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ORIGINAL RESEARCH ARTICLE

Vaginal repair of cesarean section scar defects: Preoperative hysteroscopic evaluation

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Abstract

Introduction: Cesarean section scar defects (CSDs) are one of the long-term complications following cesarean section. They can be detected by transvaginal sonography, hysterosalpingography, sonohysterography and magnetic resonance imaging (MRI). Hysteroscopy is frequently used in evaluating endometrial disease. However, the description of CSDs by hysteroscopy is very limited. Only a few papers about hysteroscopy evaluation have been published. This is an exploratory study to compare hysteroscopic findings with myometrial thickness and post-surgical outcomes.

Material and methods: From February 2019 to December 2020, 143 women with CSDs were enrolled in the observational study. All women suffered from abnormal uterine bleeding and were evaluated in a standardized way with hysteroscopy before vaginal surgery. Dome-shaped CSDs could be clearly observed in all patients under hysteroscopy. We recorded the pictures of each patient under hysteroscopy and classified them. All patients underwent outpatient review at 3 and 6 months after surgery to obtain menstrual information and CSD scar size by MRI or transvaginal sonography.

Results: Pale mucosae in the defect were meager endometrial lining covering the surface of muscle layer, cyst lesions were some cyst lesions in the defect, increased local vascularization was a vascular tree with branching and irregular vascular distribution in defect, polypoid lesions were polypoid lesions in the defect, and serrated niches were two niches at the anterior uterine isthmus. The features of the CSDs observed under hysteroscopy were identified as five phenotypes: pale mucosae (90/143, 62.9%), cyst lesions (23/143, 16.1%), polypoid lesions (19/143, 13.3%), increased local vascularization (27/143, 18.9%) and serrated niches (7/143, 4.9%). The most common finding in scar defects under hysteroscopy was pale mucosae in the CSD. The results suggest that patients with increased local vascularization and serrated niches have a high risk of thinner residual myometrium before vaginal repair ($p < 0.05$). However, there was

Abbreviations: AUB, abnormal uterine bleeding; CS, cesarean section; CSD, cesarean section scar defect; MRI, magnetic resonance imaging; TRM, thickness of the residual myometrium; VEGF, vascular endothelial growth factor.

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no significant difference in menstrual duration or in the outcome of vaginal repair for CSDs between these five phenotypes ($p > 0.05$).

Conclusions: Patients with the abnormal blood vessel or serration phenotypes of defects under hysteroscopy may have a thinner residual myometrium. The phenotypes of hysteroscopic findings of CSDs have no correlation with the outcome of repair.

KEYWORDS

cesarean section scar defect, hysteroscopy, myometrial thickness, surgical outcomes

1 | INTRODUCTION

Cesarean section (CS) plays a critical role in resolving dystocia and severe pregnancy complications, reducing maternal and perinatal morbidity and mortality. In the past few decades, the global rate of CS has increased annually.[1,2] Cesarean section scar defects (CSDs) are one of the long-term complications following CS and were first described by Fabres et al.[3] as an anatomic niche of the anterior uterine isthmus observable by transvaginal sonography and hysteroscopy. CSDs could further induce many related conditions, such as abnormal uterine bleeding (AUB), infertility, cesarean scar pregnancy and pregnant uterine rupture.[4-7]

Notably, AUB is the most common symptom of CSD and presents with longer postmenstrual spotting. The most common explanation for spotting is menstrual blood drainage obstruction in the niche of the uterus. There is also a correlation between secondary infertility and the niche of the uterus. CSD can lead to the accumulation of fluid or blood in the uterine cavity, which has an adverse effect on sperm quality and embryo transport.[8,9] Some studies have reported that CSD repair can significantly improve fertility in most women by eliminating postoperative uterine effusion and blood.[10,11]

