Research Paper:

Relationship between the number of blood gauze consumed and hemoglobin drop in craniotomy surgeries

Running title: hemoglobin drop in craniotomy surgeries

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Abstract:

Background and Aim: One of the common complications in craniotomy surgery is bleeding, which is associated with serious and sometimes life-threatening complications. For this reason, it is very important to accurately estimate the amount of blood lost and compensate it.

For this purpose, in this study, we examined the relationship between suctioned blood volume and blood gauzes volume with hemoglobin drop rate after craniotomy surgery and identified factors affecting it in hospitalized patients. So that the doctor can use the results of this research to accurately predict the amount of blood loss during the operation and avoid unnecessary blood transfusions to the patient.

Methods and Materials/Patients: 97 patients with a history of craniotomy surgery in the first 6 months of 2019 were included in the study. The information of the patients was recorded based on laboratory documentation. To calculate the volume of blood lost during the operation, the volume of blood suctioned from the operation description sheet and the volume of blood absorbed by gauzes were calculated and recorded by weighing them. Data were analyzed with IBM SPSS Statistics software version 22.

Results: In our study, 32% of patients received blood during craniotomy. According to the obtained results, the blood volume obtained from blood gauzes and suctioned blood and the total blood volume are significantly related to hemoglobin drop and their ability to predict hemoglobin drop is 6.6, 14.1 and 11.2% respectively.

In general, based on Spearman's correlation coefficient, the intensity of correlation between the number of blood gauzes and the amount of blood obtained from blood gauzes is greater than the change in the volume of blood suctioned and the amount of total bleeding.

Conclusion: This study showed that measuring the blood volume of gauzes consumed in craniotomy surgery can be more effective in predicting the amount of blood loss and hemoglobin drop of the patient after the operation even than the amount of suctioned blood.

Keywords: craniotomy, hemoglobin, anemia, brain tumor, blood transfusion

Highlights:

- Accurate calculation of blood lost by a combined method (suctioned blood and blood absorbed by blood gauzes) helps to reduce postoperative complications.
- Measuring the blood volume of consumed gauzes can be very effective in predicting the patient's hemoglobin drop.

- Hemoglobin changes have a significant relationship with blood weight obtained from blood gauzes, volume of suctioned blood and also with the number of blood gauzes.

Plain Language Summary:

1.Introduction:

A craniotomy is the removal of part of the bone from the skull to access the brain. Specialized tools are used to remove the bone, called a bone flap. The bone flap is temporarily removed and replaced after brain surgery (1, 2). Bleeding occurs after many surgeries, causing anemia and a drop in hemoglobin levels in a person (3).

Studies have shown that patients with anemia are likely to experience a prolonged hospital stay after surgery, leading to an increase in resource consumption (4). According to the conducted studies, when the hematocrit is less than 29.1% or more than 45%, along with increasing severity of anemia and polycythemia, the risk of death 30 days after the operation increases (5). Other studies have shown that in patients who underwent craniotomy, a small change in hemoglobin after the operation was associated with an increased probability of death within 30 days (6).

Bleeding after craniotomy is clinically important and requires accurate measurement of blood loss.(7) (8). when deciding to transfuse blood to neurosurgery patients, the related risks and its advantages and disadvantages should be considered. there is strong evidence that transfusion-related adverse events are associated with increased morbidity and mortality in children aged 18 to 20 years (9). The neurosurgeon must be able to make an accurate estimate of the volume of blood lost during a surgery to avoid unnecessary blood transfusions (10) (11).

A study conducted on 1032 patients showed that at least one out of every 10 patients undergoing neurosurgery suffers from postoperative anemia. The same study showed that the rate of anemia in cranial surgery was higher than in non-cranial surgery (11.8 to 10.1) (12).

Anesthesiologists must carefully assess blood loss and replace it with blood components according to clinical conditions. loading a large volume of fluid can decrease the Hb/HCT level and the dilution effect, which can cause the patient to need more blood transfusions (13) (14).

The best way to avoid this problem is to use appropriate and accurate methods to evaluate the amount of blood lost during surgery. Currently, there are several methods for estimating blood loss. Visual estimation was one of the common methods another used method is to compare hemoglobin and hematocrit before and after the operation, and another is the weighing method (the sum of the suctioned blood weight and the blood volume of blood gauze) (15)(16)(17).

