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Reliability of Visually Estimated Blood Loss with Hemoglobin Measurement: 200 Cases of Craniosynostosis Surgery

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Abstract

Background

Bleeding is one of the most common complications of craniosynostosis surgery, which its appropriate management is associated with better post-operative outcomes. The aim of this retrospective study was to evaluate the visual estimated blood loss in intraoperative management of infants with craniosynostosis surgery.

Materials and Methods

This retrospective study was performed on 200 patients who underwent craniocinostosis surgery and hospitalized in intensive care unit (ICU) at Mofid Hospital, Tehran, Iran, from July 2015 to June 2017. Data collecting was done using a self-made checklist and from patients' medical record. Required data include age, gender, method of anesthesia, and arterial blood gas (ABG), hemoglobin (Hb), and platelet (Plt) changes during surgery, volume of administered blood and fluid were recorded and evaluated. Data analysis using SPSS software (version 22.0).

Results

Among the patients, 59% (n=118) were boys, the mean age of patients was 13.3 ± 13.52 months. Anesthesia technics were total intravenous anesthesia (TIVA) (15.5%, n= 31), and inhalation or mixed (84.5%, n=169). Patients received 992.02 ± 468 ml fluid and 205.86± 100 ml blood, before surgery. There was no significant difference between preoperative Hb and first Hb in pediatric intensive care unit (PICU) (p=0.12). However, preoperative and first Plt in PICU were different (p=0.000). Also, last Hb in ABG (10.5±1.90), and the first Hb in PICU showed no significant difference (r=0.088, p=0.219).

Conclusion

According the results, visual assessment and correction of blood loss with hemoglobin measurement and by experienced anesthesiologist was a reliable and safe method in patients with craniosynostosis surgery and feasible in every operating room.

Key Words: Blood loss, Craniosynostosis, Hemoglobin, Surgical.

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1- INTRODUCTION

Craniosynostosis is a condition in which one or more cranial vault sutures prematurely fused by ossification that leads to abnormal shape of the skull. Its prevalence is approximately 1 per 2,000 live births. In addition to aesthetic issues, this disorder can lead to increased intracranial pressure (ICP), optic or auditory nerves impairments or cognitive impairment. Craniosynostosis in 85% of cases are isolated and 15% syndromic and involve various systems of the body (1, 2). The treatment is surgical repair during the first few months of life. Although craniosynostosis repair appears to be relatively safe in the absence of underlying diseases, the perioperative period can be very complicated (3, 4).

One of the major complications associated with surgery is high excessive bleeding (5). Perioperative bleeding can occur slowly or acutely that massive transfusion is required. Bleeding mainly is high risk for infants with lower age and weight, and in long duration surgeries like syndromic type. A number of Studies showed that the average volume of transfusion is 50 ml/kg but may reach to more than 100 ml/kg (6, 7). Keeping in mind, the main challenge in surgical and anesthetic management of craniosynostosis patients is to control and correct the hemorrhage and care should be focused on maintaining hemodynamic stability and prevention of coagulation disorder. Many researches are carried on management of bleeding and application of strategies to reduce it in craniosynostosis surgery (8, 9).

These approaches include less invasive surgical techniques such as endoscopic surgery, or modifying open surgical techniques (10), prescribing iron or erythropoietin before surgery, prescribing antifibrinolytics and autologous transfusion techniques such as cell salvage and preoperative autologous blood donation. *These techniques* are usually *easy* to use in older children and adults, but in infants need special equipment and skilled personnel (7, 10-27). Furthermore, overestimation or underestimation of bleeding and transfusion has minor and major complications including risks related to massive transfusion, increased myocardial workload a, pulmonary edema, anemia, cerebral hypoxia and longer duration of stay in intensive care unit (ICU) (28, 29). The accurate estimation of bleeding and appropriate compensation in craniosynostosis surgery remains a major challenge for anesthesiologist (30-33).

Using visual estimation of blood loss such as the volume of suctioned blood, drapes, swabs, blood shed on floor, soaked surgical gowns and bloody gauze are controversial. Other various methods, such as measuring hemoglobin (Hb) and hematocrit (Hct), and gravimetric central venous pressure (CVP), and electrical conductivity measurements are used. The unavailability of equipment and personnel for performing laboratory tests, the long duration of surgery and financial issues are the limitation of these methods (28, 34, 35). This study aimed to determine reliability of visually estimated blood loss with hemoglobin measurement which is a simple and feasible method in every operating room.