In recent years, as our understanding has increased, it has been reported that large CSDs in nonpregnant women are associated with the risk of uterine rupture in subsequent pregnancies.[4] Some surgical approaches, such as hysteroscopic, laparoscopic or (laparoscopic-assisted) vaginal repair for the treatment of CSDs were reported.[12-14] Laparoscopic and vaginal surgery have been approved to be minimally invasive and effective methods to treat CSD and reconstruct anatomy and function but require the operators to have sufficient surgical skills. A hysteroscopic niche resection is the least invasive technique but it was only performed when the residual myometrium between the niche and the bladder was sufficiently thick to prevent bladder injury.[12,15] Hysteroscopy is frequently used in evaluating endometrial disease and the environment of the uterine cavity. However, the description of CSDs by hysteroscopy is very limited. Only a few papers about hysteroscopy evaluation are published.[3,16]

Hysteroscopy is used to detect CSDs visually and to exclude local disease which may cause AUB. The characteristics of CSDs under hysteroscopic evaluation should be emphasized; literature reports of the phenotypes of hysteroscopic findings of CSDs are absent, and CSD features under hysteroscopy may be associated with CSD clinical presentation, for example longer postmenstrual spotting and the diminished thickness of the residual myometrium (TRM) of the uterus. The hysteroscopic findings in nonpregnant CSD women may help identify women with a higher risk of uterine rupture in subsequent pregnancies and thorough hysteroscopy examination may add further information about CSDs which may have important clinical implications.

Key message

Patients with abnormal blood vessel or serration phenotypes of defects under hysteroscopy may have thinner residual myometria.

Therefore, the aim of this study was to determine the phenotypes of CSDs under hysteroscopy and to explore the associations of these findings with the clinical characteristics and outcome of vaginal repair.

2 | MATERIAL AND METHODS

A prospective cohort study was performed in the Department of Obstetrics and Gynecology, Xin Hua Hospital affiliated to Shanghai Jiao Tong University School of Medicine. This is a tertiary referral center where experts in hysteroscopy and surgery for CSDs are available. From February 2019 to December 2020, all women who had a history of CS and CSDs, diagnosed by transvaginal sonography and magnetic resonance imaging (MRI) and who suffered from AUB, were asked to participate in the study. All of the women signed a written informed consent. The depth and length of the niche were reviewed as measured by ultrasound and MRI in the midsagittal plane. The width was measured in the horizontal plane[14] (Figure 1). Exclusion criteria were pregnancy, coagulation disorders, use of intrauterine devices, submucous myoma, endometrial hyperplasia and malignant tumor. The detailed clinical information obtained from the patients included age, childbearing history, postoperative menstrual history, number of CSs, menstrual history including AUB, and imaging findings of MRI before and after vaginal repair.

