Assessment of Blood Loss During Cesarean Section Under General Anesthesia and Epidural Analgesia Using Different Methods

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ABSTRACT

Obstetric blood loss is usually a big issue when dealing with obstetric morbidity and mortality. Blood loss during cesarean section (CS) is usually underestimated; therefore this study addressed that problem by comparing 3 different methods for assessment of blood loss during cs under general anesthesia and epidural analgesia. The study included 100 informed and consented full-term pregnant women undergoing elective cs fulfilling the inclusion criteria. Intraoperatively, for each patient blood loss was assessed by : subjectively by visual estimation by the attending staff (obstetrician, anesthetist and the scrub nurse),by weighing of blood-soaked surgical swabs and by calculation using the formula described by Bourke & Smith (15).The results showed that visual estimation of blood loss gave the lowest estimated value while the calculation gave the highest estimate of blood loss. Anesthetists gave more accurate visual estimation of blood loss than obstetricians, while scrub nurses gave the lowest estimation. Past history of cs ,breech presentation, placenta previa and manual separation of the placenta were associated with more blood loss during cs. Neither the type of anesthesia nor the patients' parity had a positive correlation with blood loss while, the weight of the patient had a positive correlation with blood loss. Conclusively, the present study pointed out that calculation of intraoperative blood loss during cs was overestimated by the formula used and was underestimated visually by the obstetricians and scrub nurses involved. Reliably, anesthetists gave a close estimation to that obtained by weighing of swabs method. The study recommended spontaneous removal of the placenta to reduce intraoperative blood loss during elective cs.

INTRODUCTION:

Delivery by cesarean section (CS) is by far one of the most commonly performed obstetric operations all over the world[1]. Nevertheless, it exposes women to the inherent risk of abdominal surgery; injury to the pelvic structures, infection and the need for blood transfusion[1]. Physiologically, towards the end of pregnancy, the uterus is perfused at a rate of 500-750 ml/min.[2], this massive hyper-perfusion results in an average blood loss of approximately 1000 ml during CS[3].

Many factors would be implicated to affect intra-operative blood loss during CS e.g. maternal causes; weight, parity, previous CS, fetal causes; multiple gestation, poly-hydramnious, malpresentation, technical causes; operative time, type of incision, placental separation technique, placental position and the type of anesthesia. Consequently, judicious estimation of operative blood loss during CS is crucially important in terms of decreased peri-operative morbidity and avoidance of the risks associated with unnecessary blood transfusion[4].

Intra-operative estimation of blood loss for CS is both poorly reproducible and typically an under-estimate[5].Therefore, comparison of surgical blood loss from one institution to another, or from one obstetrician to another is a difficult task.

Various studies had been undertaken to estimate intra-operative blood loss[6]. Visual estimation of blood loss by the operative staff is the prevalent method in spite of being claimed to be notorious by some investigators[7]. Nevertheless, visual estimation of blood loss was practiced not only by anesthetists but also by obstetricians[8], urologists[9], orthopedic surgeons[10] as well as nurses[11]. Dilution technique is another method developed by Tachoires et al[12] and was described as precise by the investigators. Indeed, estimation of blood loss was also done by atomic absorption spectrometry by Hall et al[13] which was

introduced for investigational purpose only. The photometric measurement of alkaline hematin was also another method used by some investigators but it proved to be cumbersome[14]. Many mathematical models have been suggested for calculation of blood loss e.g. the formula developed by Howe et al[10] which proved to be correlated with peri-operative hemoglobin. Another formula incorporating changes in hemoglobin and the number of blood units transfused was used by McCullough et al[9] to estimate blood loss during TURP (trans urethral resection of the prostate). None of the fore-mentioned methods of estimation of blood loss intra-operatively was reputed as "highly accurate".

Therefore, the purpose of the present prospective study was to compare three different methods of estimation of blood loss during CS :

1- Visual estimation by different operating room staff: the anesthetist, the obstetrician as well as the scrub nurse would estimate the loss by careful observation of the operative field during surgery and report it at the end.
2- Weighing of dry and wet surgical swabs before and at the end of surgery and the difference would be the blood absorbed by the swabs.
3- Application of Bourke and Smith equation[15] which is one of the acceptable formulae to calculate the intra-operative blood loss utilizing pre-operative and post-operative hematocrit values. Also, the study compared the blood loss during CS under both general anesthesia and epidural analgesia. The influence of some parameters (previous CS, parity, operative time, placental position, placental separation) on intra-operative blood loss was also tested.

