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Impact of body mass index, waist circumference and Pfannenstiel site tissue thickness, and elastosonography on operative parameters

Serap GÜLTEKİN[1], İsmail Burak GÜLTEKİN[2,*], Zehra YILMAZ[2], Bilal İÇER[2], Afra ALKAN[3], Tuncay KÜÇÜKÖZKAN[1]

[1]Department of Radiology, Faculty of Medicine, Gazi University, Ankara, Turkey

[2]Department of Obstetrics and Gynecology, Dr. Sami Ulus Women's and Children's Health Training and Research Hospital, Ankara, Turkey

[3]Department of Biostatistics, Faculty of Medicine, Yıldırım Beyazıt University, Ankara, Turkey

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Background/aim: This study aimed to evaluate the impact of body fat distribution measured by body mass index (BMI), waist circumference (WC) and Pfannenstiel incision site tissue thickness, and elastosonography on bleeding and operation time during cesarean delivery.

Materials and methods: A prospective study was made of 52 healthy, term pregnant women with prior cesarean deliveries. The impact of BMI, WC, incision site thickness, and elastosonography on preoperative and postoperative differences in hemoglobin (Hb) and hematocrit (Htc) levels and operation times was evaluated.

Results: A moderate negative relationship was found between Htc levels and WC. Htc levels were found to decrease by 0.148 units for each 1-cm increase in WC. Skin-to-fascia time was found to increase by 0.697 s with each 1-unit increase in BMI, whereas fascia-to-uterus time was found to increase by 1.117 s with each 1-cm increase in Pfannenstiel site tissue thickness. None of the elastosonographies or differences in Hb levels were found to be significant for any parameter.

Conclusion: Each of the evaluated parameters was found to have an impact on different factors: WC on Htc levels, BMI on skin-to-fascia time, and Pfannenstiel tissue thickness on fascia-to-uterus time.

Key words: Body mass index, elastosonography, operative parameters, Pfannenstiel incision, waist circumference

1. Introduction

Cesarean section is the most common major operation performed among women of reproductive age and has seen a dramatic increase worldwide over the last decade, particularly in developing countries such as Turkey (1). Repeat cesareans involve a more difficult surgery due to problems with adhesion and other intraoperative complications such as bleeding. As a result, many improvements to the techniques used in surgery and anesthesia have been suggested. Although it is a relatively safe and easy procedure, the rate of cesarean deliveries is far too high compared to other major gynecological operations. Thus, the identification of factors affecting morbidity would be valuable in this regard.

The Pfannenstiel incision was first described in 1900, and it became the incision of choice for almost all cesarean deliveries and a variety of other gynecological surgeries. The technique offers a variety of advantages, including a more aesthetic cosmetic appearance, less postoperative pain, rapid recovery, and lower incisional hernia rates (2). There have been various studies evaluating complication rates, bleeding levels, operative times, and adhesion formation related to Pfannenstiel incisions (3). Maternal morbidity and complication rates are even more pronounced in repeat cesarean deliveries, especially after a third operation (4). Maternal obesity has been found to be one of many factors related to increased complication rates, with preconceptional obesity, excessive weight gain during pregnancy, and obesity at time of delivery all being associated with adverse pregnancy outcomes and up to a twofold increase in cesarean delivery rates (5,6).

There are few studies addressing the association of maternal obesity with operation times. The vast majority of these studies used body mass index (BMI) for measuring maternal obesity. Both the total cesarean operation times and incision-to-delivery intervals were found to be increasing with increased BMI (7–9).

* Correspondence: burakgultekin@yahoo.com

There are various objective and quantitative methods for the evaluation of maternal obesity. The most commonly used methods are measurement of weight, BMI, and waist circumference (WC), all of which are practical and easy to use clinically, with WC having the additional advantage of adding the local fat distribution to the evaluation. We hypothesized that those with increased maternal weight were not a homogeneous group, and that the distribution of fat in the area of the body to be incised was a more significant determinant in the prediction of surgical complications. We proposed that local obesity, calculated from WC and tissue thickness at the site of the Pfannenstiel incision, and decreased tissue elasticity, measured by elastosonography, all had independent effects on the operative parameters of bleeding and operation times.

2. Materials and methods

2.1. Recruitment of participants

The study included 52 healthy, term pregnant women, all of whom had undergone previous cesarean deliveries and who were deemed eligible according to the inclusion criteria. All of the women were scheduled for cesarean deliveries in the gestational period of 38 weeks and 4 days to 39 weeks and 2 days. Only those women with singleton pregnancies in vertex presentation and with 1–3 prior cesarean deliveries, all carried out at our clinic, were included in the study. General anesthesia was given in all cases.

