

EVALUATION OF CESAREAN UTERINE SCAR BY THE GRAY-LEVEL HISTOGRAM

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ABSTRACT

Evaluation of Cesarean uterine scar by the gray-level histogram

OBJECTIVE. To evaluate the Cesarean uterine scar by the gray-level histogram (GLH) in women with a previous Cesarean section, performed either during or before labor (elective Cesarean).

METHODS. A prospective study was conducted with 40 women between 11 and 14 weeks of gestation, who were divided into three groups: 15 pregnant women with a previous elective Cesarean section (group A); 9 with a previous Cesarean section performed during labor (group B); and 16 with a single previous vaginal delivery (group C). The pregnant women were examined by transvaginal ultrasound, to obtain an image corresponding to the “shadow” formed by the uterine scar in groups A and B. In group C, GLH was accomplished in the region of the uterine isthmus. After capturing the image, the region of interest (ROI) was delimited and the option “histogram” was activated, automatically obtaining graphic representation. The mean, median and standard deviation (SD) were calculated for each study group. Means, medians and standard deviations (SD) were computed for each study group. The mean average for the control group’s histogram values was the normal parameter to which other groups were compared. The ANOVA test was used to compare averages of the three groups. A (p) value of < 0.05 was considered statistically significant.

RESULTS. GLHs for group A ranged from 7 to 40.5 (mean: 24.8; SD: 11.2); from 23.1 to 47.2 (mean: 34.1; SD: 9.6) for group B, and from 21.6 to 58.8 (mean: 40.3; SD: 11.3) for group C.

Conclusion. There was a significant difference for GLH in the uterine scar region of previous Cesarean sections when the surgery was elective and when performed during labor, suggesting greater tissue change in elective Cesarean sections.

KEY WORDS: Cesarean Section. Ultrasonography. Scar.

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INTRODUCTION

The potential adverse effects of Cesarean uterine scars from previous births highlight the increasing frequency of placenta previa, placenta accreta, ectopic pregnancy at the scar niche, and rupture of the uterus in subsequent pregnancies.¹⁻⁵ Anatomic changes are secondary to reduced local vascularization from fibrosis, greater in elective Cesarean sections, performed without proper formation of the lower uterine segment.⁶ Various imaging methods have been used to assess the integrity of the region in uteri with scars from previous Cesarean sections. In the seventies, hystero-graphy had a major role in showing defective scarification (presence of scar niche), recently replaced by hysterosonography, hysteroscopy and magnetic resonance, also performed outside the gestational period.⁷⁻⁹ Ultrasonography, a safe, noninvasive

method,¹⁰ has been used to that end during pregnancies since the eighties,^{2;11} however, subjective assessment of the resulting ultrasonograms are a drawback, since visuals are not enough to determine the precise echogenicity of the tissues. Hence, quantitative and computerized analysis provided by gray-level histograms from an area of interest provide the opportunity to perform minute studies of uterine scars from previous Cesarean sections, since they enable us to compare the same region in different patients.

The gray-level histogram (GLH) has been used to assess the echogenicity of the texture of various organs, showing that the method has major clinical applications. Studying the tissue from a given organ shows that it has an apparent density in a B mode image determined by the distribution of echogenic reflectors within the organ and the amplitude of the echo returning from

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the parenchyma. These are altered by disease states, providing examiners with a subjective analysis of the area studied.^{11;12}

After capturing the image and defining the region of interest (ROI) for the study, the GLH provides a graphic representation of the area with the reflexivity, disposition and amount of pixels present in it. Each pixel stores a digital signal determined by the intensity of the echo from an anatomic tissue point. The ultrasound device's computer programming provides graphic representation of the number of pixels associated with each gray level present in the image, which can also be expressed in terms of a percentage of the total number of pixels in the image. Thus, given a digital image of M lines and N columns, the GLH may be defined as $GLH = gl / M \cdot N$, where gl is the number of times the same gray level can be found in the image (Figure 1).¹³

The horizontal axis shows the gray scale in 255 measures, while the vertical axis shows the percentages of number of pixels in each gray scale. The GLHW (Gray-Level Histogram Width) represents the width of the gray-level histogram. The highest possible bar corresponds to 100 percent, and the peak is the maximum number of pixels in each scale. According to Maeda et al.,¹⁴ the GLHW is computed automatically by some ultrasound devices, or manually using the following formula: length of histogram base divided by length of full gray-level times 100 percent.

