Original Article

# Comparison of ultrasonic diagnosis of cesarean scar defects at different timepoints following cesarean section

**Yu Jiang[1,2], Xiaoyong Qiao[2,3], Tao Li[2,4], Juan Wen[1,2], Hong Luo[1,2]**

[1]Department of Ultrasound, West China Second University Hospital, Sichuan University, Chengdu, China; [2]Key Laboratory of Birth Defects and Related Diseases of Women and Children (Sichuan University), Ministry of Education, Chengdu, China; [3]Department of Reproductive Medicine, West China Second University Hospital, Sichuan University, Chengdu, China; [4]Department of Obstetrics, West China Second University Hospital, Sichuan University, Chengdu, China

*Contributions:* (I) Conception and design: Y Jiang, H Luo; (II) Administrative support: H Luo, T Li; (III) Provision of study materials or patients: Y Jiang, J Wen, T Li; (IV) Collection and assembly of data: Y Jiang, J Wen, X Qiao; (V) Data analysis and interpretation: Y Jiang, X Qiao; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

*Correspondence to:* Hong Luo, MD. Department of Ultrasound, West China Second University Hospital, Sichuan University, No. 20, 3rd Section, South Renming Road, Chengdu 610041, China; Key Laboratory of Birth Defects and Related Diseases of Women and Children (Sichuan University), Ministry of Education, Chengdu, China. Email: luohongcd1969@163.com.

**Background:** Cesarean scar defect (CSD) is a potential complication following cesarean section (CS), which has significant clinical implications, and is usually clinically diagnosed by ultrasound. However, the optimal timing for ultrasound diagnosis of CSD after CS has not been well established. This study aimed to evaluate the appropriate time for the diagnosis of CSD after CS by ultrasonography.

**Methods:** The prospective study involved 120 women who delivered by elective CS with single birth and term birth from January 2021 to June 2022. Sample enrollment was consecutive in the study. Each woman underwent 3 ultrasound examinations for CSD diagnosis at 6 weeks, 6 months, and 12 months postpartum according to a modified Delphi method. The ultrasound indicators about the incision situation were recorded and statistically analyzed. Paired 4-fold table chi-square test was used to evaluate the consistency between the 3 diagnoses. The diagnostic sensitivity and specificity were calculated using a 4-cell table. According to whether the diagnosis was consistent to that at 6 or 12 months, the 120 cases at week 6 were separated into a consistent group and inconsistent group for statistical evaluation of the ultrasound indicators. Additionally, the menstrual duration of the included women was also recorded to analyze the correlation to ultrasound indicators of CSD at 6 months postpartum using the Person correlation coefficient.

**Results:** The included 120 women were divided into normal (3–7 days, n=52) and prolonged menstrual period (>7 days, n=68) groups. The 2 groups had no statistical differences in age, body mass index (BMI), gestational week of delivery, assisted reproduction rates, or postpartum complications. Among the 120 women, 100, 66, and 61 women were diagnosed as CSD at 6 weeks, 6 months, and 12 months postpartum, respectively. The results indicated that the diagnostic results of 6 weeks were inconsistent with those of 6 or 12 months postpartum, but the last 2 diagnostic results were consistent. The diagnostic sensitivity of 6 months was 100% and the specificity was 91.53% [95% confidence interval (CI): 85.84–95.26%]. Further, significant differences were found in depth of the defect, and the thickness (T) and ratio of residual muscle between the inconsistent group and the consistent group at 6 weeks. The patients could be considered self-recovered from CSD at 6 months when the defect depth was equal to or less than 4.04±0.82 mm at 6 weeks after CS. Additionally, in the CSD group at 6 months, the length (r=0.828, P<0.001), depth (r=0.784, P<0.001), width (r=0.787, P<0.001) of the defect, the T (r=0.831, P<0.001) and ratio of residual muscle (r=0.821, P<0.001) were strongly correlated with menstrual duration.

**Conclusions:** CSD evaluation at week 6 after CS may cause misdiagnosis or overdiagnosis. The diagnosis

© Quantitative Imaging in Medicine and Surgery. All rights reserved.

of CSD was suggested to be made following 6 months or longer postpartum.

**Keywords:** Cesarean section (CS); cesarean scar defect (CSD); ultrasound; diagnosis; time

Submitted Mar 16, 2024. Accepted for publication Jul 08, 2024. Published online Jul 26, 2024.
doi: 10.21037/qims-24-531
**View this article at:** https://dx.doi.org/10.21037/qims-24-531

## Introduction

In the past 30 years, the number of women who give birth via cesarean section (CS) has gradually increased in most countries worldwide. The CS rate has even reached 54.5% in China (1). CS has both short-term and long-term complications. Cesarean scar defect (CSD) is a short-term clinical complication of CS (2).