At the moment the common method of estimating the volume of blood lost in craniotomy surgery is measuring the volume of aspirated blood, and it is not customary to use the method of weighing the volume of blood and blood gases during surgery. Due to the lack of sufficient studies on blood loss measurement methods, we decided to conduct a study with the aim of " diagnostic value of blood volume of blood gauzes compared with suctioned blood in craniotomy". And in this way, to help surgeons and anesthesiologists to identify the best method and avoid injecting more or less blood than the patients need.

2. Methods and Materials/Patients:

Our study was an analytical-cross-sectional study. The study population of this research includes patients who were admitted to Rasht's Poursina Hospital in 2019 and underwent craniotomy surgery.

All patients with a history of craniotomy surgery at Poursina Hospital in Rasht were included in the study, and patients who suffered cardiopulmonary arrest and died during surgery were excluded from the study.

Sampling by the available method and based on the article by Grant MC et al (18) and the following formula includes 97 patients admitted to Rasht's Poursina Hospital in 2019 who underwent craniotomy surgery. The sample size was calculated based on the following formula:

$$n = \frac{z^2_{1-\frac{\alpha}{2}} \times \sigma^2}{\delta^2}$$

$$\sigma = 200\,ml \quad ,\quad \delta = 0.2\,\sigma \quad ,\quad \alpha = 0.05$$

$$n = 97$$

After coordination with the university units and the approval of the ethics committee, data collection was started by the researcher.

Information such as age, gender, operation site, operation position, blood group, history of hypertension and anemia was documented. Hemoglobin before and six hours after the surgery was measured.

The volume of blood and fluid received during the operation and the suction blood volume was recorded and blood gauzes were weighed using a scale and the difference in the weight of blood and non-blood gauzes obtained. (With electronic scale SF400)

Finally, the data were analyzed using IBM SPSS Statistics software version 22. Quantitative data description was done using mean and standard deviation and qualitative data description was done using frequency and percentage.

We used ROC curves to investigate the amount of suctioned blood and the number of blood gauzes in predicting hemoglobin changes after craniotomy surgery in patients admitted to Rasht's Poursina Hospital in the first six months of 2019.

Also, to check the relationship between the variables, Pearson's correlation test was used if the variables were normal and Spearman's correlation was used if the variables were non-normal.

We used the Shapiro-Wilk test to check the normality of the variables. The error level was considered to be 5%.

3.Result:

In this study, 97 craniotomy surgeries were evaluated in terms of suctioned blood and blood gas numbers in predicting hemoglobin changes after surgery.

Table 1. Demographic characteristics and type of blood group and underlying diseases of patients undergoing craniotomy surgery

		number	Percent
Age (year)	<50	39	40.2
	50-60	21	21.6
	>60	7	38.1
mean ± Standard deviation		55.11 ± 17.27	
Min-Max		4-85	
gender	male	58	59.8
	female	39	40.2
RH	RH -	23	23.7
	RH +	74	76.3
Blood group	A+	16	16.5
	A-	3	3.1
	B+	31	32
	B-	7	7.3
	AB+	14	14.4
	AB-	4	0.25
	O+	13	13.4
	O-	9	9.3
Underlying disease	Has not	64	66

	had	33	34
Type of underlying disease	Blood pressure	11	33.3
	diabetes	0	0.0
	Blood pressure and diabetes	3	9.1
	CAD	2	6.1
	Blood pressure and GAD	13	39.4
	Blood pressure and GAD and diabetes	4	12.1
Blood received during surgery	Has not	66	68
	had	31	32

According to table 1, the majority of craniotomy surgeries were performed in people under 50 years old (40.2%). In terms of gender, the majority of the samples were men (59.8%), and in terms of blood group, the majority of patients had blood group B (32%), and the majority were RH positive (76.3%).

In the examination of the underlying diseases of the studied patients, (34%) of the patients had underlying diseases, the majority of which were hypertension (93.9%) and (21.2%) diabetes (57.6%) with They were CAD.And about (32%) patients received blood during surgery.

