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Standardized ultrasonographic approach for the assessment of risk factors of incomplete healing of the cesarean section scar in the uterus☆

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ABSTRACT

Objective: To identify factors related to the healing of a Cesarean uterine incision using the standardized ultrasonographic approach of scar assessment in the non-pregnant uterus.
Study design: Measurements of the uterine scar were taken from 409 women with a history of at least one low transverse cesarean section (CS) with a single layer uterine closure. Residual myometrial thickness (RMT), width (W) and depth (D) of the triangular hypoechoic scar niche, D/RMT ratio and clinical characteristics were analyzed. For statistical analysis, the Mann–Whitney *U* test, chi-square test, Spearman's rank correlation coefficient, ANOVA test, and logistic regression were used.
Results: 268 women presented with a scar defect. RMT values were significantly correlated with the number of CSs ($R = -0.17$) and uterus retroflection ($R = -0.15$). The presence of a scar defect was significantly associated with lower RMT values ($R = -0.33$), greater gestational age ($R = 0.10$), and younger maternal age ($R = -0.11$). The mean RMT value was significantly smaller in women with CSs performed in the second stage of labor (0.62) when compared to women with CSs in the first stage of labor (0.97) or without cervical dilatation (0.91).
Conclusion: A standardized approach of CS scar assessment in the non-pregnant uterus helps to identify women at risk of long-term complications of CS.

Introduction

Women with a cesarean section (CS) scar in the uterus are a rapidly growing population in all developed countries of the world [1]. In the last several years, there has been an expansion of knowledge of the long-term complications related to the presence of a CS scar in the uterus. These include complications related to the next pregnancy, such as a cesarean scar pregnancy, morbidly adherent placenta, and CS scar dehiscence or rupture [2–5]. There are also complications that occur in the non-pregnant state, such as abnormal uterine bleeding [6–9]. The risk of occurrence of scar-related complications seems to depend on the scar morphology and primarily on the presence of a niche in the CS scar [3–9]. To create strategies for the prevention of the long-term complications of CS, we need to know factors that are responsible for incomplete healing of the CS scar. Potential risk factors for the development of the niche were studied; however, the results are not easy to compare because of the lack of consistency in the methodology, including methods of niche detection, definition of the niche, and heterogeneous patient populations [1,6,10–13]. Taking into consideration the growing importance of this subject, the CS scar must be evaluated with the use of a standardized approach for measuring CS scars to identify the factors that affect its healing.

The aim of the study is to identify the factors related to the healing of a Cesarean uterine incision using the standardized ultrasonographic approach of scar measurement in the non-pregnant uterus.

Material and methods

This study was conducted between 2005 and 2015 in the Department of Gynecology and Obstetrics of Wroclaw Medical University, as a part of our prospective cohort study on the prediction of CS scar integrity in subsequent pregnancies [3]. All participants provided informed consent for participation in the study before entering the study. The study protocol was approved by the Ethics Committee of the Wroclaw Medical University before

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the study began. Women with a history of at least one low transverse CS with a single layer uterine closure were invited to participate in an ultrasonographic assessment of the CS scar 6 weeks after that procedure. There were the following exclusion criteria: vertical or inverted "T" uterine incision, double-layer uterine closure, congenital uterine malformations, chronic steroid administration and puerperal infection. The ultrasound examination was performed using a 4–9 MHz convex transvaginal probe of Medison SonoAce 8000SE or Voluson 730 Pro or Voluson E8 (General Electric Medical Systems, Chicago, United States). The standardized approach for imaging and measuring CS scars was used, as described in detail in our previous publications [3,14–16]. For standardization purposes, we used terms introduced by Naji et al. [17]. Briefly, this method consists of measuring the following CS scar parameters on the sagittal transection of the uterus: residual myometrial thickness (RMT), width of the triangular hypoechoic scar niche (W) and depth of the triangular hypoechoic scar niche (D). Fig. 1 presents the measurement of the standardized CS scar parameters. In cases of completely healed scars, when the niche was not present, only the RMT value was measured. The definition of the niche used in this study was as follows: "any indention representing myometrial discontinuity at the site of the scar that communicates with the uterine or cervical cavity" [6]. Additionally, the D/RMT ratio was calculated [3]. All ultrasound measurements were performed by the first author. The CSs were performed by doctors from our department using a unified single-layer uterine closure technique with a continuous absorbable polyglycolic 2-0 suture. Patients' clinical information about factors related to uterine scar healing was collected from medical records and included: gestational and maternal age at CS, cervical dilatation, number of fetuses, indication for CS, type of uterine flexion.

