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Validity of Gravimetric Measurement, Visual Guide Method, and Anesthesiologist Eyeball Visual Estimation of Blood Loss During Caesarian Section

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ABSTRACT

Background:
Accurate estimation of blood loss during caesarean section (C/S) and rapid intervention is an essential way for the management of obstetric hemorrhage. This study was conducted to assess the accuracy of the visual guide and the anesthetist's eyeball estimation methods compared to the gravimetric method during elective C/S.

methods:
A cross-sectional comparative study was conducted in Maternity Teaching Hospital, Erbil, Kurdistan Region, Iraq, from January 01, 2021, to November 01, 2021. A convenience sample of 100 women of elective C/S was included. Blood loss was estimated using the anesthetist's eyeball method, visual guide pictogram, and gravimetric method. The collected data were analyzed and used to compare the different techniques.

Results:
There was a strong, significant correlation between each of the three practised methods for estimation of the blood loss during C/S ($p<0.001$). The mean of estimated blood loss by the gravimetric method (433.8±184.5 mL) was significantly ($p\leq0.05$) less than the estimated means by the anaesthetist (492.5±188.2 mL) and by the visual guide estimation (478±185.2 mL).

Conclusions:
The visual guide method and anaesthetist eyeball estimation closely approximate blood measurement by the gravimetric method. Although the visual guide method and anaesthetist eyeball method were slightly higher than the gravimetric measurement of blood loss, this difference is unlikely to have led to errors in clinical judgment, such as over-transfusion or unrecognized massive maternal hemorrhage. The visual estimation of blood loss is a simple, fast, and readily available method for the initial evaluation of blood loss in C/S delivery.

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Introduction

Caesarean section (C/S) is one of the most common operative methods in the field of obstetrics that carries many complications during and after surgery. So, specific measures are required to manage complications and decrease adverse effects on maternal and fetal health(1).. Normal blood volume in the adult is approximately 7% of ideal body weight, and massive hemorrhage is the loss of at least >1500 mL of blood within 24 hours that significantly increases the mortality and morbidity rates(2). Obstetric hemorrhage is one of the most typical causes of maternal mortality and morbidity; however, 54–93% of maternal deaths due to obstetric hemorrhage may be preventable(3). During uncomplicated C/S, the amount of blood loss is about 400-500 mL and may reach 1000 Ml(4). Early and accurate estimation of blood loss during C/S and rapid identification of the source are essential in the management of hemorrhage. Inaccurate assessment of blood loss during surgeries can cause considerable adverse events. Underestimation may result in delayed treatment, and overestimation can lead to unnecessary blood transfusions that may cause maternal complications(5). Despite the knowledge of the inaccuracy of visual estimation, intraoperative blood loss is still estimated visually(6). This quantitative method is used for the routine measurement of blood loss by both anesthetists and obstetricians. A visual guide method using a pictogram explains how to estimate blood soak by surgical gauze(7). On the other hand, the eyeball method is the most common method used by anesthesiologists, in which blood loss estimation is determined through visual assessment of suction canisters, surgical sponges, and the operating room environment(8). Anaesthetist in developing countries may not have the luxury of point-of-care monitoring devices and may have to rely on visually estimated blood loss (EBL) in making decisions(9). The gravimetric method measures the amount of blood loss by weighing soaked surgical swabs and subtracting their known dry weight(10). Additionally, hemodynamic arterial and venous pressure measurements can be of value in the estimation of blood loss since they help assess the well-being of the circulatory system(11). Blood loss is based on the change in calculated blood volume, determined by weight, height, sex, and change in hemoglobin (Hb) and hematocrit (HCT) that must account for administered blood transfusion and crystalloid(12). Measuring HCT and Hb immediately after acute blood loss is inaccurate, and it takes approximately two hours for the plasma to equilibrate and obtain a more accurate level(13). Intraoperative blood loss estimation is a daily challenge for clinicians, and until now, a standardized method has not been used routinely. Thus, this study aimed to evaluate the accuracy of the visual guide and anesthetist's eyeball estimation methods compared to the gravimetric method, which is considered the gold standard, in elective C/S cases.

Materials and methods

A cross-sectional study recruited 100 pregnant women who were scheduled for elective lower segment C/S (LSCS) under general anaesthesia at Hawler Maternity Teaching Hospital, Erbil, Iraq, from January 01 to November 01, 2021.

Inclusion criteria

Women with a singleton pregnancy and aged ≥18 years who are scheduled for elective C/S.

Exclusion criteria

Patients at risk of massive intraoperative hemorrhage, such as those with central placenta previa. Also, women with severe cardio-respiratory disease, recent myocardial infarction, stroke, chronic hypertension, eclampsia, preeclampsia, diabetes, anaemia, bleeding tendency, and emergency C/S.