2- MATERIALS AND METHODS

In this retrospective, cross sectional study, 200 patients who underwent primary reconstruction of craniosynostosis at Mofid Hospital, Tehran-Iran, from July 2015 to June 2017 were included to the study. The study was approved by hospital ethics committee. Sample size was estimated by sample size calculator software with 95% confidence interval and $p<0.05$ considered analytically significant. Inclusion criteria were non syndromic craniosynostosis primary repair, age less than 10 years. Exclusion criteria were patients with life threatening underlying

disease such as heart and pulmonary diseases, anemia, coagulation disorders, hypothyroidism, metabolic disorders (36) and meningitis. The same team of surgeons and anesthesiologists were responsible for all the cases in our study. Perioperative period was from start of anesthesia until entrance to recovery. Postoperative period was from entering recovery room until discharge from pediatric intensive care unit (PICU). Anesthesia technics were total intravenous anesthesia (TIVA), and inhalation or mixed. In TIVA, induction was performed with thiopental 5mg/kg, fentanyl 2 µg/kg and atracurium 0.5 mg/kg in both groups and patients were intubated with spiral Uncuffed Endotracheal Tube (ETT).

In addition to standard monitoring (Blood pressure (BP), Pulse rate (PR), Electrocardiography (ECG), end tidal carbon dioxide (ETCO2), invasive monitoring including arterial line and central venous catheter was established. All of patients were in 15 degree head up position. Maintenance of anesthesia was provided by Isoflurane (1 MAC) in group A and Propofol 150 ug/kg/min and remifentanil 0.1ug/kg/min in group B. The mean blood pressure (MAP), and heart rate (HR) were recorded every 5 minutes. In inhalation anesthesia method, 15 minutes before starting craniotomy, hyperventilation with the aim of keeping partial pressure of end tidal carbon dioxide (PETCO2) around 25-30 and $Paco_2$ 30-35 mmHg was established.

Also, normocapnia ($PETCO_2$=35 mmHg) was maintained. ABG samples were used to measure $Paco_2$. During surgery, the surgeon evaluated intra cranial pressure (ICP) (37). Data collecting was done using a self-made checklist and from patients' medical record after allowing the member staffs who were responsible for maintaining the patients' records. Data include duration of anesthesia, volume of transfusion blood and fluid intake, receiving calcium and fresh frozen plasma (FFP). Total amount of bleeding was estimated based on ml of blood in suction tank and gauzes and surgical fields by continue evaluation of anesthesiologist during operation (31). Using each individual patient's preoperative hemoglobin (Hb), Hb lost was converted to volume of blood loss with the formula Volume in mL = measured Hb loss in g × (100 mL/dL)/(Preoperative Hb in g/dL) (5). All patients' demographic characteristics such as age, weight, gender, duration of anesthesia and lab results for primary outcomes including preoperative hemoglobin and platelets, last Hb in arterial blood gas (ABG), first Hb and platelets (Plt) in PICU were recorded. Last Hg of ABG had been usually checked and noted in anesthesia chart preoperatively to have a document for legal issues. Secondary outcomes including fever in PICU, volume of blood transfusion and fluid intake and length of PICU stay were also recorded.

Statistical analysis was conducted by using SPSS 22.0 software (Chicago, IL, USA). The parametric variables were presented as mean ± standard deviation [SD] and analyzed by student t-test and as appropriate. For non- parametric variables Chi-square or Mann-Whitney U-test were used, also p-value less than 0.05 was considered as statistically significant.

3- RESULTS

A total of 210 cases were investigated, of which 10 were excluded due to inadequate information in their medical record. Finally, 200 patients were enrolled in the study that among them 59% (n=118) were boys and 41% (n=82) were girls. The Mean age was 13.3 ± 13.52 months (2.5 to 108 months). The mean weight of patients was 9.30 ± 3.17 Kilograms (5 to 30 kg). Anesthesia techniques were TIVA 15.5% (n= 31) and inhalation or mixed 84.5% (n= 169). The mean duration of anesthesia was

6.9 ± 0.87 hours and the patients received 992.02 ± 468 mL fluid and 205.86 ± 100 mL blood during surgery. Also, the volume of fluid intake to weight ratio was 110.01 ± 45.88 ml/kg and the volume of transfused blood to weight ratio was 23.04 ± 12.33 ml/kg. The mean PICU length of stay was 32.2 ± 14.03 hours (8 to 96 h). None of the patients received FFP, while 80% (n=159) of them received Calcium intravenously. Bleeding in drain bag occurred in more than 50% (n=101) of the patients and 11% (n=22) had fever (temperature > 38 degrees centigrade) in PICU. There was no death during or after surgery. **Table.1** shows preoperative Hg and platelet and first measurement of Hg and platelet of patients in PICU. There was no significant difference between preoperative Hb and first Hb in PICU (p=0.12). Preoperative and first Plt count in PICU were significantly different (p=0.000). Also, Last Hb in ABG (10.5±1.90) and the first Hb in PICU showed no difference. (t=0.088, p=0.219).