CSD refers to a saclike anatomical defect in the isthmus of the anterior wall of the uterus located at the CS scar (3,4). The incidence of CSD ranges from 24% to 84% across the globe (5). It can lead to gynecological complications such as abnormal uterine bleeding, chronic pelvic pain, dysmenorrhea, and secondary infertility (6). The risk of uterine rupture, placental implantation, and placenta previa in CSD patients during a subsequent pregnancy is significantly increased, which seriously threatens the life safety of the mother and fetus (3).

Due to the above risk of CSD, the timely and effective diagnosis of CSD following CS is crucially important. The methods for CSD diagnosis include ultrasound, magnetic resonance imaging (MRI), and other methods (7,8). A modified Delphi procedure is generally considered the most appropriate method to evaluate CSD via ultrasound (9). According to the Delphi method, CSD is diagnosed when the depth of defect ≥2 mm (9). However, the method does not specify at which time a diagnosis of CSD should be considered after CS. Therefore, this study used ultrasound to analyze CSD at different timepoints after CS. The consistency of the 3 diagnostic results together with the ultrasound indicators of each examination were analyzed. The study aimed to provide a sufficient scientific basis for the optimal time of CSD diagnosis and evaluation. We present this article in accordance with the STARD reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-24-531/rc).

## Methods

### *Ethical approval*

The study was conducted in accordance with the principles of the Declaration of Helsinki (as revised in 2013). This study was approved by the Ethics Committee of West China Second University Hospital, Sichuan University (No. 2020065). Informed consent was provided by all individual participants.

### *Study design and patient selection*

This study was carried out as a monocentric and prospective study. Patients were recruited to this study using a consecutive method. All pregnant women in the study were from West China Second University Hospital between January 2021 and June 2022. The inclusion criteria were as follows: single pregnancy, term birth, between 20 and 42 years old, elective CS with bidirectional barb knot-free suture, and regular menstrual cycles before pregnancy (28–35 days cycle length, 3–7 days menstrual period). The exclusion criteria included any history of CS, myometrium surgery, uterine plastic surgery, or uterine malformation. Indications for elective CS in pregnant women without a history of previous CS included the following: fetal malpresentation, placenta previa, vasa previa, maternal complications such as heart disease, respiratory disorders, severe preeclampsia, or macrosomia, or abnormal uterine growth/tumors, such as uterine fibroids.

A total of 1,428 women were collected, and 159 women underwent 3 ultrasound examinations at 6 weeks, 6 months, and 12 months after CS according to the inclusion and exclusion criteria (*Figure 1*). As 39 women were lost during the follow-up, a total of 120 women were included in the analysis (*Figure 1*).

A menstrual period of 3–7 days was considered normal,

© Quantitative Imaging in Medicine and Surgery. All rights reserved. 