Those excluded from the study were patients requiring emergency cesarean deliveries and those with placenta previa, postpartum hemorrhage, nonvertex presentations, more than three prior cesarean deliveries, prior cesarean delivery carried out at another institution, or history of any abdominal surgery other than cesarean section.

In accordance with the Declaration of Helsinki, our study was approved by the Institutional Review Board of Keçiören Training and Research Hospital, Ankara, Turkey (IRB No. 11.02.2015/737), and informed consent was obtained from all patients.

2.2. Settings and measures

This prospective study was carried out at a tertiary referral hospital between May and July 2015. A surgeon with more than 10 years of experience in the field, who had not been informed of the study design, carried out all cesarean operations in the study with the intention of eliminating any possible differences in operation times related to the surgeon's practice and surgical technique. The elastosonographies were carried out by a single operator who was blinded to the study design.

The elastosonographic evaluations were carried out on the morning of the scheduled cesarean delivery, using the same commercially available ultrasound equipment (Hitachi RTE, HI VISION Preirus, Japan) and the same transducer (superficial probe with a frequency range of 6–13 MHz). Prior to the study, the inter- and intraobserver reproducibility of elastosonography was demonstrated in the measurements of 10 women with term pregnancies, where correlation coefficients of 0.618 and 0.652 for intra- and interobserver average measures were recorded, respectively. The elastosonographies were performed using a freehand technique (applying light repetitive compressions to the region of interest, each lasting around 1 s). The reference points were the tissue just below the skin at the site of the Pfannenstiel incision (circle A) and the subcutaneous tissue just above the fascia (circle B). Circles ranging from 3 to 5 mm were placed in the regions of interest, and strain ratios were calculated automatically by the sonographic equipment software (Figure).

BMI was calculated using the following formula: mass (kg)/(height (m)^2). WC was measured using a nonelastic tape at the point between the lower border of the rib cage and the iliac crest at the end of normal expiration. Both measurements were taken on the morning of the operation. The intraoperative Pfannenstiel incision site tissue thickness was measured in the neutral position of the tissue, without any stretching or application of pressure to the tissue. Standard scalpel handlers with horizontal notches on their metal bodies were used in intraoperative measurements. After the surgeon performed the skin incision until the level of the abdominal wall fascia, the scalpel handle was inserted perpendicular to the fascial plane. The notch on the scalpel handle at the level of the skin was noted. After the end of the operation, the corresponding notch was measured with a nonsterile standard ruler. For each case, three measurements were obtained, and the one with the highest value was recorded. The operation times were measured with an electronic chronometer by an obstetrics and gynecology resident who was involved in the study team. The blood samples for hemoglobin (Hb) assessment were taken on the morning of the operation for the preoperative Hb level and 24 h after the operation for postoperative Hb levels.

2.3. Statistical analysis

The relevance of the distribution of continuous variables such as age, WC, and maternal BMI were evaluated with a Shapiro–Wilk test, and all were found to be normally distributed. The continuous variables with normal distribution were expressed as mean ± standard deviation, while continuous variables, such as gravida and parity, were expressed as a median (IQR: interquartile range). Categorical variables such as wound infection were expressed as n (%). In order to determine the factors that may influence preoperative and postoperative differences in Hb and hematocrit (Htc), skin-to-fascia time, fascia-to-uterus time, and uterus-to-fetal extraction time, Pearson or Spearman correlation coefficients were calculated.