Table 2. Statistical indicators of hemoglobin and amount of bleeding based on the number of blood gauzes and volume of suctioned blood:

	Mean ± SD	Median	Minimum	Maximum	95% CI for mean		Rsp[a]	P-value
					lower	upper		
Preoperative Hb	1.51±12.9	13.10	9.00	15.60	12.61	13.22	0.540	<0.001
Postoperative Hb	9.91 ± 1.29	9.90	7.20	12.40	9.65	10.17	-0.027	0.794
changes in hemoglobin (gr/dl)	3.00 ± 0.86	3.20	1.20	5.30	2.83	3.18	1	_
Blood gauze count	22.10 ± 5.75	20.00	15.00	40.00	20.94	23.26	0.466	<0.001
Blood gauze weight	289.96 ± 84.77	259.60	153.80	514.40	272.87	308.04		
Blood weight of blood gauzes(grams)	135.24 ± 48.34	121.60	43.200	258.60	125.49	144.98	0.430	<0.001

Volume of blood suctioned (cc)	297.94 ± 100.50	300.00	150.00	600.00	277.68	318.19	0.304	0.002
Amount of total bleeding (cc)	433.18 ± 131.37	394.50	248.80	858.60	406.70	459.65	0.415	<0.001
Blood percentage of blood gauzes to the whole bleeding	31.43 ± 7.61	31.11	10.99	55.63	29.89	32.96	0.204	0.045
Blood percentage of suctioned blood to total bleeding	68.75 ± 7.61	68.89	44.37	89.01	76.04	70.11	-0.204	0.045

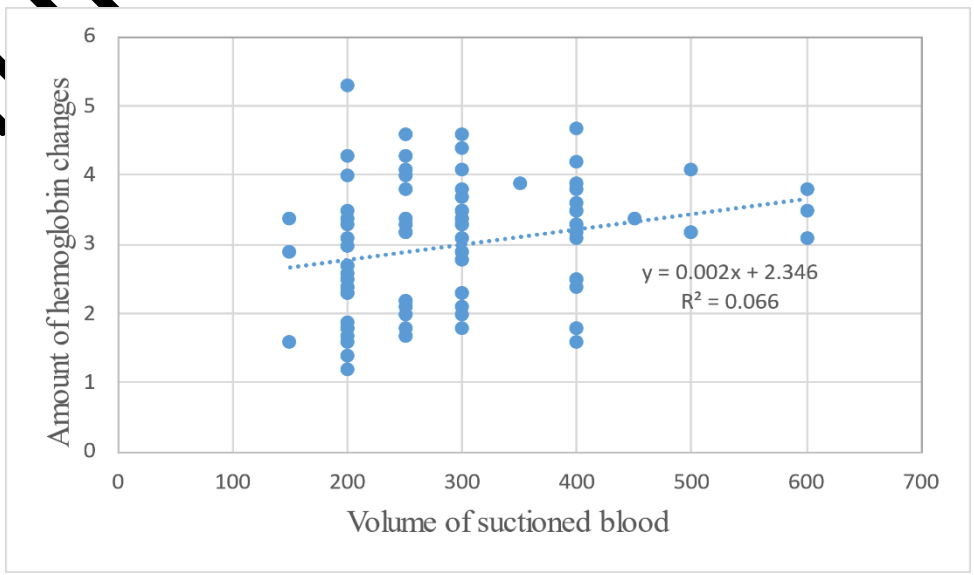
aRsp: Spearman's rho;

In general, the average percentage of suctioned blood to the total bleeding is {68.5%±7.61} and the average percentage of blood gauzes to the total bleeding is {31.43±7.61}.

Hemoglobin changes have a significant positive linear correlation with blood weight of blood gauzes, suctioned blood volume, total bleeding amount and also with the number of blood gauzes.