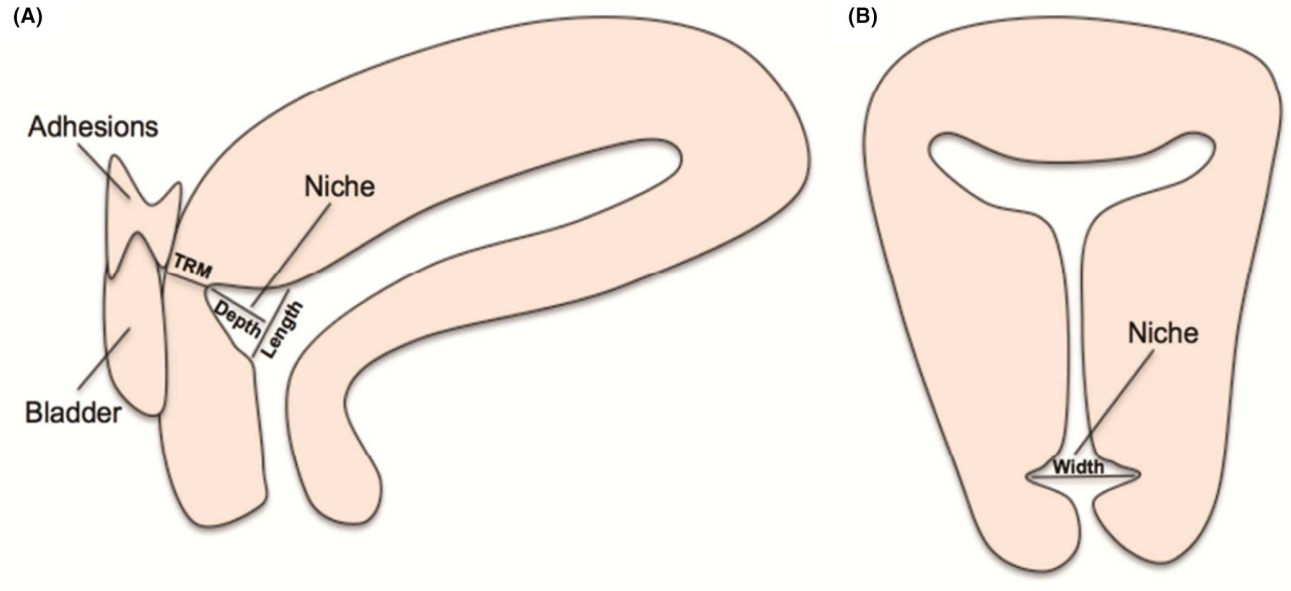

FIGURE 1 Schematic presentation of defect measurements. (A) In sagittal plane. (B) In coronal plane. TRM, thickness of the residual myometrium.

2.1 | Hysteroscopy procedure

All hysteroscopic examinations were done using a 5.5-mm continuous-flow hysteroscopic system with 30° optics (Karl Storz) and were performed by one gynecologic specialist with extensive experience in operative hysteroscopy. This 30° fore/oblique hysteroscope was elected to allow examination of the anterior wall of the uterus by turning it towards the anterior uterine wall. All women were evaluated in a standardized way with hysteroscopy at day 7–14 of the menstrual cycle. The women were placed in the lithotomy position with anesthesia and routine disinfection of the vulva and vagina. We used normal saline as a uterine distention medium at a pressure of 80–120 mmHg. Hysteroscopy was used to examine the cervical canal and uterine cavity. After entering the uterine cavity, the anterior wall of the uterus was completely evaluated by turning the hysteroscope towards it. Disruptions (niche), endometrial situation and vascular proliferation were observed. The basic characteristics, gynecologic symptoms and hysteroscopic findings, such as polyps, cysts, mucosa, size/shape/location of niche and (abnormal) vascular pattern inside the niches, were recorded.

2.2 | Procedure for vaginal repair

After an interval of one menstrual period, vaginal repair was administered at day 7–14 of the menstrual cycle. All surgical procedures were performed by an experienced surgeon as previously described.[13,14] After anesthesia, the patient was placed in the bladder lithotomy position. After perineum disinfection, the surgeon opened the anterior vaginal vault and entered the abdominal cavity. Under the guidance of the probe, the location of the defect could be found and the weak part removed completely using scissors. The myometrium was closed intermittently using 1–0 absorbable sutures. After closing the vaginal incision, gauze was placed in the vagina, and indwelling urinary catheterization was performed for 24 h.

2.3 | Follow-up

All patients underwent outpatient review at 3 and 6 months after surgery to obtain menstrual information and CSD scar size using MRI or transvaginal sonography. If the patient failed to come to the clinic in time, medical workers followed them up and collected information by phone.

2.4 | Statistical analyses

All analyses were performed using the statistical package SPSS 23.0 (SPSS Inc.). Continuous data are presented as the mean and standard deviation. Categorical data are expressed as numbers and percentages. The normality of the continuous data was tested using QQ plots. Comparisons of the proportions of clinical parameters between groups with the time interval between the CS and the hysteroscopy, different durations of menstruation and TRM of CSDs were conducted using the chi-square test (categorical data). A $p < 0.05$ was considered statistically significant.

2.5 | Ethics statement

This prospective study was approved by the ethics committee of Xin Hua Hospital affiliated to Shanghai Jiao Tong University School of Medicine (reference XHEC-H-2018-002) on August 10, 2018. All patients gave their written informed consent.

3 | RESULTS

From February 2019 to December 2020, 143 patients with CSD were eligible and enrolled in this study. They all underwent hysteroscopy for examination and vaginal repair 1 month later. Patient demographic characteristics are presented in Table 1. The mean age was 33.3 ± 3.7 years (range 25–43 years). Of the 143 women included in the study, 86 had a history of one CS and 57 had a history of repeat cesarean surgeries. A total of 84 women (61.5%) had a retroflexed uterus. All patients suffered from postmenstrual bleeding, with a mean menstrual period of 12.7 ± 3.5 days (range 9–20 days) and TRM of 2.6 ± 1.8 mm (range 0–12 mm).