MATERIAL& METHODS :

After approval of the Hospital Medical Committee, this study was conducted at United Doctors Hospital-Jeddah. It included 100 consecutive full-term pregnant females scheduled for elective lower transverse cesarean section (CS)i.e. no emergency CS's were included. The study was stopped when the pooled number reached the target i.e.100 cesarean sections. The involved subjects were informed and consented to be enrolled in the study. Only non-laboring women undergoing elective CS were eligible for the study when they sign the consent. Exclusion criteria included: abruptio placenta, any cause of ante-partum hemorrhage, pre-eclampsia, eclampsia, and patients in trial for labor ended by a CS decision.

After thorough history taking and clinical examination, cesarean sections were performed under general anesthesia (GA) or epidural anesthesia (EA) according to the patient's desire. No premedication was given.

Patients undergoing CS under GA were pre-oxygenated with 100% oxygen for 2 minutes via face mask before induction. GA was induced with propofol 2 mg/Kg. and succinylcholine 1 mg/Kg. to facilitate intubation, followed by i.v. atracurium to maintain relaxation. Patients were ventilated with 50% N2O in oxygen and 2% sevoflurane. After delivery of the baby anesthesia was maintained with 1.2% sevoflurane and 50% N2O in 50% oxygen with the addition of 100 micgm. Fentanyl i.v. for analgesia. Throughout the operation the Bispectral Index (BIS) was used and the BIS value was kept < 60 to avoid intra-operative awareness. At the end, inhalation agents were shut off and muscle relaxation was reversed by glycopyrrolate 1mg.and neostigmine 2.5mg.and extubation was performed when BIS value > 80.

Monitoring of patients under GA included: ECG, SaO2, non-invasive ABP measurement, end-tidal CO2, end-tidal N2O and sevoflurane by a gas analyzer (Datex-Ohmeda, Aestiva 5, CA, USA) and BIS (Aspect Medical System, Natick, MA, USA).

For patients undergoing CS under epidural anesthesia, an epidural catheter (Braun, Melsungen -Germany) through a Toughy 16-G needle was sited at L3-4 level in sitting position. A test dose of 3 –ml. 2% lidocaine was injected into the catheter followed 5 minutes later by 10 ml. marcaine 0.5% mixed with 10 ml. 2% lidocaine and 50 micgm. Fentanyl. Then patients were placed in the semilateral position with a wedge under the right hip and received infusion of Ringer's lactate solution 500 ml.

fast drip to be followed by another 500 ml. slower drip during the period between insertion of the epidural catheter and the start of surgery. Patients receiving EA were monitored exactly as those receiving GA except for end-tidal gas concentrations and BIS. Non- invasive blood pressure and heart rate were measured 1, 3 and 5 min. after induction of GA or every 5 min. interval after starting EA and 5min.-interval thereafter during surgery.

After delivery methergin ergomatrate (Novartis) 0.2 mg. as a single intramuscular injection was given after removal of the placenta. All patients (whether under GA or EA) received oxytocin (Novartis Pharma, Basel, Switzerland) 20 units mixed with 500 ml. Ringer's lactate solution. Total intravenous fluids during surgery would be restricted in patients undergoing epidural block to 1500 ml. for the study purpose. However, in case of hemodynamic instability –in both groups- necessitating fluids more than designated volumes, patients would be dealt with properly and would be excluded from the study later on. Intra-operative blood loss was estimated by 3 different methods for each case:

1st method : is the visual estimation method in which after skin closure the anesthetist, the obstetrician as well as the scrub nurse were asked to estimate- according to what they notice during surgery-how much blood the patient lost in ml. The recorded values were kept with the circulating nurse.

2nd method: is the mathematical calculation in which the lost blood intra-operatively would be estimated by measuring the hematocrit (Hct) immediately after hospital admission and one hour post-operatively in recovery room. The blood loss would be calculated according to the following formula:

Blood Loss = Blood Volume. In (Hct 1 / Hct 2)[15]

Where:

Blood volume = Body weight. 70 ml./Kg.