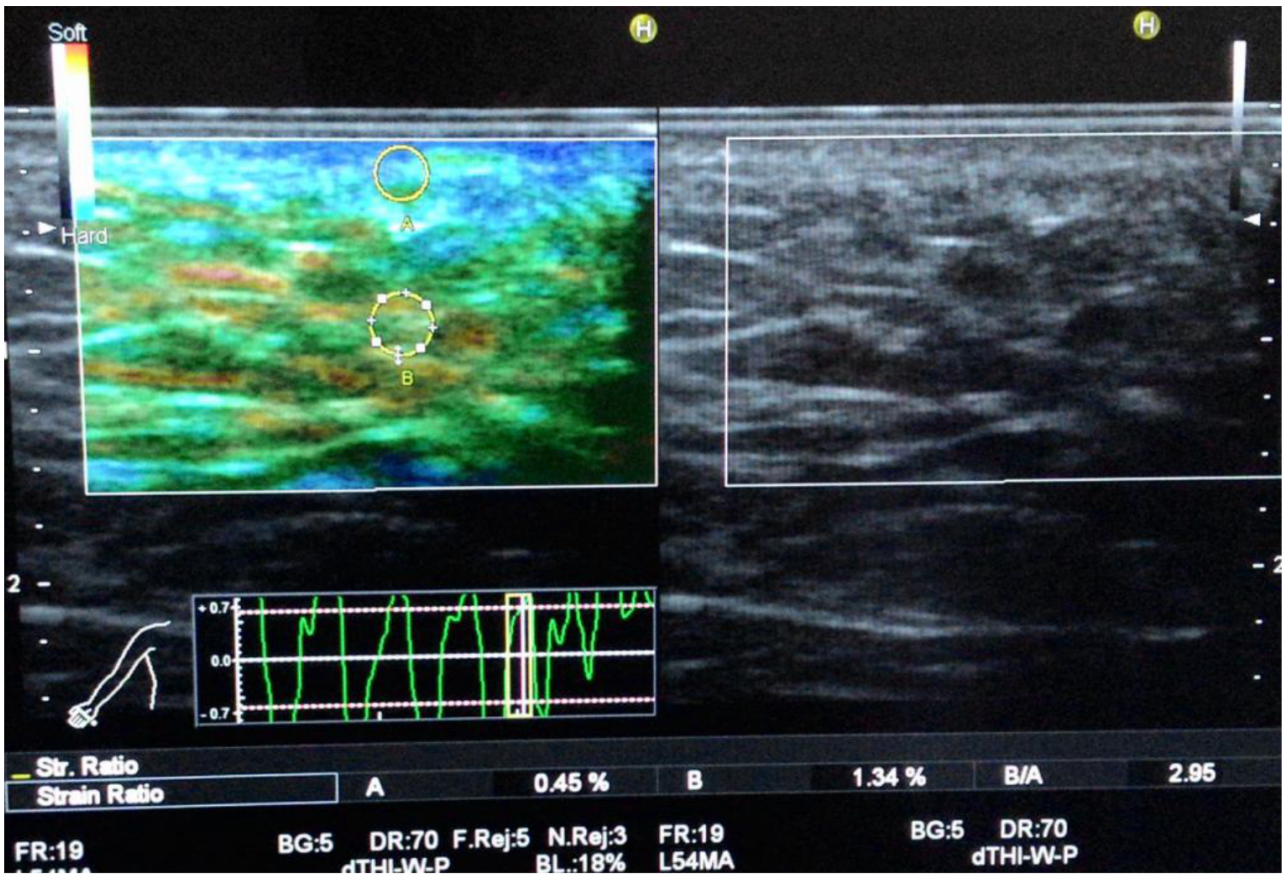

Figure. Elastosonographic measurements.

Stepwise linear regression analyses were carried out using independent variables correlated with the corresponding dependent variables. Regression coefficients with their standard errors, 95% confidence intervals (95% CI), F-statistics, adjusted coefficients of the determination of the model (R^2, adjusted R^2), and P-values were given.

Statistical analysis and calculations were performed using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY, USA).

3. Results

The mean age of the 52 women included in the study was 27.9 ± 4.8 years within a range of 19 to 38 years (Table 1). Of the total, one woman suffered a wound infection and another had a subcutaneous hematoma. No fetal complications were observed. The mean of maternal WC and BMI were 108.04 ± 6.80 cm and 30.84 ± 4.05 cm, respectively (Table 2).

Correlation analyses were carried out to define operation times (skin-to-fascia, fascia-to-uterus, etc.) and the preoperative and postoperative differences between Hb and Htc, taking into account all possible parameters that may affect them (maternal WC, BMI, Pfannenstiel site tissue thickness, and elastosonography). The difference in Hb levels was found to have no relationship with any of these parameters (Table 3), although a moderate negative relationship was found between Htc levels and WC ($r = -0.428$, $P < 0.05$). According to the stepwise regression analysis results, Htc levels decreased by 0.148 units for each 1-cm increase in WC ($\beta = -0.148$; 95% CI: −0.283 to −0.013) and WC was found to be responsible for a 14.8% difference in Htc levels (adjusted $R^2 = 0.148$, $P = 0.033$) (Table 4). Skin-to-fascia time was found to increase by 0.697 s with each 1-unit increase in BMI, and fascia-to-uterus time was found to increase by 1.117 s with each 1-cm increase in Pfannenstiel site tissue thickness (Table 4).