The uterine cavity and endometrium of all patients were normal, and no obvious endometrial or fibroid polyps or intrauterine adhesions were observed. Dome-shaped CSDs were clearly observed in all patients. A high percentage of the patients (119/143, 83.2%) had defects at the middle of the lower anterior wall of the uterus, 9.8% (14/143) on the left and 7.0% (10/143) on the right. The most common finding in scar defect mucosa by hysteroscopy was pale mucosae in the defect, with very thin and even fibrotic meager endometrial lining covering the surface of muscle layer being present in 90 women (62.9%) (Figure 2A). Several other types of images of cyst lesions (23/143, 16.1%, Figure 2B), some in scar defects, increased local vascularization (27/143, 18.9%, Figure 2C), presenting a vascular tree with branching and irregular vascular distribution in the scar defect, and polypoid lesions (19/143, 13.3%, Figure 2D), some in scar defects, were also common.

In addition, we also found that seven women (4.9%) suffered from two niches and had a history of repeat CSs (Figure 3). Therefore, of those 143 women, the features of CSDs in observed via hysteroscopy were identified as follows: pale mucosae, cyst lesions, polypoid lesions, increased local vascularization and serrated niches (Table 2).

As shown in Table 3, there was no relation between the time interval from CS to hysteroscopy and the type of CSD phenotype ($p > 0.05$). All phenotypes of CSDs can cause menstrual disorder. Before vaginal repair, we found that there was no significant difference in menstruation and TRM between the patients with pale mucosae, cyst lesions, and polypoid lesions in the defects and those without them ($p > 0.05$). However, patients with increased local vascularization and the serration CSD phenotype under hysteroscopy had relatively thinner TRM than patients with the other phenotypes of CSDs ($p = 0.030$ and $p = 0.020$), but there was no significant difference in menstruation ($p = 0.147$ and $p = 0.106$). Moreover, in about 5% of the cases, two niches were observed in seven patients with a history of repeated CSs. Although the presence of multiple niches could be diagnosed by MRI, it is interesting to view them using hysteroscopy. This will assist accurate localization of the

TABLE 1 Patient demographics

Characteristic	Patients ($n = 143$)
Age, years	33.3 ± 3.7 (25–43)
Gravidity	2.4 ± 1.4 (1–8)
Number of cesarean deliveries	
1	86 (60.1)
≥2	57 (39.9)
Duration of postmenstrual spotting after cesarean delivery, days	12.7 ± 3.5 (9–20)
Retroflexed uterus, *n* (%)	88 (61.5)
Depth of uterus, cm	8.5 ± 0.5 (7–10)
TRM, mm	2.6 ± 1.8 (0–12)

Note: Values are given as mean ± *SD* or *n* (%).

Abbreviation: TRM, thickness of the residual myometrium.

