(36.1;80.9)
	Puelacher et al. (1998)	37/45	82.2	(67.9;92.0)
	Lenzen et al. (1999)	69/69	100	(94.8;100.0)
	Rohling et al. (1999)	23/127	18.1	(11.8;25.9)
	Felfernig-Boehm et al. (2001)	3/30	10	(2.1;26.5)
	Gong et al. (2002)	16/83	19.3	(11.4;29.4)
	Nkeke et al. (2005)	3/56	5.4	(1.1;14.9)
	Kessler et al. (2006)	7/65	10.8	(4.4;20.9)
	Böttger S. (2007)	66/82	80.5	(70.3;88.4)
	Lassacher (2008)	1/55	1.8	(0.0;9.7)
	Rummasak et al. (2011)	63/208	30.3	(24.1;37.0)
	Total	**342/969**	**39**	**(22.8; 57.4)**

The overall transfusion rates are estimated using a probit-normal model. Where n is the number of patient and N is the total number of patient.

Table 8. Transfusion rate after bimaxillary surgery without additional procedures, predonation policy.

Predonation policy	Study	n/N	%	95% CI
No predonation policy	Golia et al. (1985)	0/4	0	(0.0;60.2)
	Ash and Mercuri (1985)	4/20	20	(5.7;43.7)
	Fromme et al. (1986)	35/56	62.5	(48.5;75.1)
	Lessard et al. (1989)	15/52	28.8	(17.1;43.1)
	Samman et al. (1996)	78/291	26.8	(21.8;32.3)
	Yu et al. (2000)	1/21	4.8	(0.1;23.8)
	Umstadt et al. (2000)	2/66	3	(0.4;10.5)
	Carry et al. (2001)	0/24	0	(0.0;14.2)
	Stewart et al. (2001)	9/27	33.3	(16.5;54.0)
	Panula et al. (2001)	31/91	34.1	(24.5;44.7)
	Dhariwal et al. (2004)	9/115	7.8	(3.6;14.3)
	Ueki et al. (2005)	0/29	0	(0.0;11.9)
	Landes et al. (2008)	2/70	2.9	(0.3;9.9)
	Kretschmer et al. (2008)	0/91	0	(0.0;4.0)
	Varol et al. (2009)	0/45	0	(0.0;7.9)
	Fenner et al. (2009)	0/105	0	(0.0;3.5)
	Garg (2011)	0/125	0	(0.0;2.9)
	Karimi et al. (2012)	1/32	3.1	(0.1;16.2)
	Total	**187/1264**	**12.5**	**(5.6;24.0)**
Overall total		529/2233	23.8	(14.8;35.1)

The overall transfusion rates are estimated using a probit-normal model. Where n is the number of patient and N is the total number of patient.

Table 9. Transfusion rates for bimaxillary orthognathic surgery without additional or complex procedures (numbers): summary.

Bimaxillary surgery without additional or complex procedures	n° patients	Autologous (n)=patients	Homologous (n)=patients	Total number of patients transfused (n)
Predonation policy	969	324	18	342*
No predonation policy	1264	0	187	187
	2233	324	205	529

* Concerning the 18 patients in the predonation policy group, we found the following:
- Rummasak et al. (2011)[42] had 5 patients with homologous transfusion; it is not stated if this was supplementary to the autologous blood donation.
- Hegtvedt et al. (1987)[13] had 8 patients in this group with homologous transfusion without preceding autologous transfusion.
- Rohling et al. (1999)[41] used both autologous blood and acute normovolemic hemodilution, and 2 patients had additional homologous transfusion. This is considered an overlap in the table of 2 patients.
- Kessler et al. (2006)[39] had one autologous donor receiving additional homologous blood.
- Böttger (2007)[4] referred to homologous blood transfusion for those who did not participate in the predonation program.