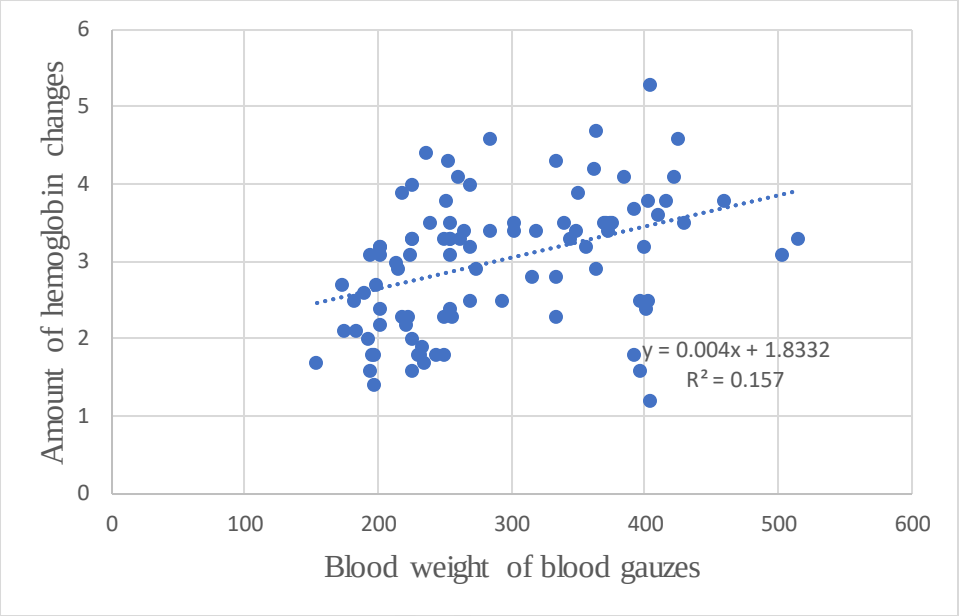
This also depends on the number of gauzes and the weight of blood gauzes, which are stronger than suctioned blood.

Figure 1. Distribution diagram of the correlation between the volume of suctioned blood and the amount of hemoglobin changes.



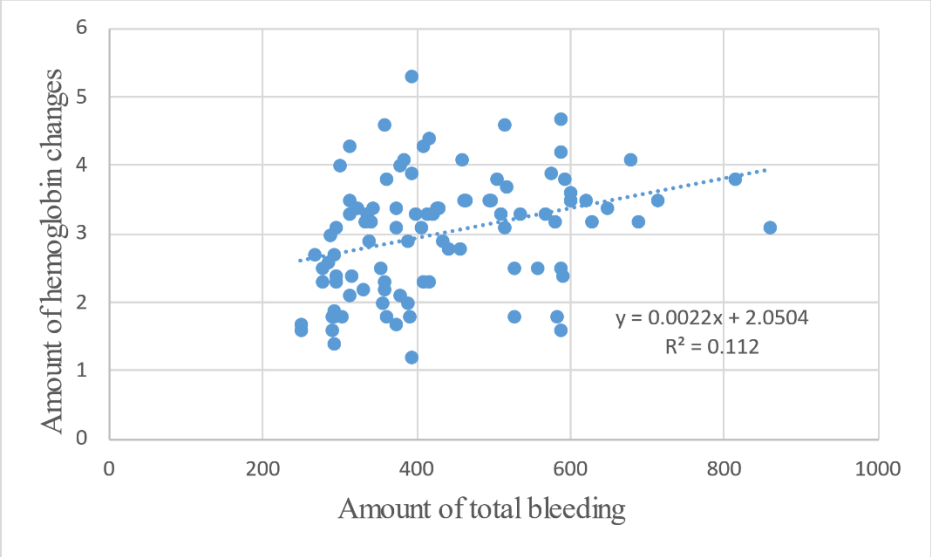
In general, based on the Spearman correlation coefficient, the intensity of the correlation between the number of blood gauzes and the amount of blood from blood gauzes is greater than the change in the volume of suctioned blood and the amount of total bleeding.

Figure 2. Distribution diagram of the correlation between blood weight and blood gauzes with hemoglobin changes in patients undergoing craniotomy surgery.