Study protocol

The patients were seen on the morning of the surgery day and history was taken using a self-developed questionnaire that included patients' age, obstetrical characteristics (gravidity, parity, gestational age, and previous LSCS delivery), and fetal and newborn characteristics (fetal presentation, indications of C/S, birth weight, and gender). Methods of intraoperative blood loss estimation include: 1. Eyeball estimation,

which was done by an experienced anaesthetist who was asked at the end of the operation how much blood loss was suspected in milliliters (mL); 2. A visual guide method that is based on a pictogram showing standard gauze saturation levels. Initially, the amniotic fluid had been excluded from the field of surgery by careful suctioning using a sucker before its spillage to the operative field. Then, blood loss during surgery was estimated by visually measuring the percentage of soaked standard surgical packs (30 ×30 cm) and referring to it as EBL, using a pictogram approved by the Louisiana State University Health Sciences Centre Institutional Review Board(14). As shown in Figure 1, 25 mL of blood was absorbed by 50% of the pack surface area, then 50 mL of blood was absorbed by 75%, and the whole surface absorbed 75 mL of blood, and 100 mL of blood was absorbed and dripped from the pack. In this case, the EBL was 250 mL(14); 3. Gravimetric method, in which the blood-soaked surgical swabs were weighed, and the difference from dry weight was recorded. Briefly, the leading researcher weighed dry packs (30 × 30 cm) before the operation (20.4 g) and at the end of the operation, all soaked packs were weighed, then the weight of dry packs was subtracted from that of soaked packs. The scrub nurse was instructed to dry up the blood in the surgical field with the weighed swabs. The placenta was not considered in the calculations, and amniotic fluid was carefully excluded to minimize error.

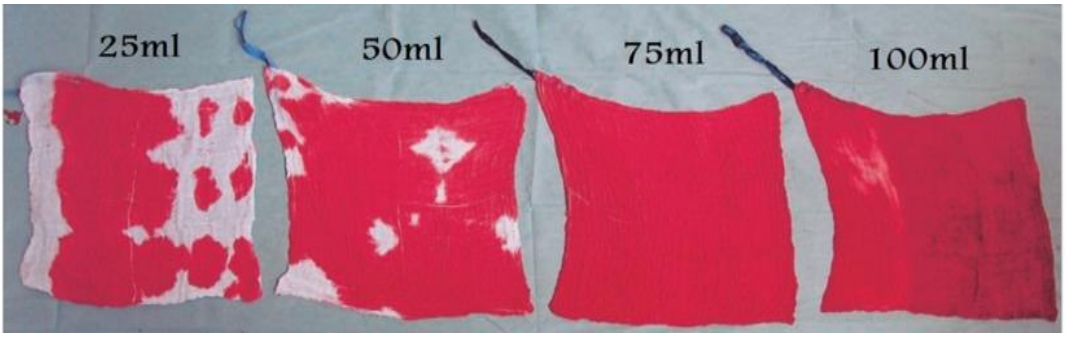

Figure 1. Estimating the blood sock of 30 × 30 cm surgical packs.

Data analysis

Data were analyzed using the Statistical Package for Social Sciences (IBM, Chicago, USA, version 25). Student's t-test (unpaired t-test) was used to compare the means of two samples. One-way analysis of variance (ANOVA) was used to compare the means of three categories. Pearson correlation coefficient (r) was calculated to assess the strength of correlation between two numerical variables. A $p \leq 0.05$ was considered statistically significant.

Results

The mean age of the patients was 31.3±6.2 years, ranging from 19 to 43 years. The most significant proportion (73%) were aged 20-35 years, had a gestational age of 37-38.6 weeks (60%), were multiparous (88%), and had two previous C/S (35%) (Table 1).

Table 1. Basic characteristics of the studied samples.

Variable	Number	Percentage
Age (Years)		
<20	1.0	1.0
20-35	73	73.0
>35	26	26.0
Gestational age (Weeks)		
37-38.6	60	60.0
39-40.6	39	39.0
≥ 41	1.0	1.0
Parity		

Primigravida	10	10.0
Multipara	88	88.0
Grand multipara	2.0	2.0
Previous Caesarean Section		
0	17	17.0
1	25	25.0
2	35	35.0
3	17	17.0
4	6	6.0
Total	**100**	**100**

Additionally, there was a strong, positive, and significant correlation (p<0.001) between each of the three methods (Table 2, Figure 2).

Table 2. Correlation between the three methods of assessment.

