Dermatology Practical & Conceptual

Can Stria Gravidarum Predict Surgical Fluid Loss in Cesarean Section?

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Key words: Stria gravidarum, surgical fluid loss, cesarean section, Davey score

Citation: Arslanca SB, Sahin O, Erkayıran U, Basarır ZO, Arslanca T. Can Stria Gravidarum Predict Surgical Fluid Loss in Cesarean Section? *Dermatol Pract Concept.* 2023;13(3):e2023175. DOI: https://doi.org/10.5826/dpc.1303a175

Accepted: November 7, 2022; **Published:** July 2023

Funding: None.

Competing Interests: None.

Authorship: All authors have contributed significantly to this publication.

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ABSTRACT

Introduction: Alterations in collagen subtypes and matrix can potentially cause fluid loss in surgery which is important in terms of liquid loss.

Objectives: The study aimed to analyze stria gravidarum (SG) and its severity in pregnant women who had undergone cesarean section (CS) and to evaluate surgical fluid loss (SFL) that occurred during CS operation.

Methods: The research was designed as a prospective clinical cohort study to compare the amount of SFL in the second cesarean section with the severity of SG at 34-37 weeks pregnant (N 308). The severity of SG was evaluated in the preoperative period using the Davey scoring. All patients were defined none, mild stria and severe stria. The SFL was calculated by weighing the pre-and post-operative weights of the sponges.

Results: The weight gain (P = 0.008) and body mass index (BMI, P = 0.017) gradually increased toward severe SG. In correlation analysis of SFL, a positive correlation was found with Davey (r=0.791; P = 0.0001), weight gained during pregnancy (r=0.328; P = 0.0001), BMI (r=0.453; P = 0.001) and newborn weight (r=0.139; P = 0.003). In the receiver operating characteristic for the predictability of SG severity on SFL, severe SG showed a potential for SFL with 95.1% specificity and 93.2% sensitivity at 791 cut-offs (area under the curve:0.987; P = 0.00001; 95% confidence interval: 0.977-0.997).

Conclusions: The SG severity and SFL showed a very strong relationship, which was a very important finding that would affect the approach of the surgeons to the patients with SG in terms of fluid loss in CS.

Introduction

As a result of immunological, metabolic, endocrine, and vascular changes that occur during pregnancy, various physiological and pathological processes occur in the skin and skin appendages of the pregnant woman [1,2]. Among the physiological skin changes seen in pregnant women such as weight gain [3], stria gravidarum (SG) is considered to be the most common skin change [4]. After birth, the skin color is characterized by bands that turn into hypopigmented, atrophic lines, and appear on the abdomen, thighs, distal femoral areas, inguinal region, and breasts after an average of 24 weeks of gestation [2,5]. These lesions, whose exact cause is unknown, are thought to develop as a result of connective tissue changes such as a decrease in the amount of elastin and fibrillin in the dermis [6,7]. After birth, it is less visible with a pale and cream-colored, atrophic appearance over time, but it does not disappear completely [8,9].

Although striae are not a serious condition that will risk health, they can cause complaints such as itching and burn on the skin, and these physical changes can cause serious anxiety in pregnant women [10]. Local retinoic acids, glycolic acid, and vitamin C may be beneficial after pregnancy [11]. Benefiting from these supplements is one of the strongest indications of how critical a collagen deficiency or disorder plays in SG [12,14]. Collagen is not only the crucial component of the extracellular-matrix, maintaining the dermis structure but also an important molecule for coagulation systems [15-17]. Although the formation of the vascular tube takes place in a polymerized 3D collagen lattice, endothelial cells cannot be organized into capillary-like structures on a hard plastic surface [18]. It is unclear how damage to the collagen matrix triggers endothelial cell organization in a vascular network and what factor might be involved. Cell-to-cell interactions in the vascular structure are essential for the endothelial cell organization to transform into a luminal structure and may be associated with SG due to altered collagen fibers and a collagen matrix [19].

Objectives

We acknowledged that alterations in collagen subtypes and matrix can potentially cause fluid loss and this issue has not been investigated in terms of SG and its severity. The present study aimed to analyze the SG data and its severity in pregnant women who had undergone cesarean section (CS) and to evaluate the relationship of these values with the surgical fluid loss (SFL) that occurred during CS operation. Thus, we focused to understand the relationship between the severity of SG and the amount of SFL during the CS.

Methods

Study Design

The study was designed as a prospective clinical cohort study to compare the amount of SFL in the second cesarean section with the severity of SG in 34-37 weeks pregnant women. The study included healthy pregnant women over the age of 18 who gave birth to a single newborn in their second CS at the Medical Center between 2020 and 2022. The study was approved by the review board of the institution (14.10.2022-07-363) and conducted following the Helsinki declaration, a set of ethical principles regarding human experimentation. All the participants read and signed the informed consent about the study.