Study	n/N	%(95% CI)
Predonation policy		
Hegtvedt et al. (1987)	41/96	42.7 (32.7;53.2)
Moenning et al. (1995)	1/33	3.0 (0.1;15.8)
Guyuron et al. (1996)	12/20	60.0 (36.1;80.9)
Puelacher et al. (1998)	37/45	82.2 (67.9;92.0)
Lenzen et al. (1999)	69/69	100.0 (94.8;100.0)
Rohlin et al. (1999)	23/127	18.1 (11.8;25.9)
Felfernig-Boehm et al. (2001)	3/30	10.0 (2.1;26.5)
Gong et al. (2002)	16/83	19.3 (11.4;29.4)
Nkeke et al. (2005)	3/56	5.4 (1.1;14.9)
Kessler et al. (2006)	7/65	10.8 (4.4;20.9)
Botger S. (2007)	66/82	80.5 (70.3;88.4)
Lassacher (2009)	1/55	1.8 (0.0;9.7)
Rummasak et al. (2011)	63/208	30.3 (24.1;37.0)
Total	342/969	39.0 (22.8;57.4)
No predonation policy		
Golia et al. (1985)	0/4	0.0 (0.0;60.2)
Ash and Mercuri (1985)	4/20	20.0 (5.7;43.7)
Fromme et al. (1986)	35/56	62.5 (48.5;75.1)
Lessard et al. (1989)	15/52	28.8 (17.1;43.1)
Samman et al. (1996)	78/291	26.8 (21.8;32.3)
Yu et al. (2000)	1/21	4.8 (0.1;23.8)
Umstadt et al. (2000)	2/66	3.0 (0.4;10.5)
Carry et al. (2001)	0/24	0.0 (0.0;14.2)
Stewart et al. (2001)	9/27	33.3 (16.5;54.0)
Panula et al. (2001)	31/91	34.1 (24.5;44.7)
Dhariwal et al. (2004)	9/115	7.8 (3.6;14.3)
Ueki et al. (2005)	0/29	0.0 (0.0;11.9)
Landes et al. (2008)	2/70	2.9 (0.3;9.9)
Kretschmer et al. (2008)	0/91	0.0 (0.0;4.0)
Varol et al. (2009)	0/45	0.0 (0.0;7.9)
Fenner et al. (2009)	0/105	0.0 (0.0;3.5)
Garg (2011)	0/125	0.0 (0.0;2.9)
Karimi et al. (2012)	1/32	3.1 (0.1;16.2)
Total	187/1264	12.5 (5.6;24.0)
Overall total	529/2233	23.8 (14.8;35.1)

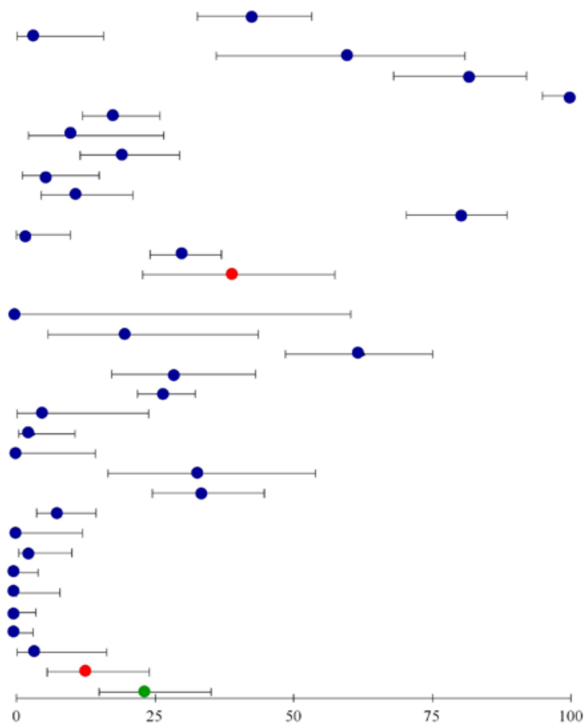

Figure 3. Error-bar chart, bimaxillary surgery without additional surgery; dots representing % of transfusion, blue dots represent study total, red dots represent group total, green dot represents overall total, horizontal lines representing 95% confidence interval.