Variable Y	Variable X	r	p-value
An anesthetist's eye ball Estimation	Gravimetric measurement	0.988	<0.001**
Visual guide Estimation	Gravimetric measurement	0.986	<0.001**
Visual guide Estimation	Anaesthetist eyeball estimation	0.995	<0.001**

**Highly significant difference

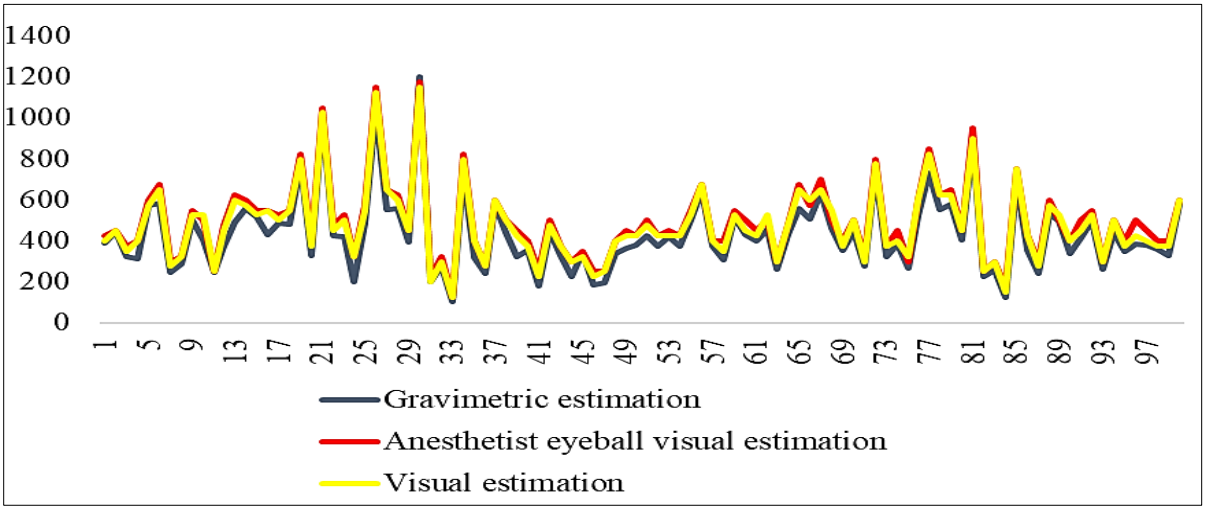

Figure 2. Blood loss in each patient was assessed using three methods of estimation.

The mean of EBL by the gravimetric method (433.8±184.5 mL) was significantly (p<0.001) less than that by the anaesthetist estimation (492.5±188.2 mL) and by the visual guide estimation (478±185.2 mL). A significant (p<0.001) difference was detected between the means of EBL by the anaesthetist and visual guide estimations (Table 3).

Table 3. Mean blood loss as estimated by three different methods.

Estimation of Blood Loss	Mean±SD	p-value
Gravimetric measurement	433.8±184.5	
Anaesthetist eyeball estimation	492.5±188.2	<0.001**
Gravimetric measurement	433.8±184.5	

Visual guide estimation	478.0±185.2	<0.001**
Anaesthetist eyeball estimation	492.5±188.2	
Visual guide estimation	478.0±185.2	<0.001**

The mean blood loss of women aged >35 years (523.8±209.1 mL) was significantly (p=0.003) higher than that of those aged ≤35 years (402.2±165.2 mL). No significant (p=0.074) difference was detected in the mean blood loss of women with a gestational age of 37-38.6 weeks (459±204 mL) and ≥39 weeks (396±145.1 mL). The mean blood loss of multiparous women (444.4±101.0 mL) was significantly (p=0.001) higher than that of primigravida women (338.7±69.9 mL). No significant association was detected between the mean blood loss and the fetal presentation (p=0.803) (Table 4).

Table 4. Mean gravimetric measurement of blood loss through different variables.

Variable	Number	Gravimetric Estimation (Mean±SD)	p-value
Age (Years)			
≤ 35*	74	402.2±165.2	0.003#
> 35	26	523.8±209.1	
Gestational Age (Weeks)			
37-38.6	60	459.0±204.0	0.074
≥ 39**	40	396.0±145.1	
Parity			
Primigravida	10	338.7±69.9	0.001##
Multipara***	90	444.4±190.4	
Fetal Presentation			
Cephalic	76	427.0±167.3	
Breech	20	457.5±254.0	0.803
Transverse	4	444.4±101.0	

*Only one patient aged <20 years, **Only one patient had a gestational age of ≥41 weeks, ***Only two patients were grand multiparous. #: Significant difference, ##: High Significant difference