Table-1: The comparison of Preoperative Hb and Plt with first Hg and Plt in PICU.

Variables	Before surgery Mean ± SD	In PICU Mean ± SD	t-test	P-value
Hemoglobin	11.35 ± 1.04	11.13± 1.89	1.56	0.12
Platelet	371400 ± 287330	212050 ± 74760	-8.30	0.000

PICU: Pediatric intensive care; SD: Standard deviation.

4- DISCUSSION

This study showed that close observation of hemodynamic changes and continues visual monitoring of blood loss by anesthesiologist is a reliable and safe method to estimate blood loss and resulting accurate corrections. Blood loss was compensated acceptably and first Hb in PICU was close to preoperative values. Although in previous studies, various methods such as colorimetric Hb, osmolarity and gravimetric were used to estimate blood loss during surgery, but due to their limitations they did not succeed perfectly. In agree with our study, some researchers resulted that close monitoring of hemodynamics and central venous pressure (CVP), and Hb measurements were preferred approach (33, 35). Guinn et al., compared anesthesiologist estimates of intraoperative blood loss with measured Hb loss to determine the accuracy of intraoperative blood loss estimation in 60 patients undergoing posterior spine surgery. Level of Hb was converted into volume of blood lost and compared with estimates of blood loss. They concluded that estimated blood loss exceeded measured blood loss by 40% on average. The finding of Guinn study does not support our results that may be due to the differences between anesthesiology team in visually estimated blood loss to determine Hb concentration of sanguineous solutions in suction canisters and surgical sponges (5). Hass et al. (2014) investigated improvements in patient blood management for pediatric craniosynostosis surgery using a rotational thromboelastometry (ROTEM) (38). In their study, the amount of unnecessary transfusion was significantly reduced. In some of the studies, simple objective techniques have been successful in determining the endpoint for transfusion or Hb measurement (5, 39). However, in Jareonrattanadaechakul study (2017), chart for visual estimation was applied which was more reliable than visual estimation method alone (40). In contrast to our results, in studies conducted on midwifery and cesarean section, orthopedics and

urology surgeries, visual estimation of blood loss were not a precision method and delayed diagnosis or underestimate of blood loss have been reported (41, 42). Furthermore, in two studies, using blood gas measurements in the estimation of blood loss was more reliable than visual approach (45, 46). However, Seruya et al. (2011) who compared estimated blood loss (EBL) and calculated blood loss (CBL) based on Hb in craniotomy surgery patients, both methods was associated with underestimated and overestimation to compensate of blood loss (43). There was a significant difference between the mean platelet count before and after the surgery, which may be due to uncompensated Plt during surgery and dilutional thrombocytopenia. In the present study, the mean length of stay in the PICU was 32.2 hours, which is less than Shastin et al. (2017) study that was 3.5 days in patients with craniosynostosis surgery (44).

It may be due to keeping hemodynamic stability during surgery and not required intensive hemodynamic challenges in PICU which resulted faster discharge. Also, none of the patients in our study received FFP, and died in PICU. Since the most important factor of mortality in this surgery is massive bleeding and consequent coagulopathy, our acceptable management of bleeding caused these findings. In addition, the mean average of transfused blood was lower than 1.5 blood volume of patients (23.04+_12.33 ml/kg) so, FFP was not administered.

4-1. Limitations of the study

One of the limitations of this study was lack of long post-operative outcomes such as need for transfusion in PICU period. Also, we did not record type of anomalies which are important factors affecting time of surgery and amount of bleeding. We recommend another prospective study aimed to visual assessment of bleeding along with serial screening component of Hct in ABGs.

5- CONCLUSION

According to the results, visual assessment of bleeding with Hb measurement can be a reliable method to assess blood loss during craniosynostosis surgery. Further studies are recommended to confirm our findings.

6- CONFLICT OF INTEREST: None.

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