stable. These series heavily influence the dataset and reflect a shift in transfusion policy. This policy is not new and was already advocated in Germany in 2003 (Habler et al., 2007).[51]
When combining the effects of time and predonation policy, we find an opposite evolution in transfusion policy. The predonation centers have not changed transfusion policy and account for the majority of blood transfusions in this series. Predonation is the most prominent risk factor in bimaxillary surgery to expose a patient to blood transfusion, even if it is autologous blood (Table 12, Table 13).
A similar attitude of liberal transfusion when autologous blood is available has been found in other surgical disciplines with about the same ratio. (Forgie et al., 1998)[52]

When further broken down by author, Table 14 presents the numbers of bimaxillary surgeries (aggregated figures) with the corresponding number and percentage of autotransfusions, clearly illustrating the wide variability in transfusion policy towards autologous blood donation.
The role of hypotension as critical risk factor for transfusion has been investigated in this series, but this must be regarded as 'very low level of evidence' because few studies are fully comparable in their mean arterial pressure and in the duration of the mean arterial pressure, or even in the way the mean arterial pressure was measured. When aggregating the data to normotension, controlled hypotension-not further specified, controlled hypotension mild, controlled hypotension moderate, and controlled

Table 10. Transfusion need for bimaxillary orthognathic surgery without additional or complex procedures (percentage).

Bimaxillary surgery without additional or complex procedures				
	n° patients	Autologous (%)	Homologous (%)	Total (%)
Predonation policy	969	324	18	342*
No predonation policy	1264	0	187	187
	2233	324	205	529

Table 11. Transfusion rates for bimaxillary surgery over the years in centers without predonation policy.

Bimaxillary surgery without additional or complex procedures			
Interval (year)	n° patients	Homologous transfusion (n)	Homologous transfusion (%)
1985–1995	132	54	41%
1996–2005	598	128	21%
≥2006	534	5	1%
1985–2012	1331	187	15%

Table 12. Transfusion rates for bimaxillary surgery over the years in centers with a predonation policy, expressed in numbers of patients transfused.

Bimaxillary surgery without additional or complex procedures				
Interval (year)	n° patients	Homologous transfusion	Autologous transfusion	Total
1985–1995	129	8	34	42
1996–2005	430	2	161	161
≥2006	410	8	129	136
	969	18	324	342*

*some patients received both autologous and homologous transfusion and are counted as 1 patient in the sum.

Table 13. Transfusion rates for bimaxillary surgery over the years in centers with a predonation policy, expressed in % of patients transfused.

Bimaxillary surgery without additional or complex procedures				
Interval (year)	n° patients	Homologous transfusion	Autologous transfusion	Total
1985–1995	129	6%	26%	33%
1996–2005	430	0,5%	37%	37%
≥2006	410	2%	31%	33%
	969	2%	33%	35%

hypotension deep and omitting the papers without any indication of blood pressure control, we find a group of 2123 procedures (Table 15, Table 16).
The groups of normotension are small groups, but both are prospective, well-controlled studies with radial artery catheter measurements of mean arterial pressure. The least that can be said from these figures is that controlled deep hypotension (MAP between 50–65 mm Hg) seems not to influence the transfusion need more than controlled mild hypotension.
It seems difficult to compare the mean blood loss in this series, but the spread in reported mean blood losses varies from 256.7 mL (Ueki et al., 2005)[21] to 1300 mL (Böttger, 2007).[4]

The statistical methods used in Table 15 and Table 16 calculated 95% exact confidence intervals (CI) for the individual studies. The overall transfusion rates and corresponding 95% confidence intervals are estimated using a probit-normal model. No significant interaction between predonation and hypotension could be shown (p=0.8072). After correction for predonation, no significant effect of hypotension could be shown (p=0.9616).

3.1.5. Bimaxillary surgery with additional complex procedures

Because Flood et al. (1990)[11] seems to be an outlier concerning their transfusion policy, these data were not retained. The papers by Kasahara et al.