Discussion

Obstetrical blood loss is one of the preventable causes of maternal mortality and morbidity, which is constantly increasing. Accurate measurement of lost blood is critical to early detection(15). Accordingly, we employed various methods for estimating blood loss during elective LSCS and compared them to determine which one is most suitable for practice in our locality. The current study indicates that all three methods yielded closely aligned results, with minimal differences in EBL values. We considered weighing of packs (gravimetric method) as the gold standard for comparative reasons because it practically shows the actual value, which neither depends on hypothetical value (as in a mathematical model), nor on personal bias (as with visual estimation). It has been widely endorsed as a gold standard in the literature, such as Doctorvaladan et al (15). and Lilley et al (16), due to its practical accuracy and consistency in quantifying actual blood loss. To enhance the validity and accuracy of the pack weighing method during the study, the amniotic fluid was carefully suctioned using a sucker to prevent contamination with blood. This allowed the difference in weight between wet and dry packs to be attributed to the blood contamination. In this regard, Withanathantrige et al (17). also noted that the amount of amniotic fluid absorbed by surgical packs does not contribute to the difference found between intraoperative blood loss, which is measured by more than one method. In this study, the results of EBL by visual guide estimation were closely matched to those of the gravimetric method. The anesthetist's estimations were also comparable. The superior accuracy of the visual guide method may be attributed to the

researcher's prior training, including two weeks of practical experience in using the Dildy III pictogram, which is approved by the Louisiana State University Health Sciences Centre Institutional Review Board[14]. Gari et al(2). concluded that the blood loss Pictogram for Visual BLE in C/S is a simple and easy tool that can significantly improve visual acuity for estimating blood loss during C/S.

Visual estimation is person-dependent, so it needs training programs to enhance the ability of operating room staff to estimate blood loss. Many centers around the world set up training sessions to improve the accuracy of visual estimation. Dildy III et al. suggested training sessions to reduce errors(14). Further analysis in this study confirms that the anesthetist's estimations during elective C/S were very close to those measured by the gravimetric method. This supports findings from Athar et al., who reported that visually EBL, whether by nurses, obstetricians, or anesthetists, generally falls within an acceptable range[18]. They also noted that anesthetists' estimations were reliably close to gravimetric measurements, a finding also observed in this study. This might be due to the anesthesiologist's daily exposure to bloody surgical fields and various operations, enabling them to provide an accurate estimate of blood loss. The present study focuses on elective C/S, where clinical conditions are more controlled, which may have contributed to this consistency. In contrast, Bell et al(19). reported that visual estimation tends to underestimate blood loss by approximately 30% compared to gravimetric measurement, irrespective of their experience, especially during vaginal deliveries. The discrepancy may be due to differences in delivery type and methodological variations.

Moreover, in the current study, the mean blood loss for fetal breech presentation and for transverse presentation was more than the blood loss in cephalic presentation. Similarly, Leblanc et al. observed that C/S blood loss was higher for fetal breech presentations than for cephalic presentations. This difference could be attributed to the greater technical difficulty encountered during transverse and breech deliveries, which are more traumatic than those involving cephalic presentations(20). The current study also found that the mean blood loss of women aged >35 years was significantly higher (523.8±209.1 mL) than the mean blood loss of women aged ≤35 years (402.2±165.2 mL), which agrees with Yoong et al (21). who prospectively studied the effect of 13 potential risk factor on blood loss during C/S and found that age of >35 years, low lying placenta, and previous C/S were significant independent risk factors for increase blood loss during C/S. Dildy III et al. reported that blood loss in large quantities was usually under-estimated and in small amounts was over-estimated(14). However, in this study, only three patients had bleeding and blood loss of >1000 mL, in which two of them were overestimated by the anaesthetist and one of them was underestimated by the principal researcher. These results may be because the number of patients who lost >1000 mL of blood was low.

The limitations of this study included a small sample size due to the nature of the study, as we included only elective C/S which is usually low in number, as well as the study was conducted in a single-center. Thus, we recommend a multicenter study with a larger sample size and including all types of C/S deliveries to avoid bias and obtain more accurate results.

Conclusions

Visual guide, anaesthetist eyeball, and gravimetric method were close to each other for measuring blood, even though the visual guide and eyeball methods were slightly higher than the gravimetric measurement, but couldn't lead to error in clinical judgment, such as over-transfusion or unrecognized massive maternal hemorrhage. Thus, the visual estimation method, especially with training and standard pictograms, is an effective and practical alternative to the gravimetric technique for estimating intraoperative blood loss during elective C/S. Incorporating these methods into clinical practice can enhance timely decision-making and improve patient outcomes.

Ethical Considerations

The study protocol was ethically approved by the Iraqi Board for Medical

Specializations (Baghdad, Iraq), the Scientific Council of Obstetrics and Gynaecology, and the Hawler Health Directorate, Erbil, Iraq. Written informed consents were obtained from each participant before starting the study, and their confidentiality was preserved.

Availability of data and materials

The datasets are available from the corresponding author upon reasonable request.

Competing interest

The authors declare that there is no conflict of interest

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Authors' contribution

EAAA: Study registration, methodology, data collection, data analysis, and writing of the original manuscript, SKA: Conceptualization, study admission, validation, supervision, edition and revision of the drafted manuscript. Both authors agreed to this submission.

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