Study Participants

All pregnant women who attended the hospital and were scheduled for CS were invited to enroll in the study. Inclusion criteria were to be admitted for the second cesarean section with the severity of SG in 34-37 weeks pregnant women who had a history of only one cesarean section. Reluctance to participate in the study, not meeting the admission criteria, having a chronic disease, and having any complications in the previous cesarean section were accepted as exclusion criteria. In addition to 7 women who were not willing to participate in the study for various personal reasons, 42 people with a midline incision, suspected preoperative placenta accreta, using corticosteroids, history of abdominopelvic surgery and/or wound infection, endometriosis or pelvic inflammatory disease were excluded from the study.

Stria-Davey Scoring and Groups

For study planning, one of the researchers consulted all eligible participants to obtain detailed anamnesis; CS history, age, body mass index, gestational age, parity, previous miscarriage, etc. The severity of SG was evaluated in the preoperative period using the four body regions (abdominal, hip, hip, and breast) where SG is most common and using

the Davey scoring system. The abdomen was divided into 4-quadrants concerning a line drawn horizontally from the midline and the navel, and each quadrant was given a score: score 0=clear skin, score 1=moderate (1–3), and score 2=many striae (4 and more). According to this calculation, the scores of all four quadrants were added together to obtain the total, and patients with none (score 0) were defined as the group I, mild (score1-2) were defined as II and severe (score 3-8) were defined as III.

C/S Operation and SFL Amount

All CS included in the study was performed and the data were recorded by two experienced residents and blinded to the results of the Davey score assessment. Surgeons were asked to measure and report the amount of SFL after performing the surgery. They calculated the amount of SFL by weighing the pre-and post-operative weights of the sponges we used in the cesarean section in the operating room and looking at the hemoglobin difference. We used sponges after the delivery of the baby and placenta and thus, excluded amnion and bleeding due to c/s. In addition, the amount of blood measured with sponge was considered to be insignificant, since there was no difference at preoperative and postoperative values of the hemoglobin and hematocrit. In this way, the weight difference between sponges reflects the amount of SFL.

Statistical Analysis

After the data were collected, they were turned into an excel spreadsheet and the data were transferred to SPSS©Statistics v22 (IBM© Corp.) and analyzed with proper methods. While quantitative data were presented as mean and standard deviation, qualitative data were presented as frequency and percentage. The Mann-Whitney test compared the Skewed data while the unpaired t-test evaluated the normally distributed quantitative data such as SFL amount. Categorical data were compared using the chi-square test or Fisher exact test if appropriate. Correlation analysis of the amount of SFL and severity was performed in the groups determined according to the Davey score. In addition, we performed a stepwise linear regression model for predictors. The receiver operating characteristics (ROC) curve was constructed to determine the best cut-off value for the amount of SFL and SG severity diagnostic fit. The best cut-off in the ROC curve has the highest true positive rate along with the lowest false positive rate. A P-value less than 0.05 was considered significant.

Results

Three hundred fifty-seven women were evaluated to participate and 49 cases did not join the present study due to not meeting the inclusion/exclusion criteria. The 308 pregnant were defined by Davey score into three subgroups: group-I included 71 as none, group II included 107 as mild, and group III included 130 women as severe. The mean age was 28.7± 6.07 years and did not differ for groups (P = 0.566). The weight gain (P = 0.008) and body mass index (BMI, P = 0.017) gradually increased toward severe SG. Hemoglobin (pre/postoperative), platelet, PT, aPTT, AST, ALT, BUN, creatinine, and fibrinogen were similar for groups. There was no significant difference in the baseline characteristics of both study groups, as seen in Table 1.

In the correlation analysis performed with the amount of SFL, a positive correlation was found with Davey (r=0.791; P = 0.0001), weight gained during pregnancy (r=0.328; P = 0.0001), BMI (r=0.453; P = 0.001) and newborn weight (r=0.139; P = 0.003). Other parameters we analyzed did not show a significant relationship with the SFL. The stepwise linear regression analysis of SFL showed Davey score-SG severity as the most dominant parameter (62.2±3.3; beta:0.67, P = 0.0001, adjusted R^2= 0.68) affecting its linearity as seen in Table 2. BMI, ALT, weight gain, age, and creatine were the other strongest parameters effective over SFL after SG severity.