OBJECTIVE

The objective of this study was to evaluate the Cesarean uterine scar by the gray-level histogram (GLH) in women with a previous Cesarean section, performed either during or before labor (elective Cesarean).

METHODS

This prospective study was performed between April 2007 and August 2008, in women between 11 and 14 weeks pregnant, who had had previous Cesarean sections and were selected in their first prenatal appointment at Pontifícia Universidade Católica de Campinas. The study was approved by the

Research Ethics Committees of Universidade Federal de São Paulo (UNIFESP-EPM) and Pontifícia Universidade Católica de Campinas, and patients gave their informed consent for voluntary participation in it.

The 40 pregnant women, with a single previous birth, were divided into three groups:

- Pregnant women with previous scar from elective Cesarean section (group A);
- Pregnant women with previous scar from Cesarean section performed during labor (group B);
- Pregnant women whose only previous birth was vaginal, making up the control group (group C).

Gestational age was determined by the date of the last period, stated confidently by the subject at the time of the test, and corrected by the first trimester ultrasound through crown-rump length. The study excluded cases featuring one or more of the following events: vaginal bleeding during current pregnancy, low-lying placenta, obesity (Body Mass Index > 35), multiple gestation, endometriosis, leiomyoma, previous repeated abortion, endometritis in previous pregnancy, or when the previous Cesarean section happened in preterm pregnancies or required a vertical incision.

Histograms were performed between 11 and 14 weeks of pregnancy because the period allows for better visibility of the uterine scar by endovaginal exams and coincides with the period when the routine first trimester ultrasonogram are usually performed. Ultrasound exams were done using the Medison Sonoace 8000 Live (Medison, Korea) device with a 6.5 MHz endocavitary transducer. After imaging the uterine scar for groups A and B and the uterine isthmus for group C, the region of interest (ROI) was defined and the *histogram* option was chosen (Figure 2), thus automatically providing its graphic representation.

We used the following adjustment in the histogram: B Mode, histogram level = 255 (8-bit memory), sample area = 1.01 cm², depth = 7 cm, overall gain = 70, frame = 105 dB, mechanical

Figure 1 - GLHW: Gray-Level Histogram Width

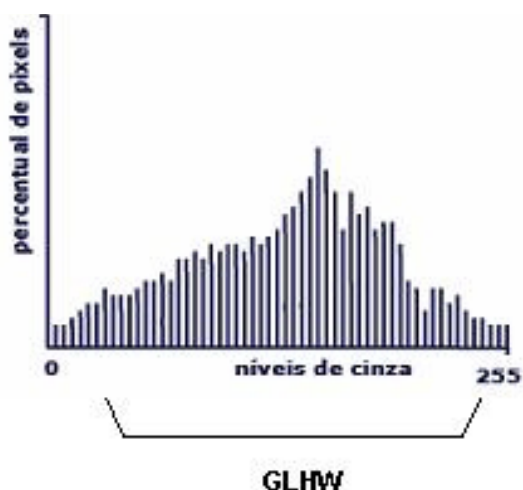


Figure 2 - GLH: Uterine scar histogram



indicator (MI) = 0.6 to 1.3, thermal bone index (TIB) = 0.3 to 0.5, A2 filter and power = 100%.

Means, medians and standard deviations (SD) were computed for each study group. The mean average for the control group's histogram values was the normal parameter to which other groups were compared. The groups were compared using Analysis of Variance (ANOVA) when variable distributions were normal (Gaussian), such as for one of the primary variables of interest, the histogram, as well as for ethnicity, age of the pregnant woman, and gestational ages.

If Analysis of Variance (ANOVA) identified statistically significant differences between groups, we used Duncan's new multiple range test to recognize differences between groups.

RESULTS

We initially studied 40 pregnant women, divided into three groups: 15 elective Cesarean sections, 9 Cesarean sections during labor, and 16 in the control group. Approximately 80 percent of patients were white in all groups, with very similar racial profiles and no statistically significant differences among them ($p = 1.00$).

There was no statistically significant difference among the three groups ($p = 0.85$) in terms of age. Mean age was 26 years old, SD 4.1 years. There was also no statistically significant difference among gestational ages upon first ultrasonography: mean 12.2 weeks, SD 0.9 weeks.