Hct 1 is the initial pre-operative hematocrit.

Hct 2 is the 1-hour post-operative hematocrit.

3rd method : is swab weighing in which the circulating nurse would measure the weight of the dry surgical swabs (ideally,28 gm. for each 20 by 20 inches abdominal swab and 4 gm. for each 4 by 4 inches swab) i.e before use and to be measured wet or soaked with blood after use. The weight difference would be nearly the lost blood taking into consideration that 1 gm. blood would be equal 1 ml. blood. The scrub nurse would be instructed to dry up all blood in the surgical field by the weighed swabs and no suction would be used except when necessary and in such a case, the collected blood in the suction bottle would be added to the blood in swabs. A highly accurate digital balance (Soehnen-Basel-Switzerland) would be used to measure the weight in grams. Care would be exercised to collect most -if not all- the amniotic fluid in a separate suction bottle. Also, the placenta would not be considered into the calculations for all patients. The circulating nurse was the one responsible for weighing, recording and keeping all the concerned data.

Besides the demographic data (age, weight, parity and history of previous CS), the following would be recorded: mean arterial blood pressure, pulse rate,SaO2,EtCO2,blood loss by the three previously described methods and some operative data; placental position, mode placental separation, incision-delivery time, operative time, and fetal head position. Discrete data were analyzed with analysis of variance test (ANOVA) while continuous variables were analyzed with unpaired Student t- test. A correlation coefficient was done between blood loss and some variables too.

RESULTS

This study included 100 consecutive term pregnant patients undergoing elective CS, their age ranged from 19-47 years with a mean of 30.6±6.0 years, the mean weight was 78.5±13.9 kg., while the mean parity was 2.1±1.8 baby. Fifty-eight patients had no history of previous C.S. while 42 patients had from 1-3 or more previous CS. The operative time ranged from 30- 90 min. with a mean of 50.9±14.8 min. while incision delivery time was 151.6±60.2 sec. General anesthesia was conducted for 78 patients while 22 patients (22.0%) asked for epidural anesthesia. Cephalic presentation was met

in 94 patients and 6 patients had breech presentation. The placenta was anterior in 92 patients and was previa in 8 patients, also spontaneous placental separation was experienced in 64 patients, while it was manually separated in 36 cases (Table 1).

The present study was carried out by a medical team included: 6 anesthetists (1 consultant and 5 registrars), 7 obstetricians (4 consultants and 3 registrars) and 6 nurses (4 scrub nurses and 2 circulating nurses).

The mean blood pressure (MBP) showed a significant increase in GA group after intubation, whereas after removal of the placenta MBP dropped in GA group more significantly than the drop in EA group (p= 0.01).

The mean pre-operative hematocrit was 37.07± 2.85 and dropped to a post-operative value of 32.55± 2.75, therefore the mean hematocrit difference was 4.5+/-1.13 table (2).

The visually estimated blood loss by obstetricians was 539.0±147.2 ml while that estimated by anesthetists was 560.0±143.2 ml., and finally the blood loss as estimated by nurse was 493.4±127.2 ml. There was a significant difference between the three estimated values (p=0.01). However, there was significantly lower estimation by nurses than by both obstetricians and anesthetists, while there was no significant difference between estimations done by obstetricians or anesthetists table (3).

Table (1): Distribution of the studied sample regarding demographic & operative data.

Variables	
Age (years)	
Range	19-47
Mean ± S.D.	30.6±6.0
Weight (Kg.)	
Range	52-115
Mean ± S.D.	78.5±13.9
Parity	
Range	0-10
Mean ± S.D.	2.1±1.8
Previous C.S.	
No	58 (58.0%)
Once	26 (26.0%)
Two	10(10.0%)
Three or more	6 (6.0%)
Operative time (min.)	
Range	30-90
Mean ± S.D.	50.9±14.8
Incision-Delivery time (sec.)	
Range	60-300
Mean ± S.D.	151.6±60.2
Anesthesia type	
Epidural	22 (22.0%)
General	78 (78.0%)
Head position	
Cephalic	94 (94.0%)
Breech	6 (6.0%)
Placental position	
Anterior	92 (92.0%)
Previa	8 (8.0%)
Placental separation	
Spontaneous	64 (64.0%)
Manual	36 (36.0%)

Table (2): Hematocrit values& Blood loss estimated by different methods (ml.)