In the ROC analysis, we did for the predictability of SG severity on SFL, severe SG showed a predictive potential for SFL with 95.1% specificity and 93.2% sensitivity at 791 cut-off value (area under the curve:0.987; P = 0.00001; 95% confidence interval: 0.977-0.997). BMI and delta hemoglobin were also analyzed for the predictability of SG severity, as seen in Figure 1. Although the delta hemoglobin did not predict the SG severity (P = 0.696), the BMI showed a potential for it (area under the curve:0.744; P = 0.008; 95% confidence interval: 0.689-0.798).

Conclusions

The present research assessed stria severity in pregnant women with CS and its relationship with the amount of SFL that occurred during CS operation. Although the difference in punch weights before and after the operation was inconsistent with blood parameters indicating the bleeding status, the SG severity and the fluid loss measured during the operation showed a very strong relationship, which was a very important finding that would affect the approach of the surgeons to the patients with SG in terms of fluid loss in CS.

The emergence of SG in pregnant individuals occurs as a result of pathological and histological changes as a result of mechanical tissue tension, mast cell degranulation due to elastolysis in the mid-dermis, and macrophage stimulation [7,17]. Gradual changes occur and collagen, elastin, and fibrillin fibers are markedly reduced. As the epidermis thins and flattens, the distance between the collagen bundles

Table 1. Demographics and clinical details of the participants.

Variables	None	Mild	Severe	P value
Age, years	27.4±5.3	29.3±6.1	30.0±6.0	0.566
BMI, kg/m^2	26.9±3.7	29.9±4.0	32.5±4.4	0.017
Weight gain, kg	9.2±3.6	11.2±4.5	13.7±5.3	0.008
Pregnancy, week	38.4±1.1	38.4±1.5	38.3±1.2	0..874
Newborn weight, kg	3110±487.5	3161±566.2	3345±596	0.302
Newborn Gender, m/f	34 / 37	61 / 46	71 / 59	0.478
Stria History, n/m/s	37 / 31 / 3	44 / 44 / 19	13 / 42 /75	0.001
Term Status, p/e/f/l	1 / 39 / 28 / 3	6 / 54 /37 /10	3 / 76 / 44 / 7	0.401
Hb – preoperative	11.6±1.4	11.6±1.5	11.8±1.5	0.121
Hb – postoperative	10.2±1.4	10.1±1.5	10.4±1.6	0.407
Platelet count x10^3	238±74	246±75	240±76	0.714
PT, sec	9.7±1.47	9.72±1.5	9.78±1.78	0.847
aPTT, sec	27.7±4.4	28.2±4	27.3±4	0.622
AST, U/L	17.8±6.9	19.2±11.5	18.7±5.4	0.609
ALT, U/L	9.15±4.96	11.2±9.86	11.9±6.71	0.297
BUN, mg/dL	10.1±9.2	8.8±5	8.9±5.3	0.438
Creatinine, mg/dL	0.5±0.15	0.5±0.12	0.49±0.14	0.899
Fibrinogen, g/L	390±52	401±58	415±73	0.856

ALT = alanine aminotransferase; aPTT = activated partial thromboplastin time AST = aspartate aminotransferase; BUN = blood urea nitrogen; Hb = hemoglobin; N/M/S = None/Moderate/Severe; P/E/F/L = Pre/Early/Full/Late Term; PLT = platelet; PT = prothrombin Time.

Table 2. The stepwise linear regression analysis of surgical fluid loss (SFL).

Model	B	SE	Beta	t	P value	Lower	Upper
Constant	87.4	63.13	-	1.38	0.167	-36.7	211.7
Davey Score	62.2	3.33	0.67	18.63	0.0001	55.6	68.7
BMI, kg/m^2	8.5	1.84	0.16	4.59	0.0001	4.86	12.1
ALT, U/L	2.18	1.09	0.06	2.002	0.046	0.03	4.33
Weight gain, kg	4.11	1.64	0.08	2.506	0.013	0.88	7.33
Age, years	3.43	1.37	0.08	2.491	0.013	0.72	6.14
Creatine, mg/dL	-8.73	4.03	-0.07	-2.16	0.031	-16.67	-0.79

ALT = Alanine aminotransferase; BMI = body mass index; SE = standard error.
Dependent: The amount of SFL was defined thgrough pre/postop measurements of punches.
Predictors: Age, pregnancy week, davey score, family history, BMI, weight gained during pregnancy, smoking, baby gender, baby weight, hemoglobin, pulse, diastolic/sistolic blood pressure, platelet, protrombin time, active partial tromboplastine time, INR, AST, ALT, BUN, creatinine, fibrinogen.

increases with the dilatation of the blood vessels, and the elastic fibers are separated [2]. As collagen and elastin are the two major components of the arterial wall, they are passive mechanical components of soft tissues and their molecular structures regulate the characteristic response of tissues to mechanical effects [20]. Previous studies reported that women with SG have problems such as adhesion and prolapsus [21,22]. However, the effects of these problems on the vessel wall in these individuals were not investigated. Surgeons should take into consideration this issue in surgical approaches such as SC where SFL is in higher amounts.