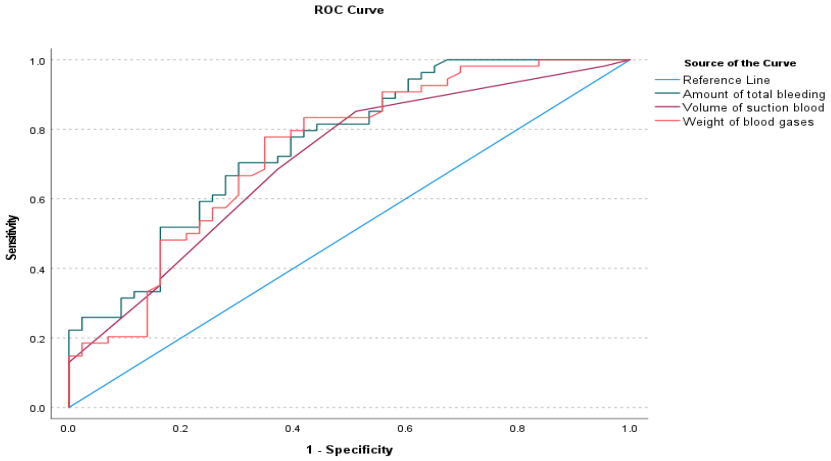
For one gram increase in blood weight of blood gauzes, 7.6 x 0.001 units affect the decrease of hemoglobin. Based on the coefficient of determination of blood weight from blood gauzes, on average 14.1% predicts changes in hemoglobin.

Figure 3. Distribution diagram of the correlation between the amount of total bleeding and the amount of hemoglobin changes



Based on the R2 coefficient, the predictive value and effect coefficient {beta} of blood weight from blood gauzes is more than whole blood and suctioned blood.

Figure 4. Prediction of ROC Curve



Based on the ROC diagram and information in Table 3, the level of predicting blood weight from blood gauzes {ROC=0.728 ± 0.005} was statistically significant

Table 3. Prediction of severe bleeding cut-off point

Area Under the Curve							
Test Result Variable(s)	Area (Area under the curve)	The standard error	P value	%95 CI		Cut off	Sensitivity - Characteristic
				lower	upper		
Blood weight of blood gauzes (grams)	0.728	0.051	0.000	0.629	0.828	110.75	60.5**%** -77.8**%**
Suctioned blood volume (cc)	0.708	0.035	0.000	0.604	0.812	275	62.8**%** -68.5**%**
Amount of total bleeding (cc)	0.759	0.049	0.000	0.663	0.854	391.8	70.0**%** -70.4**%**

The best cut-off points for predicting bleeding more than normal in the volume of suctioned blood is equal to 275 cc with sensitivity and specificity of 68.5% and 62.8%.

Finally, the amount of total bleeding to predict bleeding more than normal in the craniotomy surgery community is equal to 759±0.049, which is also statistically significant {P<0.001}.

The best cut off point for total bleeding to predict bleeding more than the normal society is 391.8 cc with sensitivity and specificity of 70.4% and 70%.

4.Discussion:

According to the World Health Organization's definition of anemia (less than 12 for women and less than 13 for men), about 80 to 90% of post-operative patients can be included in this definition, but clinically We often consider hemoglobin less than 10 as anemia after surgery (19).

Since bleeding is one of the most common complications of craniotomy surgery and it can be associated with poor clinical results and long-term hospitalization for the patient and even death, Accurate measurement of blood loss and timely injection of blood and fluids is of particular importance in these patients.

There are many studies about the methods of measuring blood loss during surgery, but since there are few studies comparing blood loss by blood gauzes and suctioned blood in predicting hemoglobin drop after surgery, we decided to investigate this issue by conducting this study so that by using its results we can predict the blood lost during the operation and at the same time prevent unnecessary blood transfusion.

The strength of our study is the specific investigation on craniotomy surgeries and also the use of a combined method (weight measurement of blood gauzes + aspirated blood) in the estimation of blood loss during surgery. By using this information, we can make a relatively accurate estimate of the amount of hemoglobin drop and reserve blood for the patient before surgery.

All the data were obtained from the detailed information recorded in the files of patients undergoing craniotomy in Rasht's Poursina Hospital. The Blood volume of blood gauzes and suctioned blood in the bottles was measured and analyzed with accurate weighing methods.

The results of our study showed that 22% of patients received blood during craniotomy. In the study of Shiferaw et al., which was conducted in 2023 on 153 patients with the aim of investigating complications after elective craniotomy, although the evaluation of blood loss in that study was done by the EBC formula (based on hemoglobin and hematocrit before and after the operation). And it was calculated in patients with a lower average age, but it showed the same results as our study (36.7%) (20).