(2009)[53] and Rummasak et al. (2011)[42] were not retained because they did not give a transfusion rate. The following papers were included in the no-predonation policy: Ash and Mercuri, 1985[7] (8 patients); Choi et al., 2009[54] (61 patients); Kretschmer et al., 2008[47] (36 patients); Landes et al., 2008[14] (13 patients); and Stewart et al., 2001[49] (2 patients).
Three papers with a predonation policy were retained in this category: Blau et al., 1992[55] (30 patients); Moenning et al., 1995[17] (155 patients); and Posnick et al., 2010[56] (34 patients). Posnick et al. (2010)[56] did not indicate a criterion of transfusion but believed a level below 7 g/dL (Hc=21%) was a definite indication for transfusion, with room for evaluation of the clinical need and transfusion before that level is reached if necessary. Blau et al. (1992)[55] stated that they did not use uniform criteria for postoperative transfusion; indeed, many patients received transfusion postoperatively before documentation of the postoperative hemoglobin concentration.
Pooling of the other data showed adherence to equal and strict transfusion criteria when considering autologous or homologous blood transfusion. The 'arithmetic' overall requirement of blood transfusion is 12.4%, which signifies a figure almost double as that of a single-jaw procedure (Table 17, Table 3).
However, when these figures are entered into a statistical model, the % are not the aritmethic % (42/339=12,4) but estimated % based on the probit-normal model containing all groups ((42/339; 20,6%; (7.1; 43.2)95%CI)).
Statistics were done in the SAS program and 95% exact confidence intervals were calculated for the individual studies. In Table 18 the overall transfusion rates and corresponding 95% confidence intervals were estimated using a probit-normal model. No significant difference between the predonation and the no-predonation policy could be shown (p=0.5047). The intra-study correlation was found to be significant. In the no-predonation policy the intra-study correlation was 0.29 (p=0.0769). The intra-study correlation in the predonation policy group was 0.26 (p= 0.0960), (Fig. 4).
Four patients in the group with the predonation policy (Table 18) received homologous blood: one in the series of Posnick et al. (2010)[56] who did not predonate, and three in the series of Moenning et al. (1995)[17] were patients that received both autologous and additional homologous blood. Total: 22 patients in the predonation policy group received a blood transfusion. Moenning's patients who received both autologous and homologous blood were classified as having received autologous blood only.
One would assume that the clinical message is clear. As long as bimaxillary surgery is straightforward, the need for blood transfusion remains well defined. Once additional procedures are executed, the risk for blood transfusion increases significantly.
Table 19 summarizes the findings of the transfusion rates reported in the reviewed articles. In the predonation policy centers obviously the transfusion rate reflects a policy rather than a transfusion need. In the other centers without predonation policy the increasing complexity of the surgical orthognathic procedure goes along with an increased transfusion rate.The statistical model used to study bimaxillary surgery with a predonation policy yielded no statistically significant difference between simple and complex procedures (p=0.1257). The intra-study correlation in the simple bimaxillary procedure group with predonation was 0.42 (p=0.0002). The intra-study correlation in the complex bimaxillary procedure group with predonation was 0.26 (p=0.1160).
The statistical model used to study bimaxillary surgery with no-predonation policy yielded no statistically significant difference between simple and complex procedures (p=0.2571), in spite of the arithmetic

Table 14. Transfusion policy according to author, in bimaxillary surgery without concomitant procedures.

		Autologous transfusion policy	
Author	**Year**	**Patients (n) with autologous transfusion**	**% autologous transfusion**
Lassacher	2008	1	2%
Moenning et al.	1995	1	3%
Nkenke et al.	2005	3	5%
Kessler et al.	2006	6	9%
Felfernig-Boehm et al.	2001	3	10%
Rohling et al.	1999	21	17%
Gong et al.	2002	16	19%
Rummasak et al.	2011	58	28%
Hegtvedt et al.	1987	33	34%
Guyuron et al.	1996	12	60%
Böttger	2007	64	78%
Puelacher et al.	1998	37	82%
Lenzen et al.	1999	69	100%

Table 15. Transfusion rate according to predonation policy and grade of hypotension: no predonation policy.