Physiologically, the formation of the vascular tube occurs in a polymerized 3d collagen lattice. However, the organization of vascular endothelial cells into capillary-like structures does not occur on a hard surface, even if the surface is covered with a suitable matrix component [23,24]. The study by Wang et al, investigating changes in collagen fibrils, reported increased prominence of dermal blood vessels in the early period of SG [20]. This alteration, branching, and widening of vessels, involving increased numbers, promote clinical erythema and explains how the appearance of striae can be improved [25]. According to them, type-I collagen

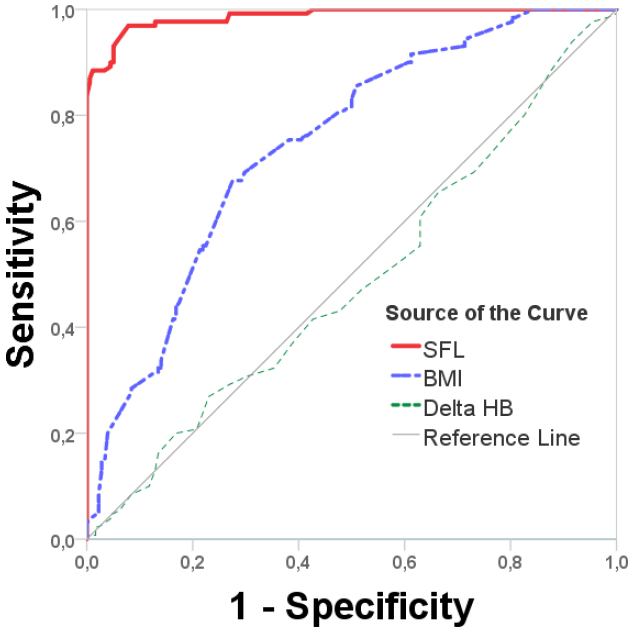

Figure 1. The ROC analysis for prediction of severe stria gravidarum. BMI = body mass index; HB = hemoglobin; SFL = surgical fluid loss.

fibril fragmentation, and decreased density of the collagenous extracellular matrix, can induce endothelial structures to form vascular tubes [18]. Although it is unclear which alterations at the collagen matrix trigger endothelial cell organization, there may be a decrease in the density of collagen. A study by Xu et al reported that damage to type-IV-collagen reveals cryptic regions that alter interactions with vascular endothelial cells [26]. Although not addressed in the studies of Xu and Wang, it is a crucial point to be investigated that these changes in the vascular endothelium may cause results in the form of leakage from the vessel wall.

In the present study, we proved a very strong correlation between SG severity and SFL during CS. As an important finding, there was no correlation between parameters such as blood cells and hemoglobin values and SG severity in this relationship. The results supported that there was no blood-borne effect on the SFL content that we detected during the surgery and that it was only due to a liquid leak. As it is known, the decrease in elastic fibers and weakening of collagen support together with the dilatation of the vessel walls can increase the permeability of the vessel wall and facilitate the passage of intravascular fluid into the extravascular space. This may lead to the weakening of vascular resistance in pregnant women who develop SG and increase fluid accumulation in the third chambers, leading to more fluid and blood loss during the operation, and consequently to the need for more isotonic fluid replacement and hypovolemia, especially in those who delivered by cesarean section. As a result, we predicted that this situation may cause systemic bleeding and fluid loss. With our results, we supported our hypothesis based on the fact that there may be excessive fluid loss in individuals with SG in CS operations. As the most important point, the relationship between these losses and the severity of SG was independent of bleeding.

Although it is novel research in its field, it had strengths and limitations. First, the main strength is that it is the first research to analyze the association between the severity of SG and SFL in pregnant, with a large sample size. Second, demographics such as the age, BMI, and fetal weight of all pregnant were similar which may lessen the bias when comparing the SG groups. Because we performed the current analysis as a prospective design, we were able to compare blood data such as Hb concentration, Platelets, and RBC before and immediately after the CS to understand SFL content. However, the study proceeded without any long-term follow-up. Among the participants, a collagen measurement could be made in neither the blood nor the SFL.

Severe SG according to Davey score was positively associated with the SFL and evaluation of SG status is a quick method that may be used for the prediction of SFL. The severity of SG and the SFL measured during the operation showed a very strong relationship, which was a very important finding that would affect the approach of the surgeons to the patients with SG in terms of fluid loss in CS. Nevertheless, multicenter studies with more participants are needed in clinical and surgical applications to follow the classification of SG severity and thus predict the possible amount of SFL.

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