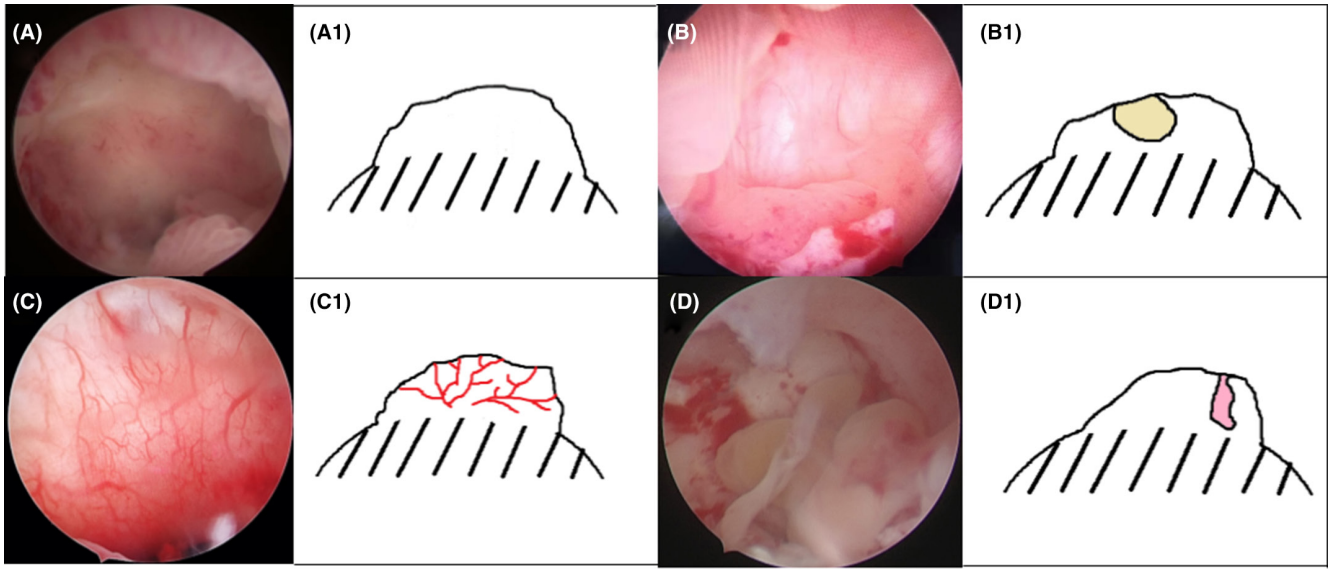

FIGURE 2 Hysteroscopic images of cesarean section scar defects. (A and A1) Pale mucosae in the defect. (B and B1) Cyst lesions in the defect. (C and C1) Increased local vascularization in the defect. (D and D1) Polypoid lesions in the defect.

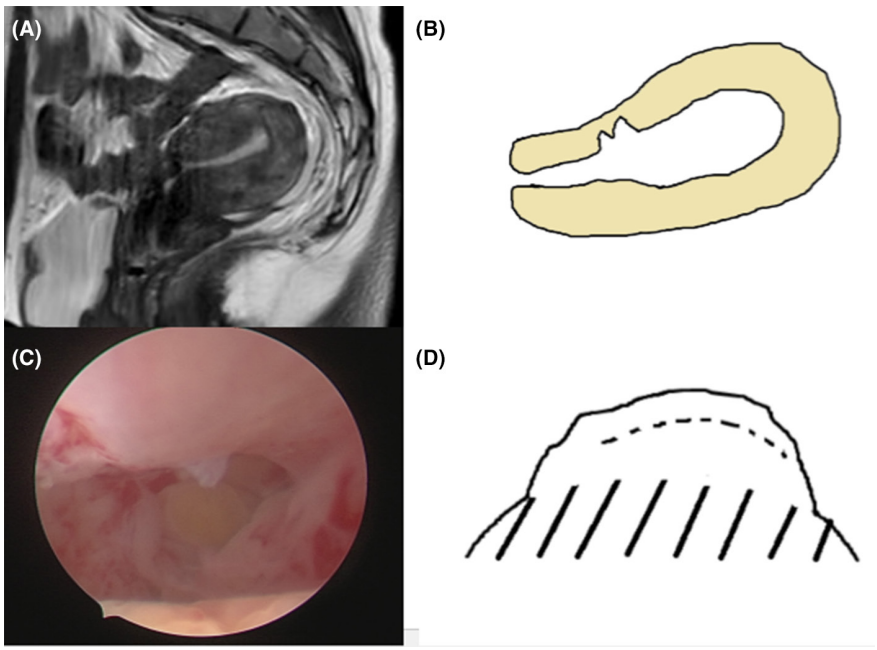

FIGURE 3 Images of defects in repeat cesarean sections. (A) MRI scans of defects in the longitudinal plane. (B) Diagram of defects in the longitudinal plane. (C) Diagram of defects in the transverse plane. (D) Hysteroscopic image of defects.

TABLE 2 Hysteroscopic findings of cesarean section scar defects in patients

Hysteroscopic finding	*n* (%)
Location of defects	
Middle	119 (83.2)
Left	14 (9.8)
Right	10 (7.0)
Pale mucosae in the defect	90 (62.9)
Cyst lesions in the defect	23 (16.1)
Polypoid lesions in the defect	19 (13.3)
Increased local vascularization	27 (18.9)
Serrated niche	7 (4.9)

Note: Values are given as *n* (%).

