Research

A study of haemoglobin concentration on outcome of blood transfusion in maxillofacial surgery patients in Zaria, Northwest Nigeria

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Abstract

Background: Blood transfusion is widely practiced in maxillofacial surgery to correct anaemia, to restore blood volume after a loss and to prevent systemic complications of hypovolaemia. The haemoglobin concentration is one of the factors that determine when blood should be transfused.

Objectives: This study assessed the impact of haemoglobin level in determining the appropriateness of blood transfusion in maxillofacial surgical patients.

Methodology: We evaluated haemoglobin concentration of 100 maxillofacial surgical patients from January, 2005 to April, 2006. Males were 63 and females 37. Haemoglobin concentration of one hundred patients scheduled for elective maxillofacial surgery was determined during the preoperative, intraoperative and postoperative phases.

Results: Out of 100 patients, 75% of the patients had haemoglobin concentration of 10 g/dl and above while the remaining 25% had below 10 g/dl at presentation. The pre-transfusion haemoglobin concentration ranged from 5g/dl to 12 g/dl. The haemoglobin level 24-hr postoperative ranged between 7g/dl and 13.3 g/dl.

Conclusion: This study had shown that raising the haemoglobin level of the patient with nutritional and iron supplements before surgery, lowering the transfusion trigger and target haemoglobin threshold for blood transfusion has a significant effect on the reduction in the use of allogeneic blood in surgery without compromising patient outcome.

Keywords

Blood, transfusion, haemoglobin, blood loss, maxillofacial surgery

Introduction

Maxillofacial surgery is widely practiced globally, and it is well established because of its capacity to correct many dentofacial deformities, treatment of jaw tumours and fractures of facial bones[1]. While surgical precision is important, clinicians should pay attention to other parameters such as the patients' haemoglobin level, intra-operative blood loss and operation time[2]. All parties involved in the surgery such as the maxillofacial surgeons, anaesthesiologists, and even the patients should be interested in the patients' blood level, expected blood loss, and anticipated need for blood transfusion[3]. The role of blood transfusion in surgery, burns, medicine has undergone re-evaluation over the years. It has been recommended that blood transfusion be used only when there is an apparent physiologic need, based on the patient vital signs, estimation of blood loss and evaluation of blood volume, clinical and laboratory evaluation of end organ perfusion[4].

However, haemoglobin is a protein found in the red blood cells that carries oxygen in the body and gives blood its red colour. It is an iron containing oxygen-transport metallo-protein in the red blood cells[2]. Haemoglobin (Hb) estimation is used to screen for anaemia and to assist in evaluating the patient's response to anaemia therapy. Current transfusion protocols use a

specific (trigger) level of haemoglobin (Hb) or haematocrit that dictates when to transfuse packed red cells or whole blood[4]. American Society Anaesthesiologist (ASA) uses Hb levels of 6g/dl as the trigger to require transfusion[5].

There have not been any 'common triggers' but with the on-going research, different triggers were adopted. This has changed from the traditional Hb <10g/dl to recent < 7g/dl, also range of haemoglobin level of 6-8g/dl, these triggers are not used independently but alongside other physiological parameters to decide the need to or not to transfuse[5-7]. Electrocardiographic changes associated with tissue hypoxia can occur at Hb level of <5.0g/dl to 6.0g/dl [8]. An Hb value less than 5.0g/dl can lead to heart failure and death[8]. Each unit of packed red cells (PRBC) is expected to raise circulating hemoglobin by approximately 1g/dl [10].

Transfusion of blood and blood products is an invaluable therapeutic measure. However, its cost and risks are of importance. Some workers[5-7] reported that considerable number of these transfusions are inappropriate and unwarranted. Several authors[11-12] have advocated various strategies to minimize transfusion requirements in surgery which include: carefully planned surgical incisions to avoid major blood vessels, paying attention to hemostasis, use of hypotensive anaesthesia and using of subcutaneous adrenaline-soaked pads.

The screening and correction of anaemia and replacement of depleted iron stores should be a key component of preoperative management of elective surgical patients[1]. However, to be able to increase the haemoglobin concentration preoperatively and postoperatively; amino acids, iron and vitamin C supplementation could be helpful without resorting to transfusion[6,7].

Good laboratory practice in all aspects of haemoglobin determination; compatibility testing and component preparation, the storage and transportation of blood and its products are essential. This study aimed to define the role of haemoglobin concentration in determining the units of blood transfused in maxillofacial surgical patients.