4. Discussion

The purpose of this study was to evaluate the effects of local body fat distribution and tissue elasticity at the site of a previous Pfannenstiel incision on the operative parameters of bleeding and operation times. It was hypothesized that both increased amounts of bleeding (evaluated from differences in preoperative and postoperative Hb and Htc levels) and operation times would be related to lower tissue elasticity at the Pfannenstiel incision site (evaluated by elastosonography) and to higher body fat distributed

Table 1. Demographic findings.

	Min.–max.	Mean ± SD Median (IQR)
Age (years)	19.0–38.0	27.9 ± 4.8
Gravida	2.0–6.0	3.0 (2.0)
Parity	1.0–3.0	2.0 (1.0)
Number of previous cesareans	1.0–3.0	1.0 (1.0)

Table 2. Distribution of variable parameters.

	Min.–max.	Mean ± SD
Waist circumference (cm)	93.00–123.00	108.04 ± 6.80
Maternal BMI	24.22–38.05	30.84 ± 4.05
Pfannenstiel tissue thickness (US) (mm)	15.60–38.30	24.07 ± 4.82
Pfannenstiel tissue thickness (op.) (mm)	17.00–41.00	26.88 ± 5.11
Pfannenstiel site strain ratio (B/A)	0.13–0.66	0.35 ± 0.14
Preop. Hb–postop. Hb (mg/dL)	1.40–2.00	0.76 ± 0.76
Preop. Htc–postop. Htc (mg/dL)	2.10–7.10	2.73 ± 2.35
Skin-to-fascia time (s)	10.00–28.00	17.04 ± 4.57
Fascia-to-uterus time (s)	58.00–106.00	82.08 ± 14.26
Uterus-to-fetal extraction time (s)	25.00–60.00	36.96 ± 7.98

Table 3. Correlation analysis (Pearson correlation coefficient).

	Preop. Hb–postop. Hb	Preop. Htc–postop. Htc	Skin-to-fascia time	Fascia-to-uterus time	Uterus-to-fetal extraction time
Number of previous cesareans[1]	–0.143	0.048	0.442*	–0.106	0.186
Waist circumference	–0.318	–0.428*	0.429*	–0.029	0.128
Maternal BMI	–0.086	–0.134	0.618***	0.161	0.277
Pfannenstiel tissue thickness (US)	–0.027	–0.036	0.510**	0.336	–0.085
Pfannenstiel tissue thickness (op.)	–0.073	–0.046	0.520**	0.400*	–0.039
Pfannenstiel site strain ratio (B/A)	–0.202	–0.203	0.370	–0.306	0.228

[1] Spearman rho coefficient, *P < 0.05, **P < 0.01,***P ≤ 0.001.

at or near the incision site (evaluated with measurements of WC and Pfannenstiel incision site tissue thickness). Contrary to the hypothesis, decreased elasticity was found to have no relationship with any of these parameters. Moreover, each parameter was found to have an impact on different factors: previous cesarean section on skin-to-fascia time, WC on Htc levels and skin-to-fascia time, BMI on skin-to-fascia time, and Pfannenstiel incision site tissue thickness on skin-to-fascia time and fascia-to-uterus time. The only parameter found to be associated with increased bleeding was WC, not BMI. This finding concurred with our hypothesis that the local distribution of increased fat at

Table 4. Regression analysis.

Dependent variable	Independent variable	β	Std. error	95% CI	F	P
Preop. Htc–postop. Htc	Waist circumference	–0.148	0.065	–0.283 to –0.013	5.153[1]	0.033
	Constant	–18.713	7.053	–33.304 to –4.123		
Skin-to-fascia time	Maternal BMI	0.697	0.185	0.315 to 1.079	14.237[2]	0.001
	Constant	–4.447	5.742	–16.325 to 7.430		
Fascia-to-uterus time	Pfannenstiel tissue thickness (intraop.)	1.117	0.533	0.041 to 2.221	4.390[3]	0.047
	Constant	52.043	14.582	21.878 to 82.208		

[1] $R^2 = 0.183$, adjusted $R^2 = 0.148$.
[2] $R^2 = 0.382$, adjusted $R^2 = 0.355$.
[3] $R^2 = 0.160$, adjusted $R^2 = 0.124$.

or near the incision site was a more important determinant of the parameters of bleeding and operation time.

The vast majority of studies evaluating the impact of maternal obesity on wound complications and obstetrical parameters use BMI as the only measurement of obesity (10,11). In a large-scale and well-designed study, evaluating the relationships between BMI, incision-to-delivery interval, and total operative time of cesarean deliveries in 21,372 singleton pregnancies, BMI was found to be associated with increased operation times (12). However, as we observed in our study, the group of pregnant women with the same BMI was not homogeneous in terms of body fat distribution and hence the outcome of the parameters evaluated in our study. We can thus conclude that using only BMI in such studies can have a significant influence on the results.