	Range	Mean ± S.D.	P
Hematocrit values for all patients			
Pre-operative	31.2-41.6	37.05±2.85	
Post-operative	27.3-38.2	32.55±2.75	
Difference	3.9-3.2	4.50±1.13	
Visually estimated blood loss			
Obstetrician	250-900	539.0 ±147.2	0.01*
Anesthetist.	350-1000	560.0 ±143.2	
Nurse	250-800	493.4 ±127.2	
Blood loss estimated by:			
1- Average visual method	333-800	528.9 ±114.6	
2- Weight of swabs	306-1147	577.7 ±186.7	0.002*
3- Calculation	66-1290	627.0 ±180.6	

Table (3): Comparison between blood loss (ml.) calculated by weighing swabs and that estimated by operative team members.

	Range	Mean ± S.D.	p
Blood loss calculated by:			
Weight of swabs	306-1147	577.7±186.7	
Estimated blood loss			
Obstetrician	250-900	539.0±147.2	0.046*
Anesthetist.	350-1000	560.0±143.2	0.32
Nurse	250-800	493.4±127.2	0.01*

Table (4): Relation between blood loss (by weight of swabs) and some variables.

	Blood loss (ml.) Mean ± S.D.	P
Previous C.S.		
No	550.2±181.4	0.042*
Yes	615.7±191.6	
Type of anesthesia		
General	572.6±171.6	0.21
Epidural	595.8±241.7	
Fetal presentation		
Breech	586.34±188.02	0.012*
Cephalic	443.0±110.0	
Placental position		
Anterior	560.8±171.4	0.001*
Previa	772.8±271.7	
Placental separation		
Spontaneous	544.7±178.2	0.024*
Manual	595.4±205.7	

Blood loss estimation showed a significant (p=0.002) difference between the three methods. The lowest estimated value was that of visual estimation and the estimated blood loss by the mathematical formula (calculated loss) gave the highest value table (2).

For comparison, weighing the swabs was considered the standard method of blood loss estimation in the present study. Accordingly, it was found that there was a significant difference between both the obstetricians (p=0.046) and nurse (p=0.01) estimated values for blood loss when

compared to values of blood lost by swab weighing. Surprisingly, no significant difference was observed between the anesthetists estimation and that of swab weighing (p=0.32) (Table 3). So, blood loss estimation by the anesthetists-in this work- was the closest estimation to that estimated by weighing the surgical swabs.

Table (4): show a significant increase in blood loss for patients with past history of C.S (p=0.42). also there was a significant increase of blood loss also when the presenting part was the breech. There was a highly significant increase of blood loss when the placental position was previa (p= 0.001) and when it was separated manually (p=0.024). Anesthesia type, whether general or epidural, did not result in significant increase in blood loss as estimated by weighing of swabs in this study (p=0.21). Also, no significant difference was noted when blood loss (estimated by swab weighing) was correlated to age, parity, OR time, ID time. Nevertheless, body weight of the patients had a significantly positive correlation with estimated blood loss (p=0.002) while parity had a non-significant negative correlation with estimated blood loss (p = 0.070).

DISCUSSION

Obstetric blood loss is a major cause of maternal mortality and is unfortunately always under-estimated and consequently inadequately replaced[16]. Cesarean section is specially associated with varying degrees of blood loss[17].

In the present study, blood loss is significantly under-estimated when assessed visually by both obstetricians and scrub nurses, whereas –anesthetists- regardless the expertise- were able to give the closest figures to that of blood loss assessed by swab weighing method.