Methodology

Study design

Haemoglobin concentrations of one hundred maxillofacial surgical patients who presented at the Maxillofacial Units of Ahmadu Bello University Teaching Hospital, Zaria with various surgical diseases and requiring blood transfusion over a period of 16 months (July 2005 to October 2006) where determined using Calorimetry Method. A Calorimetic method consists of changing the haemoglobin of the sample to carbon monoxide haemoglobin, which was compared to standard solution using a Calorimeter to make the comparisons. Hospitex Calorimetry Machine, test tubes and standards solution were used for the haemoglobin determination. All these patients were planned for elective maxillofacial surgical procedures for which blood transfusion was anticipated. The results were analyzed using Microsoft Excel 2007.

This study was retrospective in nature and the sample size was calculated using Taro Yamane (1967) formula. $n=\frac{N}{1+N\,(e)^2}$. Where: n= Sample size, N= Population = 134 (no of patients that had surgery during period of study), 1= Constant, e=Margin of error = 5%=0.05, n = 100.

These 100 patients were grouped under 18 separate surgical procedures. Under each procedure the number of patients, units of blood crossmatched and number of units transfused were recorded.

Data Analysis*:* Data was stored and analyzed using IBM SPSS statistics for windows version and results were presented as simple frequencies, percentages and descriptive statistics. .

Ethical Approval: This was obtained from the ethical and scientific committee of Ahmadu Bello University Teaching Hospital, Zaria, Nigeria. The project number is ESC/2005/00228.

Results

The study included 63 males and 37 females, and their age ranged from 7 years to 69 with mean age of 38.5 year. At presentation 75% of the patients had haemoglobin concentration of > 10 g/dl. Eight of the patients with haemoglobin below 8 g/dl presented with malignant tumours (Table 2). Preoperatively, 74 (74.0%) of the patients had a preoperative haemoglobin in concentration above 10g/dl, while the remaining 26 (26.0%) had between 9 and 10 g/dl (Table 2). The pre-transfusion haemoglobin concentration ranged from 5 to 12g/dl with a mean of 9.0g/dl. (Table 2). At the 24-hour post-operative period, the haemoglobin level ranged between 7 and 13.3 g/dl with a mean of 10.2g/dl (Table 2). Distribution of haematocrit just before transfusion showed that considerable number of the transfusion that was done were unwarranted as some patients were transfused even at the haematocrit of 30-34% (Figure 1). In this study, transfusion need was based on preoperative, intraoperative, and postoperative conditions of the patients. The mandible and the maxillae were the common sites of surgeries in

this study and had the highest transfusion demands. Also, excison of giant neurofibroma and malignant tumour ablative surgeries required more blood transfusion. The observation in this study showed that not all surgeries required blood transfusion as many units of blood crossmatched were not transfused and many patients for which blood were crossmatched did not need the blood (Table 4)

Table 1. Age and sex distribution of patients seen

Age/ Years	Male		Female		Total	
	No.	%	No.	%	No.	%
0-9	5	7.9	9	24.3	14	14.0
10-19	10	15.9	3	8.1	13	13.0
20-29	13	20.6	9	24.3	22	22.0
30-39	12	19.0	5	13.5	17	17.0
40-49	10	15.9	6	16.2	16	16.0
50-59	9	14.3	3	8.1	12	12.0
60-69	4	6.3	2	5.4	6	6.0
Total	**63**	**100.0**	**37**	**100.0**	**100**	**100.0**

Table 2. Distribution of HB at presentation, pre-operative, and 24-hour post-operative periods

Haemoglobin in g/dl	No of patients – Freq (%)		Total (%)
	Male	Female	
HB at Presentation			
5-6	3 (4.8)	1 (2.7)	4 (4.0)
7-8	4 (6.3)	3 (8.1)	7 (7.0)
9-10	8 (12.7)	6 (16.2)	14 (14.0)
11-12	18 (28.7)	15 (40.5)	33 (33.0)
13-14	20 (31.7)	10 (27.0)	30 (30.0)
15-16	6 (9.5)	2 (5.4)	8 (8.0)
17-18	4 (6.3)	0 (0)	4 (4.0)
Total	63 (100.0)	37 (100.0)	100 (100.0)
Pre-operative HB			
8.0 - 9.9	8 (13.6)	11 (32.4)	19 (20.4)
10.0 - 11.9	22 (39.3)	15 (44.1)	37 (39.8)
12.0- 13.9	18 (30.5)	8 (23.5)	26 (28.0)
14.0 - 15.9)	11 (18.6)	0 (0)	11 (11.8)
Total	**59 (100.0)**	**34 (100.0)**	**93 (100.0)**
24 hours post-operative HB			
7.0 – 8.0	8 (13.6)	4 (11.8)	12 (12.9)
9.0 – 10.0	30 (50.6)	23 (67.6)	53 (57.0)
11.0 – 12.0	18 (30.5)	6 (17.6)	24 (25.8)
13.0 – 14.0	3 (5.1)	1 (3.0)	4 (4.3)
Total	59 (100.0)	34 (100.0)	93 (100.0)