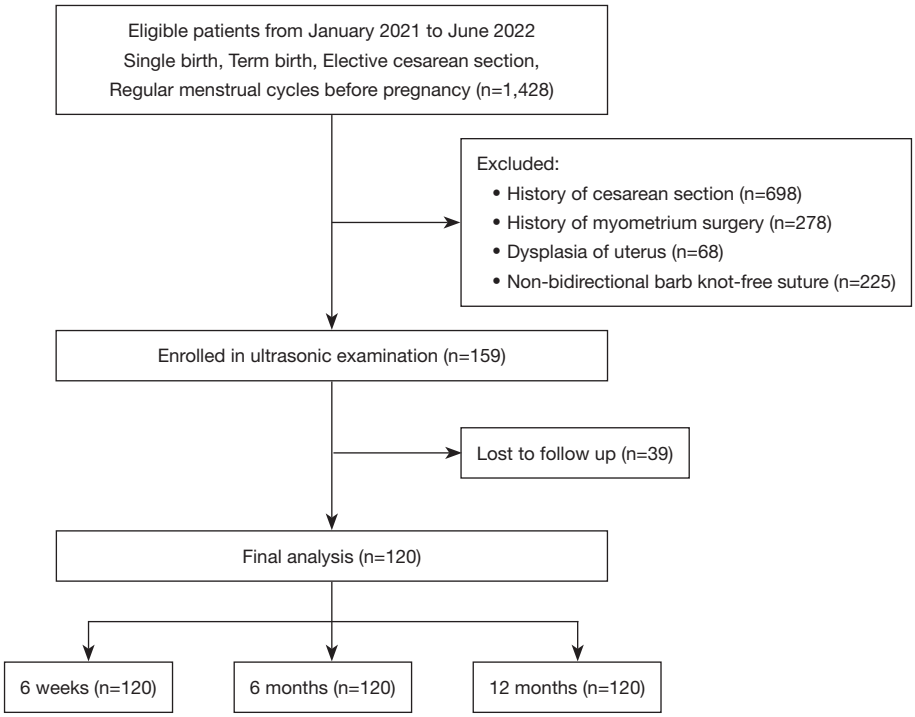


**Figure 1** The flowchart of participants throughout the study.

and >7 days was recorded as prolonged (10,11). First, participants were divided into 2 groups based on the duration of their postpartum period: the normal period group (3–7 days) and the prolonged period group (>7 days). Basic demographic and obstetric data of both groups were analyzed. Then, participants were categorized into 3 groups based on the timing of examination: 6 weeks postpartum, 6 months postpartum, and 12 months postpartum. To assess the consistency of diagnosis results among the 3 groups, further comparisons were made. If the diagnosis results were inconsistent, patients diagnosed with CSD in each group were subdivided into consistent and inconsistent groups. Statistical differences in various ultrasound indicators were then analyzed between these 2 groups. For the group where the diagnosis results were consistent, the relationship between each ultrasound index and postpartum menstrual time was examined.

### *Data collection*

For women who met the inclusion criteria, the basic data were collected at the time of enrollment. This included age, height, weight, whether the pregnancy was assisted by reproductive techniques, whether the pregnancy was complicated by gestational diabetes or gestational hypertension, whether there were postpartum complications by 6 weeks postpartum (such as wound infection or placenta residue), and the duration of postpartum menstruation.

### *Sonographic assessment*

GE Voluson E10 and GE Voluson E8 (GE Healthcare, Milwaukee, WI, USA) color Doppler ultrasonic diagnostic instruments were used, and the frequency of transvaginal ultrasound was 2–10 MHz. The bladder was emptied, and lithotomy was taken. Data analysis was conducted by 2 sonographers with more than 8 years of experience. The Delphi method for ultrasonic diagnosis of CSD (9) is described as follows: at the incision of the lower anterior wall in the longitudinal section of uterus, the muscular layer is discontinuous, but the serosal layer is continuous; 1 or more wedge-shaped or cystic dark areas can be observed; the depth of the dark area is ≥2 mm, and the tip protrudes from the surface of the serous membrane. Once a CSD was diagnosed, the ultrasonic indicators of the defects (*Figure 2*) were collected including (9):

(I) Length of the defect (L): the largest length of the defect in the sagittal view of the uterus (*Figure 2A*). (II)

© Quantitative Imaging in Medicine and Surgery. All rights reserved. 

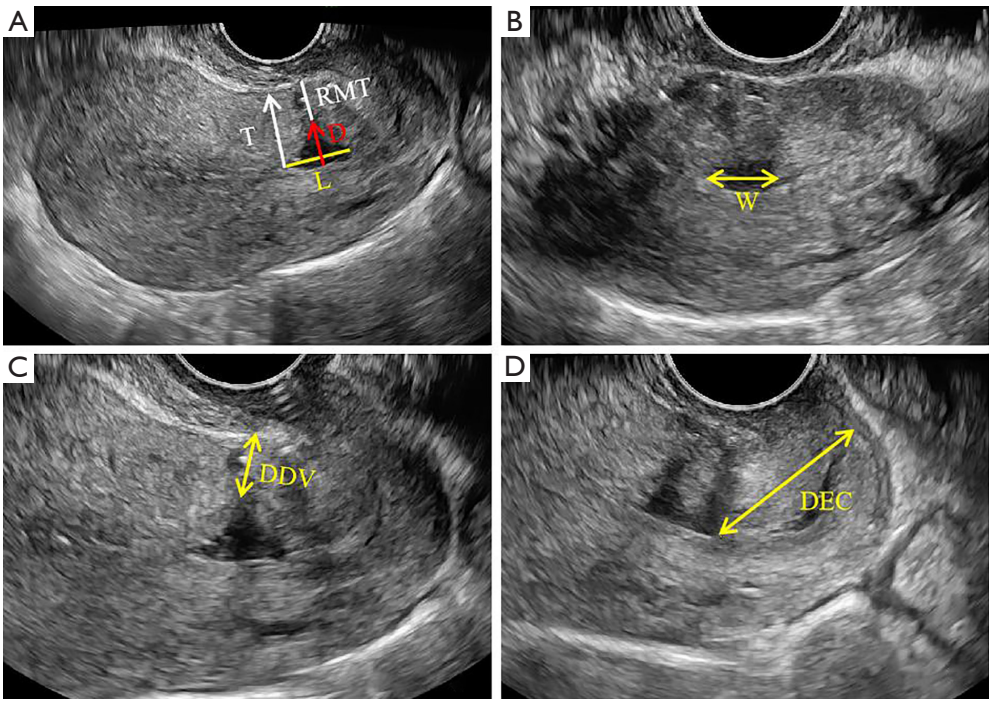


**Figure 2** Ultrasonic indicators measurement of cesarean scar defect. (A) L represents the length of the defect (yellow line), D represents the depth of the defect (red arrow line), RMT represents the thickness of the residual muscle layer (white line), and T represents the thickness of the adjacent muscle layer (white arrow line). (B) W represents the width of the defect (yellow double arrow line). (C) DDV represents the distance from defect to vesico-vaginal fold (yellow double arrow line). (D) DEC represents the distance from the defect to the external cervix (yellow double arrow line). T, the thickness of the adjacent muscle layer; D, depth of the defect; L, length of the defect; RMT, residual muscle thickness; W, width of the defect; DVV, distance from defect to vesico-vaginal fold; DEC, distance from defect to the external cervix.