TABLE 3 Phenotypes of defects under hysteroscopy and the time interval between the CS and the hysteroscopy

Hysteroscopic finding	*n*	Time interval (months)	*p*
Increased local vascularization			
No	115	64.1 ± 38.5	0.969
Yes	27	64.4 ± 36.4	
Polypoid lesions in the defect			
No	124	64.0 ± 38.4	0.880
Yes	19	65.4 ± 36.1	
Cyst lesions in the defect			
No	120	65.3 ± 38.6	0.239
Yes	23	54.9 ± 33.1	
Pale mucosae in the defect			
No	53	64.4 ± 39.3	0.921
Yes	90	63.8 ± 36.0	

Note: Values are given as mean ± *SD*.
Abbreviation: CS, cesarean section.

defects and help ensure that the surgeon does not miss correction of a second niche. After vaginal repair, there was no significant difference in menstruation or TRM among the five phenotypes in terms of the hysteroscopic findings ($p > 0.05$, Table 4).

4 | DISCUSSION

The present study showed that we were able to describe the number, location, mucosal type, presence of polyps and abnormal blood vessels under hysteroscopy of symptomatic women with a history of one or more CSs. This is could be very useful: it will enable the gynecologist to detect the exact site and extent of CSDs in order to identify specific changes, which is of great importance before surgical correction.

AUB, often manifesting as postmenstrual spotting, is the most common clinical manifestation in patients with CSD and is associated with dark red or brown discharge after main menstruation. Possible mechanisms for AUB caused by CSD include impaired blood drainage and in situ production.[17] The outflow tract was blocked, so menstrual blood remained in the CSD.[3,15] Resection of myometrial defect in the anterior uterine isthmus and re-suturing of the myometrium to smooth the drainage tract, improved the gynecological symptoms such as postmenstrual spotting, and the anatomic structure of the uterus was repaired by a vaginal procedure.

In this study, we describe the number, location, mucosal type, polyps and abnormal blood vessels with direct visualization using hysteroscopy as shown in Table 2. To our knowledge, five phenotypes identified under hysteroscopy were proposed for the first

TABLE 4 Relation between the phenotypes of defects in hysteroscopy, TRM and duration of menstruation

Hysteroscopic finding	No.	TRM before VR (mm)	*p*	Duration of menstruation after CS (days)	*p*	TRM after VR (mm)	*p*	Duration of menstruation after VR (days)	*p*
Increased local vascularization									
No	115	2.6 ± 1.5	0.030	12.5 ± 3.5	0.147	6.9 ± 2.1	0.345	7.4 ± 2.3	0.875
Yes	27	2.1 ± 1.2		13.6 ± 3.5		7.4 ± 1.7		7.5 ± 1.9	
Polypoid lesions in the defect									
No	124	2.6 ± 1.5	0.210	12.9 ± 3.5	0.214	7.0 ± 1.9	0.845	7.4 ± 2.3	0.422
Yes	19	2.3 ± 1.0		11.9 ± 3.5		7.2 ± 2.8		7.1 ± 1.2	
Cyst lesions in the defect									
No	120	2.5 ± 1.5	0.492	12.6 ± 3.6	0.164	7.2 ± 2.1	0.130	7.4 ± 2.3	0.599
Yes	23	2.8 ± 1.4		13.6 ± 2.7		6.3 ± 1.8		7.2 ± 1.2	
Pale mucosae in the defect									
No	53	2.6 ± 1.5	0.849	12.8 ± 3.7	0.792	6.9 ± 2.0	0.292	7.1 ± 1.5	0.204
Yes	90	2.5 ± 1.4		12.6 ± 3.1		7.3 ± 2.1		7.9 ± 3.0	
Serrated niche									
No	136	2.7 ± 1.8	0.020	12.6 ± 3.5	0.106	7.0 ± 1.9	0.524	7.4 ± 2.2	0.667
Yes	7	1.6 ± 0.8		15.2 ± 3.2		8.3 ± 3.7		7.3 ± 0.5	

Note: Values are given as mean ± *SD*.

Abbreviations: CS, cesarean section; TRM, the thickness of the residual myometrium; VR, vaginal repair.

time in the literature: pale mucosae, cyst lesions, polypoid lesions, increased local vascularization and serrated niche. It is extremely importance to note that more hysteroscopic findings were seen in patients with CSDs, the most common being pale mucosae (62.9%) and increased local vascularization (18.9%).