Predonation policy	Hypotension	Study	n/N	%	95% CI
No predonation policy	**Normo tension**	Fromme et al. (1986)	10/18	55.6	(30.8;78.5)
		Total	10/18	29.3	(14.2;50.9)
	Controlled hypotension mild	Fromme et al. (1986)	11/17	64.7	(38.3;85.8)
		Samman et al. (1996)	78/291	26.8	(21.8;32.3)
		Dhariwal et al. (2004)	9/115	7.8	(3.6;14.3)
		Ueki et al. (2005)	0/29	0	(0.0;11.9)
		Karimi et al. (2012)	1/32	3.1	(0.1;16.2)
		Total	**99/484**	31.1	**(17.1;49.8)**
	Controlled hypotension moderate	Lessard et al. (1989)	12/27	44.4	(25.5;64.7)
		Yu et al. (2000)	1/21	4.8	(0.1;23.8)
		Stewart et al. (2001)	9/27	33.3	(16.5;54.0)
		Kretschmer et al. (2008)	0/91	0	(0.0;4.0)
		Total	**22/166**	30	**(15.1;50.8)**
	Controlled hypotension deep	Golia et al. (1985)	0/4	0	(0.0;60.2)
		Fromme et al. (1986)	14/21	66.7	(43.0;85.4)
		Lessard et al. (1989)	3/25	12	(2.5;31.2)
		Carry et al. (2001)	0/24	0	(0.0;14.2)
		Varol et al. (2009)	0/45	0	(0.0;7.9)
		Total	**17/119**	**24.4**	**(11.9;43.6)**

Where n is the number of patient and N is the total number of patient.

Table 16. Transfusion rate according to predonation policy and grade of hypotension: predonation policy.

Predonation policy	Hypotension	Study	n/N	%	95% CI
Predonation policy	**Normo tension**	Felfernig-Boehm et al. (2001)	1/10	10	(0.3;44.5)
		Total	**1/10**	**31.3**	**(6.6;74.5)**
	Controlled hypotension moderate	Rohling et al. (1999)	23/127	18.1	(11.8;25.9)
		Lenzen et al. (1999)	69/69	100	(94.8;100.0)
		Lassacher (2008)	1/55	1.8	(0.0;9.7)
		Rummasak et al. (2011)	63/208	30.3	(24.1;37.0)
		Total	**156/459**	**47.4**	**(26.9;68.8)**
	Controlled hypotension deep	Moenning et al. (1995)	1/33	3	(0.1;15.8)
		Guyuron et al. (1996)	12/20	60	(36.1;80.9)
		Felfernig-Boehm et al. (2001)	1/10	10	(0.3;44.5)
		Böttger S. (2007)	66/82	80.5	(70.3;88.4)
		Total	**80/145**	**42.8**	**(23.5;64.5)**
		Overall total	**385/1401**	**26.7**	**(15.6;40.8)**

Where n is the number of patient and N is the total number of patient.

Study	n/N	%(95% CI)
Predonation policy		
Blau et al. (1992)	17/30	56.7 (37.4;74.5)
Moenning et al. (1995)	2/67	3.0 (0.4;10.4)
Moenning et al. (1996)	1/88	1.1 (0.0;6.2)
Posnick et al. (2010)	2/34	5.9 (0.7;19.7)
Total	22/219	15.3 (2.6;46.2)
No predonation policy		
Ash and Mercuri (1985)	6/8	75.0 (34.9;96.8)
Stewart et al. (2001)	1/2	50.0 (1.3;98.7)
Landes et al. (2008)	0/13	0.0 (0.0;24.7)
Kretschmer et al. (2008)	2/36	5.6 (0.7;18.7)
Choi et al. (2009)	11/61	18.0 (9.4;30.0)
Total	20/120	25.7 (6.4;58.5)
Overall total	42/339	20.6 (7.1;43.2)