Depth of the defect (D): the largest depth of the defect in the sagittal view of the uterus (*Figure 2A*). (III) Width of the defect (W): the largest transverse diameter of the defect in the cross-section of the uterus (*Figure 2B*). (IV) Residual muscle thickness (RMT): the distance between the defective point and the serosal layer in the sagittal view of the uterus (the measurement direction is perpendicular to the serous membrane) (*Figure 2A*). (V) Thickness (T): the distance between the upper margin of the defect and the serous layer in the sagittal view of the uterus (the measurement direction is perpendicular to the serous membrane) (*Figure 2A*). (VI) RMT/T (%): it was used to calculate the proportion of residual muscle (%). (VII) Distance from defect to vesico-vaginal fold (DDV): the distance from the apex of the defect to the vesico-vaginal (VV) fold was measured in the sagittal view of the uterus (*Figure 2C*). (VIII) Distance from the defect to the external cervix (DEC): the distance from the lower margin of the defect to the external cervix in the sagittal view of the uterus (*Figure 2D*).

### *Statistical analysis*

The statistical software SPSS 20.0 (IBM Corp., Armonk, NY, USA) was used for the data analysis. The data of continuous variables were expressed as mean ± standard deviation (SD), and the rate of the count data was expressed as percentages (%). Normality was assessed using the Shapiro-Wilk test. Basic demographic and obstetric data between the 2 groups were analyzed using Students' *t*-test for continuous variables, and the count data between the 2 groups were subjected to chi-square test. Paired 4-fold table chi-square test was used to evaluate the consistency in diagnosis of the 3 timepoints. The diagnostic sensitivity and specificity of 6 months and 6 weeks postpartum were calculated using a 4-cell table. Ultrasonic indicators of CSD between the 2 groups were analyzed using Student's *t*-test. Pearson correlation analysis was used to determine the correlation between ultrasound indicators of CSD in 6 months postpartum and menstrual duration. The

© Quantitative Imaging in Medicine and Surgery. All rights reserved. 

**Table 1** Clinical characteristics of the women according to postpartum menstrual period

| Basic characteristics of the patients | Normal menstrual period (3–7 days) (n=52) | Prolonged menstrual period (>7 day) (n=68) | P value |
|---|---|---|---|
| Age of pregnant woman (years) | 34.87±6.05 | 32.49±3.52 | 0.168 |
| BMI (kg/m$^2$) | 21.93±1.73 | 21.71±1.95 | 0.717 |
| Gestational week of delivery | 37.88±1.30 | 37.94±1.14 | 0.390 |
| Assisted reproduction: IVF/ICSI | 9 (17.31) | 11 (16.18) | 0.530 |
| Gestational diabetes mellitus | 6 (11.54) | 7 (10.29) | 0.870 |
| Gestational hypertension | 6 (11.54) | 5 (7.35) | 0.527 |
| Complications at 6 weeks postpartum | | | 0.438 |
| No | 48 (92.31) | 61 (89.71) | |
| Yes (e.g., wound infection, placenta residue, or others) | 4 (7.69) | 7 (10.29) | |

The data of continuous variables were expressed as mean ± standard deviation, and the rate of the count data was expressed as percentages (%). Basic demographic and obstetric data between the two groups was performed using Students' *t*-test for continuous variables, and the count data between the two groups was used by chi-square test. Significance level $\alpha$=0.05. BMI, body mass index; IVF/ICSI, *in vitro* fertilization/intracytoplasmatic sperm injection.

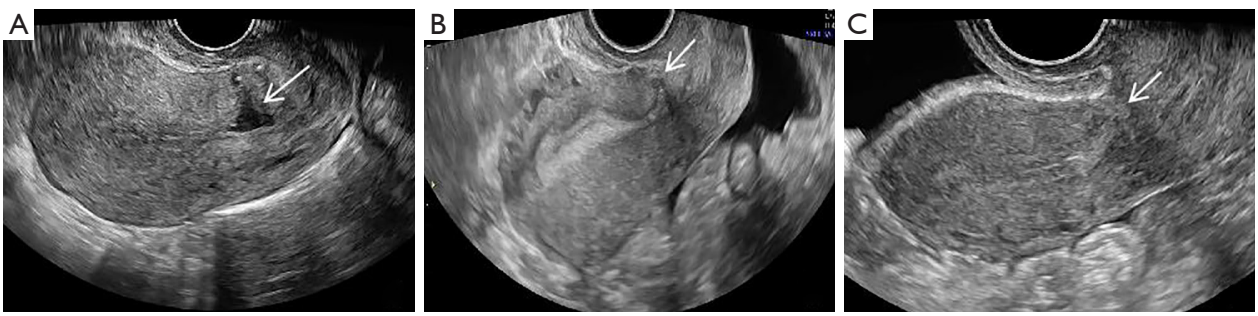


**Figure 3** Ultrasound images of the uterus from the same woman at (A) 6 weeks, (B) 6 months, and (C) 12 months postpartum. The white arrows show the caesarean section scar of the uterus, the presence of a defect in (A), and absence of (A) defect in (B) and (C).