Pregnant women with more than three previous cesarean deliveries were excluded from the study, because the standardized surgical procedure had only been in use at the clinic for the preceding 6 years. Furthermore, there are studies reporting increased maternal morbidity and complication rates in repeat cesarean deliveries, especially after a third operation (13).

Decreased tissue elasticity at the site of the Pfannenstiel incision, assessed by elastosonography, was found to be related to neither the amount of bleeding nor the skin-to-fascia operation time. The reason for this may be the bypassing of this step as fast as possible by way of sharp dissection, and the relative avascularity of this region following repeat operations. Skin-to-fascia time was significantly associated with the thickness but not the stiffness of the tissue at the Pfannenstiel incision site: the thicker the tissue, the longer the operation time. In contrast to our findings, a previous study found an indirect association between depressed abdominal scars and intraabdominal adhesions (14).

One of the limitations of this study is related to the design of the elastosonographic component of the scar. Scar maturation, fibrin deposition/reorganization, possible keloid formation processes, and resulting elastosonographic changes may all be affected by each successive pregnancy. With increasing time intervals between pregnancies, and as time goes by, a decrease in hardness and increase in elasticity may be observed. Because our study lacked data on the time interval between pregnancies and the number of pregnancies experienced by each woman, we could not analyze or discuss the effects of these parameters on elastosonographic scar changes. However, we did not aim to find out the possible reasons for changes in elasticity; instead, we only analyzed parameters such as operation times and intraoperative bleeding amounts regarding any change in elasticity and we found no difference in these factors with changing elasticity.

Other limitations in the design of the study involve the inclusion of only pregnant women who had undergone prior cesarean sections and the method used to investigate intraoperative blood loss. An investigation of the effect of abdominal wall thickness on the incidence of surgical complications and the inclusion of patients without a history of abdominal surgery in the study may be considered more suitable, because scars from previous operations would affect the outcomes independently of abdominal wall thickness. Only women who had undergone a prior cesarean section were included in the study, because they had the advantage of being scheduled for the operation, which gave us enough time to carry out the required measurements and obtain their informed consent. Although there are several methods of assessing intraoperative blood loss, such as visual estimation, direct measurement, gravimetry, photometry, or evaluating pre- and postoperative Hb/Htc differences, we chose the last option, given its ease of application and

the lack of requirement of extra equipment. Another limitation of such studies is the difficulty in obtaining the primary reports on previous cesarean deliveries. The different surgical techniques used in previous cesarean operations had a significant effect on adhesion formation and the level of intraoperative bleeding, with the leading diversities in surgical techniques being related to peritonization, rectus muscle closure, formation of a bladder flap, closure of subcutaneous tissue, and the use of superficial wound drains (15–18). In order to overcome all of these technical diversities, only pregnant women whose previous cesarean deliveries had been carried out at our institution were included in the study, where a standard surgical technique for cesarean sections has been in place for 6 years. The preferred transverse incision type was a Pfannenstiel incision, placed on a natural skin fold located two fingerbreadths above the symphysis pubis. The fascia is separated from the underlying muscle using both blunt and sharp dissections, and the parietal peritoneum is opened bluntly. No bladder flap is formed. The lower segment of the uterus is incised for 4–5 cm until bulging membranes are seen, and then the incision is bluntly extended upward and laterally. The uterus is exteriorized after delivery and closed in full thickness as one layer, sparing the peritoneum. No peritoneum closure is made and no approximation or closure of the rectus muscles is carried out. No superficial wound drains are used, and subcutaneous tissue is not sutured unless the subcutaneous fat tissue thickness exceeds 30 mm.

The aim of this study was to find any possible correlation of operation times and intraoperative bleeding with either increased whole body mass or local tissue thickness and elasticity at the Pfannenstiel incision site. Rather than evaluating overall operation times, the current study aimed to identify the individual times for each particular step, starting from skin incision and culminating in the fetal extraction. Although the study sample was small, and each of the variables found to be significant in the statistical analysis appeared to have only minor clinical influence, the study can be considered valuable in its design. Our findings, especially those related to bleeding, may be underestimated in the pregnant population due to a physiologic tendency towards clotting. There would be practical clinical implications of our findings, especially increased bleeding being positively correlated with WC but not BMI, in nonpregnant populations. Despite our findings being statistically significant, we can offer no definitive conclusions due to the small size of the sample. Nevertheless, our findings may lead to further prospective studies on this topic in the future, both in pregnant and nonpregnant populations.

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