CSDs can be diagnosed by transvaginal sonography or MRI, but hysteroscopic examination can add important findings, including the relation between the imaging tests and hysteroscopic evaluation of defects. To our knowledge, this is the first study recording CSD phenotypes under hysteroscopic observation and evaluating the relation between those phenotypes and menstruation/TRM before and after vaginal repair. Notably, it was found that women with increased local vascularization and serration of the niche were more likely to have thinner TRM.

Some studies have indicated that the promotion of angiogenesis occurs via vascular endothelial growth factor (VEGF).[18,19] After CS, the myometrium and blood vessels are destroyed. When re-suturing the incision, the tissue is repaired quickly, and the fast-growing cells consume a large amount of oxygen, resulting in local hypoxia.[20,21] This hypoxic condition induces the activation of VEGF to promote angiogenesis and increase local perfusion.[22] However, there was a vicious cycle, in which the uterine incision was not repaired properly and formed a diverticulum, which again promoted angiogenesis, resulting in increased local vascularization in the defects, as seen under hysteroscopy, and a diminished TRM. Patients with a serrated niche who had multiple CSs had poor incision healing and a diminished TRM. There was some correlation between hysteroscopy and myometrial thickness, which until now was of questionable clinical relevance, but which is here considered an area of interest of particular note.

It could be plausible to consider that the diminished TRM of niches in nonpregnant women is more likely to be associated with the risk of uterine rupture in subsequent pregnancies, which may lead to dramatic consequences for both mothers and their infants.

Another interesting finding in the present study is that there was no relation between the time interval from the CS to the hysteroscopy and the phenotypes of CSD by hysteroscopic observation. It could be postulated that CSDs will not be resolved over time and those women should be counseled for correction of these defects to resolve their symptoms or before attempting pregnancy.

There are some limitations to this study. First, the study included symptomatic patients with CSDs only. Other hysteroscopic findings may be present in asymptomatic women with a history of CS. This outside the scope of the present study. Conducting diagnostic hysteroscopy under anesthesia is another limitation. These findings may be seen by other hysteroscopists using office hysteroscopy. Further prospective and mega data population studies are needed to examine the relation between the clinical symptoms of CSD and the phenotypes of the niche in hysteroscopic evaluation.

5 | CONCLUSION

To the best of our knowledge this is the first article describing the hysteroscopic appearance of CSDs in symptomatic women. This may improve the identification and treatment of CSDs and may have clinical implications. We propose, for the first time, that the morphology of CSDs under hysteroscopy be evaluated and classified.

The phenotypes involving abnormal blood vessels or serrations in the niche under hysteroscopic observation often indicate a thinner residual muscle, which may require surgical repair or intervention, especially for women who desire a subsequent pregnancy. The phenotypes under hysteroscopy could be used for future studies looking into this area. We therefore recommend diagnostic hysteroscopy in symptomatic patients with CSDs before surgery or attempting pregnancy. In addition, vaginal repair is a minimally invasive and effective method to treat CSD; however, surgical experience is needed.

AUTHOR CONTRIBUTIONS

HC and HZ: data collection, manuscript writing. YW: data collection and review. XW: project development and data analysis.

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CONFLICT OF INTEREST

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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REFERENCES