correlation coefficients of 1.0 were considered perfect, 0.7–0.9 indicated a strong correlation, 0.4–0.6 indicated a moderate correlation, 0.1–0.3 indicated a weak correlation, and 0.0 indicated no correlation. A 2-sided P value of <0.05 was considered statistically significant.

## Results

### *Patient characteristics*

A total of 120 pregnant women studied were divided into 2 groups according to postpartum menstrual period: a normal menstrual period group (3–7 days) and a prolonged menstrual period group (>7 days). The basic demographic and obstetric data of the 2 groups had no statistical differences (*Table 1*).

### *The consistency of CSD diagnoses at different postpartum timepoints*

A total of 120 women were included in this study. Among them, 100 women were diagnosed with CSD at 6 weeks postpartum, 66 met the diagnostic criteria at 6 months postpartum, and 61 were diagnosed at 12 months postpartum; 34 cases at 6 months postpartum and 39 cases at 12 months postpartum did not meet the diagnosis of CSD. *Figure 3* illustrates an example of CSD detected at 6 weeks postpartum, which was shown to have resolved by 6 and 12 months postpartum.

© Quantitative Imaging in Medicine and Surgery. All rights reserved. 

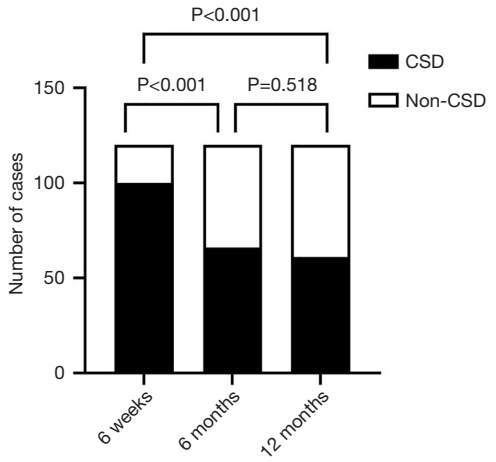


**Figure 4** Consistency evaluation of CSD diagnoses at different timepoints after cesarean section by using chi-square test of 4-fold table. Significance level α=0.05. CSD, cesarean scar defects.

**Table 2** The table of CSD and non-CSD cases diagnosed by ultrasound at 6 months, 6 weeks, and 12 months postpartum

| Groups | 12 months postpartum (n) | |
|---|---|---|
| | CSD | Non-CSD |
| 6 months postpartum (n) | | |
| CSD | 61 | 5 |
| Non-CSD | 0 | 54 |
| 6 weeks postpartum (n) | | |
| CSD | 61 | 39 |
| Non-CSD | 0 | 20 |

CSD, cesarean scar defects.

Compared to the diagnostic results at 6 and 12 months after delivery, the chi-square value of that at week 6 was 22.585 (P<0.001), 28.700 (P<0.001), respectively. The chi-square value of diagnosis at 6 and 12 months postpartum was 0.418 (P=0.518) (*Figure 4*). This meant the diagnostic results of 6 weeks were inconsistent with those of 6 or 12 months postpartum, whereas it was consistent between the diagnosis of 6 and 12 months postpartum. As shown in *Table 2*, the diagnostic sensitivity of 6 months and 6 weeks postpartum were both 100%. The diagnostic specificity of 6 months postpartum was 91.53% [95% confidence interval (CI): 85.84–95.26%], whereas the diagnostic specificity of 6 weeks postpartum was 33.90% (95% CI: 26.55–42.98%).

### *The analysis of ultrasound indicators of CSD*

In the 100 cases diagnosed as CSD at 6 weeks postpartum, only 66 cases still meet the diagnostic criteria, and 34 cases were excluded from CSD at 6 months postpartum. According to the diagnostic consistency, the 100 cases were divided into 2 groups: a consistent group (66 cases) and an inconsistent group (34 cases). Further, as revealed by the ultrasound indicators, we found that the depth of defect in the consistent group (5.92±1.61 mm) was significantly greater than that in the inconsistent group (4.04±0.82 mm), and the T and the ratio of residual muscle were significantly smaller than those in the inconsistent group (*Table 3*). The ultrasound indicators of CSD indicated no statistical differences between 6 and 12 months postpartum groups (*Table 3*).