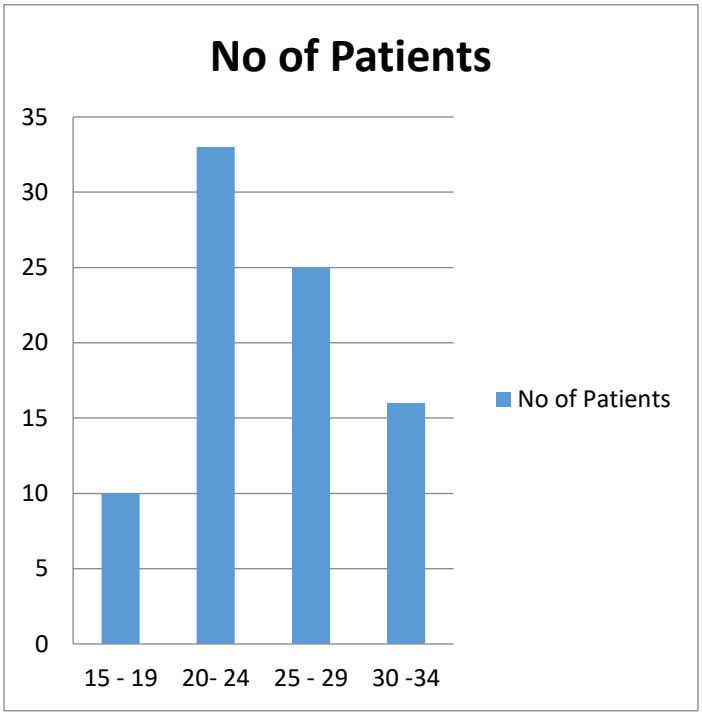

Figure 1. Distribution of haematocrit value just before transfusion intraoperatively.

Table 3. Distribution of patients by histological/clinical diagnosis

Diagnosis	No. of patients	Percent
Infective lesion		
Chronic osteomyelitis of mandible	2	2.0
Developmental lesion		
Tongue lymphangioma	2	2.0
Traumatic lesion		
Avulsive of injury	2	2.0
Neoplasms		
Benign odontogenic tumors		
Ameloblastoma of mandible	24	24.0

Diagnosis	No. of patients	Percent
Ameloblastoma of maxillae	5	5.0
Benign salivary gland tumors	1	1.0
Odontogenic fibromyxoma	5	5.0
Pleomorphic adenoma of parotid gland	2	2.0
Other benign lesions		
Plexiform neurofibroma	4	4.0
Frontocele	3	3.0
Giant cell granuloma	5	5.0
Malignant epithelial lesions		
Squamous cell carcinoma	5	5.0
Mucus gland carcinoma	1	1.0
Mucoepidermoid carcinoma	3	3.0
Acinic cell carcinoma	1	1.0
Adenoid cystic carcinoma	2	2.0
Mesenchymal malignant neoplasm		
Osteogenic sarcoma	2	2.0
Chondrosarcoma	1	1.0
Malignant fibrous histocytoma	1	1.0
Embryonal rhabdomyosarcoma	6	6.0
Alveolar rhabdomyosarcoma	6	6.0
Plasmacytoma of mandible	1	1.0
Fibrosarcoma	3	3.0
Angiosarcoma of the jaws	3	3.0
Fibro-osseous lesion		
Ossifying fibroma	4	4.0
Fibrous dysplasia	6	6.0
Total	100	100.0

Table 4. Surgical Procedures and Units of Blood transfused

Surgical procedures	No. of patients	Units of blood crossmatched	Units of blood transfused	Units of blood not used
Mandibulectomy	47	98	88	10
Maxillectomy	17	34	31	03
Parotidectomy	7	10	7	03
Excision of giant neurofibroma	4	14	14	-
Excision of giant cell granuloma	5	8	6	02
Excision of fibro-osseous lesion	10	20	18	02
Excision of tongue lymphangioma	2	3	2	01
Excision of malignant tumours	6	19	19	-
Sequestrectomy of chronic osteomyelitis	2	2	-	2
Total	**100**	**208**	**185**	**23**

Discussion

Patient's age, surgical procedure, co-morbid illness, predicted blood loss and the cause of anaemia as well as the haemoglobin level should be considered before transfusion[9]. Nevertheless in surgical settings haemoglobin concentration of 7g/dl is used as a threshold for transfusion.[10-12] The transfusion threshold of 7g/dl was used in the study.