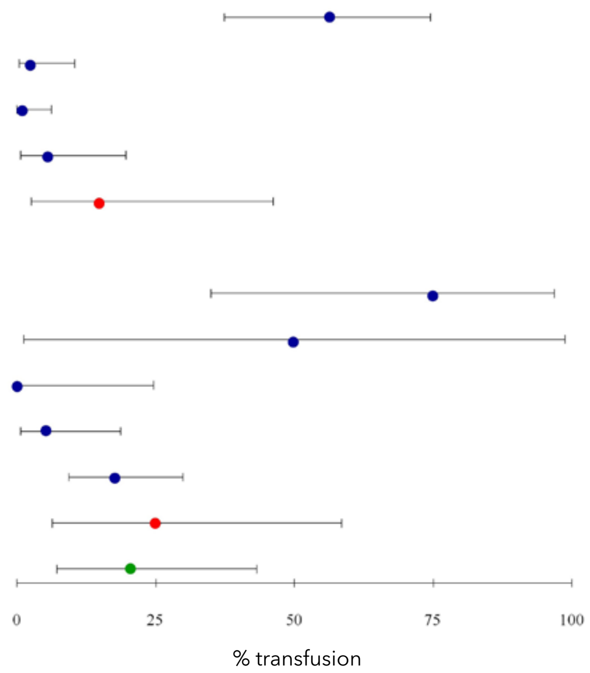

Figure 4. Error-bar chart, bimaxillary surgery without additional surgery; dots representing % of transfusion, blue dots represent study total, red dots represent group total, green dot represents overall total, horizontal lines representing 95% confidence interval; overall % is an estimate using a beta-binomial model.

Table 17. Transfusion rate in bimaxillary surgery with additional or complex procedures.

Predonation policy	Study	n/N	%	95% CI
No predonation policy	Ash and Mercuri (1985)	6/8	75	(34.9;96.8)
	Stewart et al. (2001)	1/2	50	(1.3;98.7)
	Landes et al. (2008)	0/13	0	(0.0;24.7)
	Kretschmer et al. (2008)	2/36	5.6	(0.7;18.7)
	Choi et al. (2009)	11/61	18	(9.4;30.0)
	Total	**20/120**	**25.7**	**(6.4;58.5)**
Predonation policy	Blau et al. (1992)	17/30	56.7	(37.4;74.5)
	Moenning et al. (1995)	2/67	3	(0.4;10.4)
	Moenning et al. (1996)	1/88	1.1	(0.0;6.2)
	Posnick et al. (2010)	2/34	5.9	(0.7;19.7)
	Total	**22/219**	**15.3**	**(2.6;46.2)**
Overall total		42/339	20.6	(7.1;43.2)

Where n is the number of patient and N is the total number of patient.

Table 18. Transfusion rate in bimaxillary surgery with additional or complex procedures; predonation versus no-predonation policy, summary.

Bimaxillary surgery with additional or complex procedures				
	Patients (n)	Autologous (n)	Homologous (n)	n° transfused patients
Predonation policy	219	21	1	22
No predonation policy	120	0	20	20
Total	339	21	21	42

Table 19. Summary of transfusion rate according to procedure and predonation policy.

Procedure	Transfusion rate (n/N)		Transfusion rate (%)*		statistical model
	Predonation	No predonation	Predonation	No predonation	
	n/N	n/N	%	%	
BSSO single jaw	-	-	**	**	case-reports
Le Fort I single jaw simple	35/118	19/408	26,3	4,5	probit-normal
Le Fort I single jaw complex	3/54	8/105	5,6	7,6	logistic regression
Bimaxillary surgery simple	342/969	187/1264	39	12,5	probit-normal
Bimaxillary surgery complex	22/219	20/120	15,3	25,7	probit-normal