### *The correlation analysis of ultrasound indicator of CSD and menstrual duration*

We next analyzed the correlation of ultrasound indicators of CSD and menstrual duration time by using Person correlation coefficient analysis. In the CSD group at 6 months postpartum, the length (r=0.828, P<0.001), depth (r=0.784, P<0.001), and width (r=0.787, P<0.001) of the defect, and the T (r=0.831, P<0.001) and ratio of residual muscle (r=0.821, P<0.001) were strongly correlated with menstrual duration. The DEC (r=0.644, P=0.001) and the distance from the defect to the VV fold was moderately correlated with menstrual duration (r=0.439, P=0.032, *Table 4*). The results suggested that CSD was closely related to prolonged menstrual period.

## Discussion

At present, there is no unified standard for the diagnosis of CSD, and the modified Delphi procedure is generally considered the most appropriate and popular method to evaluate the CSD (9). However, the Delphi method does not specify the time that CSD diagnosis should be made after CS (9). In this study, ultrasonic evaluation of CSD for postpartum mothers with regular condition and no branching was performed at 6 weeks, 6 months, and 12 months after CS. CSD was diagnosed when the depth of defect ≥2 mm according to the modified Delphi procedure (9). Although the same diagnostic criteria were adopted, there were significant differences in the CSD

© Quantitative Imaging in Medicine and Surgery. All rights reserved. 

**Table 3** Comparison of ultrasonic indicators of three CSD diagnoses at different timepoints after cesarean section

| Ultrasonic indicators | 6 weeks | | | 6 months (n=66) | 12 months (n=61) | P value[2] |
|---|---|---|---|---|---|---|
| | Inconsistent (n=34) | Consistent (n=66) | P value[1] | | | |
| L (mm) | 7.93±2.12 | 8.30±3.29 | 0.784 | 4.08±1.08 | 4.57±0.99 | 0.056 |
| D (mm) | 4.04±0.82 | 5.92±1.61 | 0.036* | 4.16±0.88 | 3.91±0.93 | 0.202 |
| W (mm) | 9.69±3.67 | 11.58±3.59 | 0.180 | 7.03±2.06 | 6.38±1.73 | 0.114 |
| RMT (mm) | 9.84±1.83 | 7.42±2.36 | 0.020* | 7.67±1.98 | 7.98±2.22 | 0.507 |
| T (mm) | 15.21±3.22 | 15.23±4.51 | 0.581 | 14.87±4.01 | 14.52±3.54 | 0.497 |
| RMT/T (%) | 60.97±11.19 | 48.69±13.40 | 0.024* | 51.59±15.12 | 54.95±15.50 | 0.396 |
| DVV (mm) | 15.94±3.21 | 15.02±3.99 | 0.591 | 14.94±6.12 | 15.40±5.54 | 0.712 |
| DEC (mm) | 25.83±2.83 | 27.58±3.59 | 0.388 | 25.42±4.93 | 24.64±4.94 | 0.414 |

Data are presented as mean ± standard deviation. [1], Student's *t*-test analysis of the ultrasonic indicators of CSD between the inconsistent group and the consistent group at 6 weeks. [2], Student's *t*-test analysis of the ultrasonic indicators of CSD between 6 and 12 months. *, comparison between the consistent group and the inconsistent group at 6 weeks postpartum, P<0.05. CSD, cesarean scar defects; L, length of the defect; D, depth of the defect; W, width of the defect; RMT, residual muscle thickness; T, the thickness of the adjacent muscle layer; DVV, distance from defect to vesico-vaginal fold; DEC, distance from defect to the external cervix.

**Table 4** Correlation between ultrasonic indicators of CSD diagnosed in 6 months postpartum and menstrual duration

| Ultrasonic indicators | Correlation coefficient | P value |
|---|---|---|
| L (mm) | 0.828 | <0.001 |
| D (mm) | 0.784 | <0.001 |
| W (mm) | 0.787 | <0.001 |
| RMT (mm) | 0.831 | <0.001 |
| RMT/T (%) | 0.821 | <0.001 |
| DVV (mm) | 0.439 | 0.032 |
| DEC (mm) | 0.644 | 0.001 |

The correlation of ultrasound indicators of CSD and menstrual duration time by using Person correlation coefficient analysis. Significance level $\alpha$=0.05. CSD, cesarean scar defects; L, length of the defect; D, depth of the defect; W, width of the defect; RMT, residual muscle thickness; T, the thickness of the adjacent muscle layer; DVV, distance from defect to vesico-vaginal fold; DEC, distance from defect to external cervical.

incidence at different times by ultrasound. CSD incidence was highest at 6 weeks postpartum (83.3%), and then it reduced at 6 months postpartum (55.0%), which suggested the occurrence of false positives at week 6 postpartum. The 6 months' diagnosis result was consistent with that at 12 months, indicating that there was no significant difference to make the diagnosis at 6 and 12 months. Our results suggested that 6 weeks' diagnosis is not very accurate, and CSD diagnosis should be made following 6 months or longer after CS.