Actually, we considered weighing of swabs is the gold-standard for comparative reasons because in fact it represents a practically real value which is neither dependent on personal bias (as in visual estimation) nor dependent on hypothetical values (as with mathematical models).Not only in this study, but also Prasertcharoensuk et al[18] considered it a gold-standard against which they compared other methods of determination of blood loss during CS. To add more accuracy and credibility of swab weighing method during the present work, the amniotic fluid was aspirated separately to avoid mixing with blood swabbed away. So, the difference in dry and wet swab weighing could be confidently attributed to blood soiling only. Additionally, Ramadani[1] suggested that the amount of amniotic fluid absorbed in surgical swabs did not contribute to the difference found between intra-operative blood loss measured by more than one method[19]. In the present study, obstetricians gave significantly lower estimation of blood loss (mean 539 ml.) with a wide range of estimation. This finding was similar to Villeneuve et al[13] who found that some obstetricians assessed blood loss during CS as low as mean 579 ml. Expectedly, obstetricians vary with their experience and consequently their assessment as mentioned in different studies[4,20]. Duthie et al[8] confessed that obstetricians' error in estimating the volume of blood loss was specially high if the measured blood loss was over 600 ml. On the other hand, nurses in the present work significantly under-estimated blood loss (mean 493 ml.). Here the wide range of estimation noted could be attributed to the difference in experience in OR because the pool nurses we had actually, had different levels of experience. On the contrary, in an attempt to measure the nurses accuracy of estimation of blood loss, Higgins[11] found that 71% of his sample nurses over-estimated and 25% under-estimated blood loss. He found also that nurses had significant difficulty in estimating very small and very large amounts of blood, and nurses were consistent in estimating repeated samples with the same amount of blood. He concluded that neither education, nor years of experience could make any difference, contrary to our findings in this work. Another study made by Glover[21] tested midwives experience in estimating blood loss during normal delivery came to the conclusion that they under-estimated blood loss by 30-50%. Visual estimation of blood loss during CS –in the present work- appeared to have high accuracy in essence of anesthetists' evaluation without significant difference with what estimated by swab weighing. Being daily exposed to

bloody surgical fields for repeated times with different procedures made anesthetists more able to give a precise estimated figure for blood loss. In disagreement with that McCullough et al[9] concluded that anesthetists under-estimated visually blood loss during TURP as well as urologists. Actually, the operative situation is different in TURP from CS where in TURP the irrigating solution and its absorption make estimation more difficult. Also, being open field makes blood loss during CS more easily estimated. So, visual estimation of blood loss as a method -whether average or by single OR staff except for anesthetists- tends to under-estimate blood loss which could affect consequent management and accordingly the morbidity[17]. Different parameters have been used as variables to estimate intra-operative blood loss using mathematical models. Hemoglobin concentration[10], hematocrit level[15], body weight, and number of units transfused[9] too. In the present work Hct level was used together with body weight as variables in the mathematical equation adopted. The mean Hct drop was 4.5% which was close to what reported by Combs et al[22] who had a mean drop of Hct (difference between preop. and 3rd day postop. Hct) of 4.2%, also Andrews et al[23] reported a Hct difference of 5% in his work, whereas Vimala et al[4] noticed a 10% drop in Hct post-cesarean occurring in approximately in 6% of CS patients only. Methodologically, post-operative Hct in the present work was measured one hour postoperatively to reflect strictly the intra-opertive blood loss only.

In fact in our work, using Bourke & Smith formula[15] resulted in insignificant over-estimation of blood loss during CS, which was also claimed to be a disadvantage of most of the formulae suggested for calculation of blood loss as Bourke and Smith[15] concluded. Brecher et al[5] also found that blood loss calculated using Hct as a variable gave an average 2.1 times overestimation of intra-operative blood loss compared to visual estimation by anesthetists. Many drawbacks of mathematical calculation of blood loss by different formulae have been explored for example:

1- Using body weight as a basic multiplication factor in most of the equations proved to be misleading specially when taking into consideration that full-term pregnant weight includes the weight of the baby and the amniotic fluid which ultimately increases body weight falsely.
2- Fransen et al[24] pointed out that the defect in the mathematical application lies in the fact that the use of Hct considerably over-estimates blood loss and erythrocytic volume appeared to be a more appropriate variable than Hct to measure blood loss.
3- Finally, Hahn[25] found that all the theoretical relationship between blood loss and changes in Hct used for the calculation assumed a strict normo-volemic situation which is difficult to maintain intra-operative. To avoid this bias of hemodilution in the present study the intra-operative fluids were limited to a standard 1 liter in CS under general and 1 1/2 liter in CS under epidural anesthesia. However, Horowitz et al[26] mentioned that although 2-3 liters of isotonic solutions were given during CS yet, no effect of hemodilution appeared on Hct levels which were consistently stable.