The number of changes in hemoglobin before and after the operation in our study was on average 3+0.86, In the study of Parthiban Giribabu et al., which was conducted on 1025 patients to investigate the risk factors and the effect of anemia after neurosurgery, this amount was reported as 1 gram. The reason for this can be the difference in the amount of blood injected during the operation and the type of surgery being investigated (12).

The frequency of the underlying disease of blood pressure in our study subjects was(33%). which is a higher number compared to Shiferaw et al.'s study (7.8%), the reason for this difference can be the higher average age of our study subjects and also high blood pressure statistics in our country (20).

The average amount of total bleeding in our study, which was obtained from the sum of the blood weight of blood gauzes and suctioned blood, was equal to 433.18±131.3. In Shiferaw et al.'s study, which was performed on 153 patients undergoing elective craniotomy, the average amount of blood lost was 1040±727 (20). The reason for this difference can be the different blood measurement method in this study (hemoglobin and hematocrit calculation method before and after the operation) and the difference in the surgeon's technique and skill. Also in our study, the blood on the Surgical gowns and the surgical bed was not calculated, which could be one of the causes of this difference.

The results of our study showed that the number of changes in hemoglobin with the number of blood gauzes, the weight of blood obtained from them, the volume of suctioned blood and the amount of total bleeding had a significant positive linear correlation, this also depends on the number of gauzes and the weight of blood gauzes, which are stronger than suctioned blood.

This is while in the field of surgery, the surgeon's concern is generally focused on the volume of suctioned blood, for this reason, the volume of suctioned blood is regularly monitored and reported, but the number of blood gauzes used may be neglected.

Many studies have not been done on the comparison of aspirated blood and blood obtained from blood gauzes in predicting post-operative hemoglobin drop.

Our data analysis showed that for one gram increase in blood weight from blood gauzes, hemoglobin decreases by (6.7*0.001) units, on the other hand, suctioned blood has an average effect on hemoglobin drop by (2.2*0.001).

This strong relationship between the blood volume of consumed gauzes and hemoglobin drop can be due to the use of a high number of gauzes used during the operation. In our study, the number of consumed gauzes was even reported up to 45.

These results show that although the volume of suctioned blood can be a predictor of hemoglobin drop and the subsequent blood transfusion can prevent the decrease of hemoglobin to some extent, but if only this volume is used as the basis for blood unit injection, The risk of anemia and its complications are still relevant, especially in patients whose blood volume of consumed gauzes is greater than the volume of suctioned blood.

Therefore, it is necessary to not only rely on suctioned blood in craniotomy surgery when deciding to start blood transfusion, and the number of blood gauzes consumed in the operation field should also be seriously considered in the calculations and use combined methods to calculate the amount of blood lost.

One of the limitations of our study was the lack of examination of the blood absorbed into the surgical wounds, since a large amount of blood is lost in this way during surgical procedures, especially in cases of severe bleeding, carrying out further studies with the aim of evaluating the effect of this volume of blood on hemoglobin drop can be associated with achieving better outcomes after this type of surgery.

Our suggestion for future researches is to repeat the study with a higher sample size and investigate in other types of surgeries, especially major surgeries, as well as consider the duration of surgeries in the amount of blood lost, so that using the results of those studies, a more accurate decision can be made. It should be adopted for the amount of blood transfusion

in patients undergoing various surgeries and prevent further complications for patients and imposing additional costs on the hospital.

5.CONCLUSION:

The results of our study showed that both methods of measuring the volume of blood lost, i.e., suctioned blood and the blood volume of blood gauzes, are effective in reducing hemoglobin, but the effect coefficient of the blood volume of gauzes consumed during craniotomy surgery can be even higher than that of suctioned blood. This shows that measuring the number of gauzes consumed during this surgery can be effective in predicting the amount of blood loss and hemoglobin drop of the patient after the operation, and by accurately calculating the blood loss, it can reduce the complications after the operation. Caused by hemoglobin drop and improve blood count and injection system to help in craniotomy surgeries.

Ethical Considerations

Compliance with ethical guidelines:

This study was approved by the Ethics Committee of the University of Guilan code: IR.GUMS.REC.1399.168.

Honesty and ethical standards were observed in the use of information, results and their publication. The patient's personal information was preserved and no one, except the research team, had access to the information under investigation.

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Approving the final version of the manuscript: All authors.

Conflict of interest:

The authors declared that they have no conflict of interest.

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