* The % transfusion rate results from the statistical model used.
** Reported transfusions after BSSO-surgery reflect cases with excessive accidental peroperative bleeding.
Where n is the number of patient and N is the total number of patient.

differences (12.5% vs 25.7% in the probit-normal statistical model). The reasons are wide confidence intervals and small sample sizes. The intra-study correlation in the simple bimaxillary procedure group without predonation was 0.32 (p=0.0047). The intra-study correlation in the complex bimaxillary procedure group without predonation was 0.30 (p=0.0941). The clinical interpretation of the statistical result is that we failed to prove a significantly different transfusion behaviour beween simple and complex bimaxillary procedures. It should not be interpreted as having been proven that there is no difference in transfusion rate.

4. Discussion and Conclusions

Transfusion for BSSO surgery is rather independent of the duration of surgery and will be necessary only in the event of a vascular injury.

Several techniques are implemented to reduce the blood loss and subsequent blood transfusion in orthognathic surgery. This review showed a 'very low level of evidence' that the deliberate hypotensive anesthesia is indeed correlated with less blood loss, but it remains one of the most commonly used techniques during maxillary surgery.[57-59] More than any other factor this review showed that transfusion policy, rather than strict criteria, initiates the decision to transfuse. This trend is endorsed in the paper by Faverani et al.[41] who suggest that the indication of blood replacement should be based not only on laboratory parameters (primarily, reduced Hb and Hct levels) but also on clinical signs indicative of a true need for transfusion, such as tachycardia, tremor, diaphoresis, and malaise.

If a liberal reinfusion strategy of autologous blood is avoided, single Le Fort I surgery without additional or complex procedures has historically been accompanied by a blood transfusion need of about 4.5 %, and in the case of additional procedures, about 7.6% or less depending on the criteria for transfusion. There seems to be no influence of additional procedures, whether it concerns segmentation or grafting, on the transfusion need in single Le Fort I surgery, as long as strict transfusion criteria are followed.

Bimaxillary surgery is less dependent on the depth of hypotension and rather on additional measures to lessen blood loss during surgery. Contemporary approaches allow bimaxillary surgery without complex or additional procedures in ASA I patients with a transfusion need as low as 1–2%. Depending on the criteria for transfusion and the availability of predonated blood, this transfusion rate can reach levels as high as 33–35%.

Complex bimaxillary surgery–which is becoming more frequent in contemporary orthognathic surgery in the field of enhanced facial sculpturing, multisegmental Le Fort I osteotomies, and large bimaxillary movements with harvesting of iliac crest bone grafts in medically more compromised patients with OSAS–will approach an overall blood transfusion rate of about 20.6 % and surpass the 10% limit that German centers use to offer a predonation policy to their patients.

Author Contributions

CP designed the study and wrote the manuscript; JOA and IL reviewed the manuscript.

Acknowledgments

The authors declare no conflict of interest related to this study. There are no conflicts of interest and no financial interests to be disclosed.

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Questions

Autodonation of blood in orthognathic surgery is:

❑a. Required whenever Hgb levels drop below 10 g/dL;
❑b. Never mandatory but can be an option in complex orthognathic surgery;
❑c. Legally required in bimaxillary osteotomies;
❑d. The treatment of choice in bloodloss in Jehova's witnesses.

Blood transfusion policy seems to be triggered mainly by:

❑a. The inclusion of a Le Fort I type orthognathic surgery;
❑b. Drop in Hgb level of 4 g/dL compared to the preoperative Hgb level;
❑c. Age of the patient;
❑d. Transfusion policy of the surgical team.

The best way to avoid the need for blood transfusion in orthognathic surgery in healthy patients is:

❑a. The use of topical hemostatics;
❑b. Short operation times;
❑c. To only consider transfusion whenever Hgb < 7g/dL in healthy patients;
❑d. Perioperative hypotension.

Transfusion for BSSO surgery is:

❑a. Dependent on the duration of surgery;
❑b. Independent of the duration of surgery;
❑c. Frequently used;
❑d. Necessary whenever predonation of blood has occurred.