The indications for CS were divided according to the cervical dilatation into the following groups:

- Group 1: CSs without cervical dilatation (including elective and emergency indications),
- Group 2: CSs in the first stage of labor,
- Group 3: CSs in the second stage of labor.

As all multifetal pregnancies were delivered by elective CS, this group was analyzed separately.

Statistical analysis was performed using the computer package Statistica software v. 10 (StatSoft, Tulsa, OK, USA). To determine the statistical significance of differences between groups, the Mann–Whitney *U* test for continuous variables and the chi-square test for categorical data were used. Relationships were analyzed with Spearman's rank correlation coefficient. Verification of the hypothesis of the means' equality of parameters of cesarean scar for groups of patients with various cervical dilatations was performed by one-way analysis of variance (ANOVA test). To examine the influence of selected clinical factors (independent variables) on the risk of development of cesarean scar (dependent variable), a logistic regression was performed using a quasi-Newton method. To count loss function, the maximum likelihood method was used. There was a 5% error of inference, and the associated significance level $p < 0.05$ indicated the existence of significant differences.

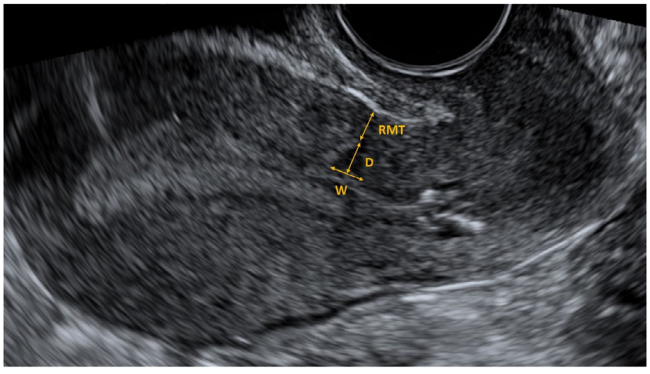

Fig. 1. The measurement of the standardized Cesarean section scar parameters in the non-pregnant uterus.
Legend: RMT—residual myometrial thickness; D—depth of the scar niche; W—width of the scar niche.

Results

Following inclusion and exclusion criteria, the study group included finally 399 women with a mean age of 31.14 (SD = 4.02) years. Gestational age at CS varied from 29 to 42 weeks with the median value of 39 gestational weeks. Out of the 399 patients, 131 had intact caesarean scars, and 268 had scars with a defect. A majority of the women in the study were in the first pregnancy (80.45%). Cesarean section was performed mostly due to elective reasons (53.89%). Detailed characteristics of the study group are presented in Table 1.

RMT values were significantly negatively correlated with the number of CS ($R = -0.17$), while positively correlated with anteflexion of the uterus ($R = -0.15$). The presence of a scar defect was significantly associated with lower values of RMT ($R = -0.33$), greater gestational age at CS ($R = 0.10$), and younger maternal age at CS ($R = -0.11$). Maternal age was negatively correlated with cervical dilatation ($R = -0.18$). Correlation coefficients are presented in Table 2. Additionally, younger patients had CS during active labor more often ($R = -0.18$). Maternal age significantly differentiated patients with CS during active labor and without cervical dilatation (mean age 29.38 vs 31.44; $p = 0.0003$).

A logistic regression showed that maternal age at CS and RMT value are important for estimating the risk of developing a uterine scar defect; however, only RMT was statistically significant as measured by the statistical test Wald chi^2 ($p = 0.0000$). The odds ratio indicates that the risk of uterine scar defect decreases on average 6 times (OR = 5.74) from 3.21 to 10.27 with a 95% likelihood for elevated values of RMT. Results of the logistic regression analysis are presented in Table 3.

The one-way analysis of variance showed significant differences of mean RMT values between groups of different cervical dilatation. The mean RMT value (0.62) was significantly smaller in women from group 3 than in women from group 2 (0.97) or from group 1 (0.91). No significant differences were found in terms of the other scar parameters, such as W, D, and D/RMT ratio. The results of the ANOVA analysis together with the results of the post-hoc tests are presented in Table 4.

Discussion

To the best of our knowledge, this is a study on the largest group of women that assessed CS scar morphology in the non-pregnant uterus in relation to the potential risk factors of incomplete scar healing [6]. In our study, the standardized approach for measuring CS scars was used, and an analysis of the correlations among the studied factors and all standardized scar parameters was possible. These parameters included the residual myometrial thickness, depth and width of the scar niche. Our study revealed that the niche was found in 67.1% of women. In four previous studies using a random group of women with a history of one or multiple CS, the prevalence of the niche assessed by transvaginal ultrasound varied between 24% and 70% [6,7,18–20]. However, in those studies, the time of the scar assessment was 6 months to 5 years after the CS