1. Walker R, Turnbull D, Wilkinson C. Strategies to address global cesarean section rates: a review of the evidence. *Birth*. 2002;29:28-39.
2. Molina G, Weiser TG, Lipsitz SR, et al. Relationship between cesarean delivery rate and maternal and neonatal mortality. *JAMA*. 2015;314:2263-2270.
3. Fabres C, Aviles G, De La Jara C, et al. The cesarean delivery scar pouch: clinical implications and diagnostic correlation between transvaginal sonography and hysteroscopy. *J Ultrasound Med*. 2003;22:695-700; quiz 701-2.
4. Vikhareva Osser O, Valentin L. Clinical importance of appearance of cesarean hysterotomy scar at transvaginal ultrasonography in nonpregnant women. *Obstet Gynecol*. 2011;117:525-532.
5. Tower AM, Frishman GN. Cesarean scar defects: an underrecognized cause of abnormal uterine bleeding and other gynecologic complications. *J Minim Invasive Gynecol*. 2013;20:562-572.
6. Bij de Vaate AJ, van der Voet LF, Naji O, et al. Prevalence, potential risk factors for development and symptoms related to the presence of uterine niches following cesarean section: systematic review. *Ultrasound Obstet Gynecol*. 2014;43:372-382.
7. Glenn TL, Han E. Cesarean scar defect: far from understood. *Fertil Steril*. 2021;116:369-370.
8. Vissers J, Hehenkamp W, Lambalk CB, Huirne JA. Post-caesarean section niche-related impaired fertility: hypothetical mechanisms. *Hum Reprod*. 2020;35:1484-1494.
9. Kremer TG, Ghiorzi IB, Dibi RP. Isthmocele: an overview of diagnosis and treatment. *Rev Assoc Med Bras*. 2019;65:714-721.
10. Donnez O, Donnez J, Orellana R, Dolmans MM. Gynecological and obstetrical outcomes after laparoscopic repair of a cesarean scar defect in a series of 38 women. *Fertil Steril*. 2017;107:289-296.e2.
11. Vervoort A, Vissers J, Hehenkamp W, Brolmann H, Huirne J. The effect of laparoscopic resection of large niches in the uterine caesarean scar on symptoms, ultrasound findings and quality of life: a prospective cohort study. *BJOG*. 2018;125:317-325.
12. van der Voet LF, Vervoort AJ, Veersema S, BijdeVaate AJ, Brolmann HA, Huirne JA. Minimally invasive therapy for gynaecological symptoms related to a niche in the caesarean scar: a systematic review. *BJOG*. 2014;121:145-156.
13. Chen H, Wang H, Zhou J, Xiong Y, Wang X. Vaginal repair of cesarean section scar diverticula diagnosed in non-pregnant women. *J Minim Invasive Gynecol*. 2019;26:526-534.
14. Zhou J, Yao M, Wang H, Tan W, Chen P, Wang X. Vaginal repair of cesarean section scar diverticula that resulted in improved postoperative menstruation. *J Minim Invasive Gynecol*. 2016;23:969-978.
15. Vervoort A, van der Voet LF, Hehenkamp W, et al. Hysteroscopic resection of a uterine caesarean scar defect (niche) in women with postmenstrual spotting: a randomised controlled trial. *BJOG*. 2018;125:326-334.
16. Chang Y, Tsai EM, Long CY, Lee CL, Kay N. Resectoscopic treatment combined with sonohysterographic evaluation of women with postmenstrual bleeding as a result of previous cesarean delivery scar defects. *Am J Obstet Gynecol*. 2009;200(370):e1-e4.
17. Chen YY, Tsai CC, Kung FT, Lan KC, Ou YC. Association between hysteroscopic findings of previous cesarean delivery scar defects and abnormal uterine bleeding. *Taiwan J Obstet Gynecol*. 2019;58:541-544.
18. Cho J, Kim TH, Seok J, et al. Vascular remodeling by placenta-derived mesenchymal stem cells restores ovarian function in ovariectomized rat model via the VEGF pathway. *Lab Invest*. 2021;101:304-317.
19. Reynaud D, Sergent F, Abi Nahed R, et al. Evidence-based view of safety and effectiveness of prokineticin receptors antagonists during pregnancy. *Biomedicine*. 2021;9:309.
20. Befani C, Liakos P. The role of hypoxia-inducible factor-2 alpha in angiogenesis. *J Cell Physiol*. 2018;233:9087-9098.
21. Lee Y, Jung J, Cho KJ, et al. Increased SCF/c-kit by hypoxia promotes autophagy of human placental chorionic plate-derived mesenchymal stem cells via regulating the phosphorylation of mTOR. *J Cell Biochem*. 2013;114:79-88.
22. Liu XH, Bai CG, Xu ZY, et al. Therapeutic potential of angiogenin modified mesenchymal stem cells: angiogenin improves mesenchymal stem cells survival under hypoxia and enhances vasculogenesis in myocardial infarction. *Microvasc Res*. 2008;76:23-30.

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