In our study, using the same diagnostic criteria, the incidence of CSD at 6 months postpartum was significantly lower than that at 6 weeks postpartum. By tracing the data at week 6 postpartum for each included patient, 66 cases' diagnosis of CSD was consistent with the diagnosis at 6 months postpartum, and 34 cases were misdiagnosed at week 6 following CS. Then, the 100 cases of CSD at week 6 were separated into 2 groups, a consistent group and an inconsistent group. The ultrasonic indicators of these 2 groups are summarized in *Table 3*. It was concluded that when the depth of defect was ≥5.92±1.61 mm at 6 weeks postpartum, the diagnostic results were consistent with those at 6 months postpartum. This result suggests that when the depth of defect is ≥5.92±1.61 mm at 6 weeks postpartum, we should be highly vigilant about the possibility of CSD confirmation in the following several months. We further found that the lower the D was, the higher the T and ratio of residual muscle were in the inconsistent group than those in the consistent group.

Previous studies have shown that CSD may lead to abnormal uterine bleeding, dysmenorrhea, and poor fertility (12,13). Abnormal uterine bleeding is associated with the ratio of RMT postpartum (14). Although the relationship between other ultrasonic indicators of CSD and abnormal uterine bleeding has not been fully clarified, the observation of abnormal menstruation is helpful for our screening and

© Quantitative Imaging in Medicine and Surgery. All rights reserved. 

diagnosis of CSD (15). By accurately measuring ultrasound indicators of CSD and analyzing them with postpartum menstrual time, we found that all the recorded ultrasound indicators especially the length, depth, and W, and the T and ratio of residual muscle ($r>0.7$) were correlated with prolonged postpartum menstruation. These results confirmed the accuracy of CSD diagnosis at 6 months and the relationship between CSD and prolonged postpartum menstruation.

The inconsistency observed between CSD diagnoses at 6 weeks and 6 months postpartum may be attributed to the ongoing process of cesarean scar self-repair. Although the standard puerperal period typically ends at 6 weeks postpartum, focusing on uterine rehabilitation, the process of scar repair following CS may extend beyond this timeframe (16). Factors such as the suturing technique, presence of diabetes during pregnancy, and placental attachment can influence scar healing, potentially leading to delays or complications in the repair process (17). This prolonged and continuous tissue remodeling process may not be fully resolved by 6 weeks postpartum for some women, particularly those with underlying risk factors. This approach aligns with findings from literature on scar repair in contexts other than CS, supporting the notion that scar healing may be more complete after 6 months (18-20).

Given that scar repair following CS is likely to continue for several months, a premature diagnosis of CSD at 6 weeks postpartum may result in over-diagnosis and misinterpretation of maternal prognosis and long-term risk. Therefore, we recommend that women undergo ultrasound examination for CSD at 6 months or later postpartum to ensure more accurate diagnosis and better informed clinical decisions.

Several limitations of our study should be considered. First, it was a single-center study with a relatively small sample size, which may have led to selection bias. Second, we preliminarily evaluated the ultrasonic measurements of CSD. In the future, we will establish an ultrasonic evaluation model of CSD based on clinical symptoms, such as prolonged menstrual period, irregular vaginal bleeding, and secondary infertility.

## Conclusions

Our study demonstrated that the sonographic diagnosis of CSD at 6 weeks after CS is not very appropriate, and may cause overdiagnosis or misdiagnosis. The diagnosis of CSD is suggested to be made following 6 months or longer postpartum. In addition, the defect depth of the ultrasonic indicators was associated with the self-repair and CSD diagnosis. The CSD could be self-repaired when the defect depth was equal to or less than 4.04±0.82 mm at 6 weeks after CS. Conversely, when the defect depth exceeded 5.92±1.61 mm, self-repair was less likely, indicating a higher risk of persistent CSD.

## Acknowledgments

*Funding:* This study was supported by Key Technologies Research and Development Program "Reproductive Health and Women and Children's Health Protection" in 2022 under grant number 2022YFC2703300.

## Footnote

*Reporting Checklist:* The authors have completed the STARD reporting checklist. Available at https://qims.amegroups.com/article/view/10.21037/qims-24-531/rc

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-24-531/coif). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The prospective study was conducted according to the Declaration of Helsinki (as revised in 2013) and was approved by the Ethics Committee of West China Second University Hospital, Sichuan University (No. 2020065), and informed consent was provided by all individual participants.

*Open Access Statement:* This is an Open Access article distributed in accordance with the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license).

© Quantitative Imaging in Medicine and Surgery. All rights reserved. 

See: https://creativecommons.org/licenses/by-nc-nd/4.0/.