Moreover, Oxygen delivery to the tissue usually depends on the haemoglobin concentration and the cardiac output. When the haemoglobin concentration falls below 7g/dl; the compensatory mechanism of cardiac output fails, thus necessitating blood transfusion[13]

According to Friedman et al[14], factors which precipitated blood transfusion during surgery include haemoglobin concentration, and the clinical signs and symptoms of anaemia. Also, Akinbami et al[2] in their study on blood loss during maxillofacial surgery concluded that the volume of blood loss greatly determines when to transfuse. The policy in our hospital stipulates a minimum of 10g/dl haemoglobin concentration for patient undergoing elective maxillofacial surgery under general anaesthesia. Globally, the trend is between 8 and 10g/dl [15]. This study utilized the same support and ceiling haemoglobin level for regulating blood transfusion to both men and women.

However, malignant cells depress bone narrow thereby reducing haemopoesis, therefore cancer patients usually have low haemoglobin level[14]. Majority of the cancer patients in this study had Hb level <8g/dl, this could be attributed to poor nutrition and blood loss when the tumour bleeds.
Only a few of the oral and maxillofacial procedures generate very little blood loss. Procedures such as orthognathic surgery, maxillofacial reconstruction surgery, tumour ablative surgery and those related to craniofacial trauma and head and neck cancer, are associated with greater loss of blood[3]. Achieving satisfactory hemostasis during maxillofacial surgery is difficult because of the vascularity of the region[4]. Therefore provision must be made for blood transfusion.

Moreover, the increasing demand for blood and its products together with the rising costs and transfusion associated morbidity led to a number of studies in the late 1970's reviewing blood ordering and transfusion practices to ensure that blood is giving only when absolutely needed. This study had shown that few patients were transfused without needing the blood. This was evidenced by the post transfusion Hb concentration.

This study observed that the mean haemoglobin concentration for men aged 16 to 69 years was 14.3g/dl and 12.5g/dl for women in the same age group, this is in close agreement with Friedman et al[14] that recorded a mean haemoglobin concentration of men aged 18 to 79 as 15.7g/dl and for women in the same age range as 14.3g/dl in the same environment. The difference could be attributed to the low socio-economic status of the patients in our study center. However, the average the mean haematocrit of men is higher than that of women[12-14]. This could be as a result of the effect of the androgenic hormone in men, which enhances haemopoiesis[14-15]. Also, post-pubertal women lose blood with each menstrual period, and this represents a complete loss of iron from the body, thus making women need more iron supplements more than men[15].
In this study, 25% of our patients scheduled for elective maxillofacial surgery were aneamic (haemoglobin concentration less than 10g/dl). Faris et al[8] in their study also reported that 25% of patients for elective orthopaedic surgery were anaemic. Prompt initiation of anaemic corrective measures is therefore essential in these patients. Iron supplements, ascorbic acid and high protein diet were used to correct the anaemia in this study.

In this study, patients with haemoglobin concentration ranging from 10 to 12g/dl had a high risk for requiring allogeneic transfusion and benefited more from pre-operation iron supplementation. This is similar to Carson et al[18] study who noted that patients with haemoglobin concentration of between 10 and 13g/dl in the immediate preoperative period were at risk of requiring allogeneic blood.
Protein is essential in the correction of anaemia as it supplies the amino acids, which are the building blocks in the formation of the structure of the red blood cells[18]. Iron is essential in the formation of haemoglobin, also in order to make sufficient number of red cell, vitamin B and folic acid are required[16].
Few patients have signs and symptoms of anaemia when the heamoglobin concentration is greater than 7 to 8g/dl[7-12]. Weakness occurs when the haemoglobin drops to 6g/dl and dyspnea and congestive heart failure supervenes at haemoglobin of 2.0 to 2.5g/dl[12]. In this study, signs and symptoms of anaemia were manifested when the haemoglobin concentration was less than 7g/dl, these include weakness, palpitations and dyspnea.

Conclusion
Haemoglobin concentration have been proven to be the key component of transfusion trigger. The outcome of this study showed that to improve blood ordering system for elective maxillofacial surgery procedures, it is essential to increase preoperative haemoglobin concentration such that less blood will be transfused.

Authors' contribution
All authors were involved in the conceptualization, planning, data collection, interpretation of the result, manuscript preparation, proofreading, and gave approval of the final manuscript.

Conflict of Interest
No conflict of interest.

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