Regarding the type of anesthesia, in the present work no significant difference in blood loss between GA and EA groups was found. Although from the hemodynamic point of view, mean blood pressure showed significantly lower figures in EA group after injection of bolus local anesthetics and after delivery while it was significantly lower in GA group after placental removal. These results implied a lower potential for blood loss in EA than during GA which was not the case.

Differently, many investigators documented the more blood loss during CS under GA than under EA[23,27,28] most of them attributed the difference to the use of halogenated agents during GA which can interfere with uterine contractility and hence increase the potential for blood loss during CS. Gilstrap et al[29] estimated 8% difference between pre and postoperative Hct when only 0.5 vol.% halothane was used. However, we used sevoflurane in our study which is less tocolytic than halothane

at 1MAC level[30] which might contribute to the less blood loss noticed in GA group. Lao et al[28] studied blood loss in pre-term CS and found that GA was associated with more blood loss than EA because of the less adequately formed lower segment, the more vascularity of that segment and the less responsive uterus to oxytocin-due to less number of oxytocin receptors[31]. Nevertheless, in our study we included only the full-term CS patients. Finally, Andrews et al[23] argued how patients undergoing CS under EA lost less blood than GA patients. He stated that EA patients received large volumes of intra-operative fluids, which theoretically could increase the influence of hemodilution resulting in lower post-operative Hct levels. Alternatively, hemodilution might have resulted in a reduction of the actual erythrocyte mass subsequently lost. Additionally, functional sympathectomy during EA may cause pooling of blood in capacitance vessels decreasing the amount of blood available for loss.

Other variables studied included the history of previous CS which was associated with a significantly higher blood loss than patients without previous CS. Also, CS for fetal breech presentation showed higher blood loss than CS for cephalic presentation which could be explained by the more technical difficulty faced during delivery of the breech which is more traumatic than delivery of the head first. Clearly, CS for placenta previa was significantly associated with more blood loss than other placental positions. However, in the present study patients with placenta previa under EA lost more blood (mean 972 ml.) than under GA (mean 614 ml.) which may be explained by the longer time taken for the establishment of the epidural block and the uterine congestion - due to sympathectomy- noticed by the obstetricians during the study.

One more variable studied was the mode of placental separation during CS. In the present study, manual separation resulted in more blood loss than spontaneous delivery of the placenta which was statistically significant. On the contrary Gol et al[19] reported no greater risk of blood loss with patients for CS with manually removed placenta (mean 598 ml.) than spontaneously delivered placenta (mean 626 ml.) Ramadani[1] in his study found a significant drop of hemoglobin level after CS in which the placenta was removed manually than spontaneous removal group. He added that former studies reported higher operative blood loss in patients who had placenta removed by hand traction[32].McCurdy et al[33] concluded that manual shearing of the placenta from the decidua basalis layer before significant involution of the implantation bed, theoretically may result in unaltered perfusion to this area and an increase in blood loss.

Lastly, in this study age, parity, OR time and ID time all had no significant impact on blood loss during CS. Ohkuchi et al[34] when prospectively studied the effect of 13 potential risk factor on blood loss during CS found that low lying placenta, previous CS and age above 35 years all were significant independent risk factors for excess blood loss during CS. Meanwhile, the weight of the patient showed a positive correlation with the amount of estimated blood loss by weighing of swabs. The same positive correlation could be expected –although not performed in the study-when calculated blood loss was correlated with weight since the body weight was a determinant factor in the used equation.

Conclusively, the present study showed that calculation of intra-operative blood loss during CS was over-estimated by the formula used and was under-estimated visually by the obstetricians and scrub nurses involved. Reliably, anesthetists gave the closest estimation to that obtained by weighing of swabs method. The study also pointed out that the anesthetic technique - whether general or epidural- for CS had no influence on blood loss. The study recommended spontaneous removal of the placenta to reduce intra-operative blood loss during elective CS.

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