## References


1. Tang D, Laporte A, Gao X, Coyte PC. The effect of the two-child policy on cesarean section in China: Identification using difference-in-differences techniques. Midwifery 2022;107:103260.
2. Liu X, Huang D, Landon MB, Cheng W, Chen Y. Trends in Cesarean Delivery Rate after Cessation of the One-Child Policy in China. Am J Perinatol 2021;38:e84-91.
3. Zhou D, Wu F, Zhang Q, Cui Y, Huang S, Lv Q. Clinical outcomes of hysteroscopy-assisted transvaginal repair of cesarean scar defect. J Obstet Gynaecol Res 2020;46:279-85.
4. Jordans IPM, de Leeuw RL, Stegwee SI, Amso NN, Barri Soldevila PN, van den Bosch T, Bourne T, Brölmann HAM, Donnez O, Dueholm M, Hehenkamp WJK, Jastrow N, Jurkovic D, Mashiach R, Naji O, Streuli I, Timmerman D, van der Voet LF, Huirne JAF. Niche definition and guidance for detailed niche evaluation. Acta Obstet Gynecol Scand 2019;98:1351-2.
5. Tang X, Wang J, Du Y, Xie M, Zhang H, Xu H, Hua K. Caesarean scar defect: Risk factors and comparison of evaluation efficacy between transvaginal sonography and magnetic resonance imaging. Eur J Obstet Gynecol Reprod Biol 2019;242:1-6.
6. Nezhat C, Falik R, Li A. Surgical management of niche, isthmocele, uteroperitoneal fistula, or cesarean scar defect: a critical rebirth in the medical literature. Fertil Steril 2017;107:69-71.
7. Borges LM, Scapinelli A, de Baptista Depes D, Lippi UG, Coelho Lopes RG. Findings in patients with postmenstrual spotting with prior cesarean section. J Minim Invasive Gynecol 2010;17:361-4.
8. Ofili-Yebovi D, Ben-Nagi J, Sawyer E, Yazbek J, Lee C, Gonzalez J, Jurkovic D. Deficient lower-segment Cesarean section scars: prevalence and risk factors. Ultrasound Obstet Gynecol 2008;31:72-7.
9. Jordans IPM, de Leeuw RA, Stegwee SI, Amso NN, Barri-Soldevila PN, van den Bosch T, Bourne T, Brölmann HAM, Donnez O, Dueholm M, Hehenkamp WJK, Jastrow N, Jurkovic D, Mashiach R, Naji O, Streuli I, Timmerman D, van der Voet LF, Huirne JAF. Sonographic examination of uterine niche in non-pregnant women: a modified Delphi procedure. Ultrasound Obstet Gynecol 2019;53:107-15.
10. Deligeoroglou E, Creatsas G. Menstrual disorders. Endocr Dev 2012;22:160-70.
11. Wang CJ, Huang HJ, Chao A, Lin YP, Pan YJ, Horng SG. Challenges in the transvaginal management of abnormal uterine bleeding secondary to cesarean section scar defect. Eur J Obstet Gynecol Reprod Biol 2011;154:218-22.
12. Luo L, Niu G, Wang Q, Xie HZ, Yao SZ. Vaginal repair of cesarean section scar diverticula. J Minim Invasive Gynecol 2012;19:454-8.
13. Tulandi T, Cohen A. Emerging Manifestations of Cesarean Scar Defect in Reproductive-aged Women. J Minim Invasive Gynecol 2016;23:893-902.
14. Vikhareva Osser O, Valentin L. Risk factors for incomplete healing of the uterine incision after caesarean section. BJOG 2010;117:1119-26.
15. Yi H, Liu J, Li Q, Wu X, Yang Q. Application of cluster enhanced recovery measures in elective cesarean section of scar uterus patients. Minerva Med 2023;114:554-6.
16. Fabres C, Arriagada P, Fernández C, Mackenna A, Zegers F, Fernández E. Surgical treatment and follow-up of women with intermenstrual bleeding due to cesarean section scar defect. J Minim Invasive Gynecol 2005;12:25-8.
17. Liu SJ, Lv W, Li W. Laparoscopic repair with hysteroscopy of cesarean scar diverticulum. J Obstet Gynaecol Res 2016;42:1719-23.
18. Cangkrama M, Wietecha M, Werner S. Wound Repair, Scar Formation, and Cancer: Converging on Activin. Trends Mol Med 2020;26:1107-17.
19. Monavarian M, Kader S, Moeinzadeh S, Jabbari E. Regenerative Scar-Free Skin Wound Healing. Tissue Eng Part B Rev 2019;25:294-311.
20. Son D, Harijan A. Overview of surgical scar prevention and management. J Korean Med Sci 2014;29:751-7.


**Cite this article as:** Jiang Y, Qiao X, Li T, Wen J, Luo H. Comparison of ultrasonic diagnosis of cesarean scar defects at different timepoints following cesarean section. Quant Imaging Med Surg 2024;14(8):5490-5498. doi: 10.21037/qims-24-531

© Quantitative Imaging in Medicine and Surgery. All rights reserved. 