GLHs for the first group (elective Cesarean) ranged from 7 to 40.5 (mean: 24.8; SD: 11.2); from 23.1 to 47.2 (mean: 34.1; SD: 9.6 for the second group, and from 21.6 to 58.8 (mean: 40.3; SD: 11.3) for the control group. Table 1 provides the means, medians, standard deviations, maximums and minimums of GLHs from all three groups.

Comparing GLHs from group A patients with those from group B, we found, with $p = 0.0008$, a statistically significant difference between mean histogram values for the elective Cesarean section group (lower value) and the other two groups.

DISCUSSION

The number of Cesarean sections throughout the world has increased considerably since the seventies.¹⁵ With more Cesarean sections, the assessment of uterine scars, especially those from previous Cesarean sections, acquired major importance in

obstetrics, because it can alter local anatomy and compromise the future, predisposing patients to pathologies such as placenta previa, placenta accreta, rupture of the uterus or ectopic pregnancies at the scar niche.^{1:16}

In the literature, the study most similar to ours is Zimmer et al.¹⁷ This study did not focus on measuring the lower segment, but rather on the location of uterine scars from previous Cesarean sections. The authors made transvaginal examinations between 14 and 16 gestational weeks to compare uterine scars in patients who had previous elective Cesarean sections or during labor. Patients were divided into groups by asking them if the Cesarean section was performed before or after uterine contractions started. The ultrasound image corresponding to the scar was considered a hypoechoic line in the isthmus-cervix region. Results show that the line was seen more often when the Cesarean section was performed during labor (75.7% x 52.7%), and the scar was most distant of the internal orifice of the cervix in the same conditions (17.9 x 14.6 mm). The variable prematurity only had an impact when the previous Cesarean section was elective, with the scar closer to the uterine body. Therefore, we conclude that during uterine contractions, Cesarean sections are performed on the cervical tissue, but when performed before labor they include myometrial tissue.

The findings agree with the physiological process of effacement, shortening and softening of the cervix during uterine contractions, when the cervix becomes part of the segment. However, the process has not been defined histologically or demonstrated by ultrasound.

Likewise, this study sought to assess the scar considering the moment when the Cesarean section was performed, so as to verify if the lower uterine segment maturation process can also be demonstrated through the difference in tissue echogenicity quantitatively through the histogram. The histogram translates the reflexivity, disposition, and amount of pixels present in a given region of interest as computerized information. Each pixel stores a digital signal determined by the intensity of the echo from an anatomic tissue point.¹⁴ The advantage of this computerized, quantitative method is that the examination is easily performed and it allows for better analysis of tissue echogenicity, since it does not rely exclusively on visual assessments, which differs from examiner to examiner.

Recently, the literature has stressed the role of collagen in scarification, since it is the only filamentary extracellular matrix and the primary biological element responsible for the tensile resistance of tissue. A study using uterine scar tissue from human beings found an association between uterine dehiscence and the amount of collagen. The study showed that dehiscent scars that had increased amounts of collagen.¹⁸

Collagen is an hyperrefracting tissue, because it hinders the passage of ultrasound waves;¹⁹ therefore, it forms a hypoechoic line (a "shadow") behind the scar. Thus, we can infer that the greater the scarring process, the greater the amount of collagen, the greater the "shadowing", and the lower the histogram.

Table 1. Comparison between groups of pregnant women according to histogram values

	N	Mean	SD	Median	Minimum	Maximum
GA	15	24.8	11.2	23.8	7.0	40.5
GB	9	34.1	9.6	32.1	23.1	47.2
GC	16	40.3	11.3	43.3	21.6	58.8

SD, standard deviation; GA, elective Cesarean section; GB, Cesarean section during labor; GC, control group.

Our study showed statistically significant differences between the reflexivity, disposition and amount of pixels present in the Cesarean section uterine scar area among the various groups. We found lower mean values in histograms from the elective Cesarean group than in the two others ($p = 0.008$). Therefore, we can infer that there is more collagen deposition in the scar of these patients, which is more frequent in irregular scarification processes.

We believe the GLH method can help assess uterine scar regions. Our findings suggest that we should, when possible, avoid elective Cesarean sections to properly aid delivery, thus decreasing damages to the uterine matrix and the risk of placenta previa, placenta accreta, rupture of the uterus, and ectopic pregnancies at the scar niche.

CONCLUSION

There was a significant difference for gray-level histograms (GLH) in the uterine scar region of previous Cesarean sections when the surgery was elective and when performed during labor, suggesting greater tissue change in elective Cesarean sections.

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