Original Article

Clinical analysis of uterine parameters evaluated by preoperative magnetic resonance imaging in patients treated by hysteroscopic approach with previous cesarean scar defect-related abnormal uterine bleeding: a retrospective cohort study

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Background: As the cesarean delivery rate continues to rise globally, the treatment of previous cesarean scar defects (PCSD) remains challenging. This study aimed to analyze the variables that may influence the clinical cure rate of patients with PCSD-related abnormal uterine bleeding (AUB) as determined by preoperative magnetic resonance imaging (MRI) following hysteroscopic therapy.

Methods: Women who underwent hysteroscopic surgery for PCSD-related AUB at the Gynecology Department of Third Xiangya Hospital of Central South University from 2018 to 2022 were recruited to this retrospective cohort investigation. A total of 147 patients were enrolled in this study and underwent follow-up over 6 months. The significance of clinical characteristics linked to the clinical cure rate of AUB was examined by logistic regression.

Results: There were 64 clinically cured (43.5%) and 83 non-clinically cured (56.5%) patients in the study. There were no significant differences in the age, menstrual duration, gravidity, parity, number of cesarean sections, time since the previous cesarean section, uterus position, width, depth, and thickness of the remaining muscle layer of the defect by MRI T2-weighted images (T2WI) before hysteroscopic surgery between the 2 groups. MRI T2WI of the myometrial thickness adjacent to the defect [P=0.038, odds ratio (OR) =2.095, 95% confidence interval (CI): 1.047–4.261] and the distance from the defect to the external cervical os (P=0.021, OR =2.254, 95% CI: 1.136–4.540) before hysteroscopic surgery are risk factors for the clinical cure rate.

Conclusions: The myometrial thickness adjacent to the defect and the distance from the defect to the external cervical os in preoperative MRI are risk factors for clinical cure rate in patients with PCSD-related AUB after hysteroscopic treatment, which is helpful for evaluating the prognosis of disease.

Keywords: Abnormal uterine bleeding (AUB); hysteroscopy; magnetic resonance imaging (MRI); outcome; previous cesarean scar defect (PCSD)

Submitted Aug 23, 2023. Accepted for publication Jan 10, 2024. Published online Mar 01, 2024.
doi: 10.21037/qims-23-1205
View this article at: https://dx.doi.org/10.21037/qims-23-1205

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Introduction

The cesarean delivery rate continues to rise globally, as reported by the World Health Organization (WHO) (1,2). In the past decade, although great efforts have been implemented to decrease the cesarean delivery rate in China, the overall national cesarean delivery rate is still high (3-6). It has been shown that inappropriate cesarean delivery is related to numerous short- and long-term complications in women, including bleeding, infection, pelvic adhesions, abnormal placentation, uterine rupture, still birth, preterm birth, and even hysterectomy in the subsequent pregnancy (7,8).

As one of the long-term complications, a previous cesarean scar defect (PCSD) is the presence of a triangular area in the myometrium of the anterior lower uterine wall at the site of the previous caesarean incision, of which the critical clinical symptoms are abnormal uterine bleeding (AUB), dysmenorrhea, chronic pelvic pain, and secondary infertility (9-11). The predominant clinical symptom of PCSD-related AUB is early-cycle intermenstrual bleeding or a protracted menstrual period following the cesarean delivery, which has a considerable detrimental impact on the quality of life of women (11-14). According to a recent systematic review (11), the prevalence of AUB in PCSD patients presenting for imaging for a gynecologic indication is 76.4%, and the mean menstrual duration in symptomatic patients with PCSD is as long as 13.4 days.

Hysteroscopic surgery for PCSD involves the removal of the superior and inferior edge of the uterine scar defect to facilitate the drainage of menstrual blood and fulguration of the bottom of the defect to prevent blood production in the meantime (15-17). In our previous study (18), the clinical efficacy of PCSD-related AUB with hysteroscopic treatment was 78.8%, but the clinical cure rate was only 24.2%. It seems that not all of the patients were ideal candidates for the surgery.

Studies on magnetic resonance imaging (MRI) for PCSD diagnosis and prognosis have rarely been reported to date. The aim of this study was to analyze the factors that might have an impact on the clinical cure rate of patients with PCSD-related AUB following hysteroscopic treatment as assessed by preoperative MRI. We present this article in accordance with the STROBE reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-23-1205/rc).

Methods

Patients

All 254 patients (N=254) with PCSD-related AUB who underwent hysteroscopic surgery in the Gynecology Department of Third Xiangya Hospital of Central South University from 2018 to 2022 were retrospectively recruited for this study. The inclusion criteria for this study included the following: (I) patients with prolonged menstrual duration of at least 3 months following their cesarean delivery; (II) normal ovarian function and ovulation; (III) PCSD was diagnosed by hysteroscopy. The exclusion criteria were as follows: (I) patients with other identified causes of AUB, such as endometrial polyps, adenomyosis, and ovulation disorder; (II) patients who had experienced acute general inflammation or postoperative infection; (III) patients with uncontrolled systemic disease; (IV) patients with malignant tumors or precancerous lesions; (V) patients who were lactating; (VI) patients who had undergone subsequent therapy following surgery within 6 months, such as hormone therapy; (VII) lost to follow-up. A total of 147 patients (n=147) were identified according to the above criteria. A flow chart of detailed participant selection is presented in *Figure 1*.

Ethical statement

The protocol of this study was approved by the Ethics Committee of the Third Xiangya Hospital of Central South University (No. 2020-S625). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). All patients involved in this study received diagnosis and treatment according to standard procedures. All patients were fully informed of surgical procedures, the benefits, potential risks, and outcomes of the treatment before the surgery. All participants provided informed consent.

MRI examination

All participants underwent MRI (Ingenia 3.0T; Philips Co., Eindhoven, Netherlands) evaluation by T2-weighted images (T2WI) pre-operation during the middle to late luteal phase to reduce vaginal bleeding interference. The imaging protocol comprised a T2WI fat saturation sequence (sagittal and coronal planes, repetition time 4,000 ms, echo time

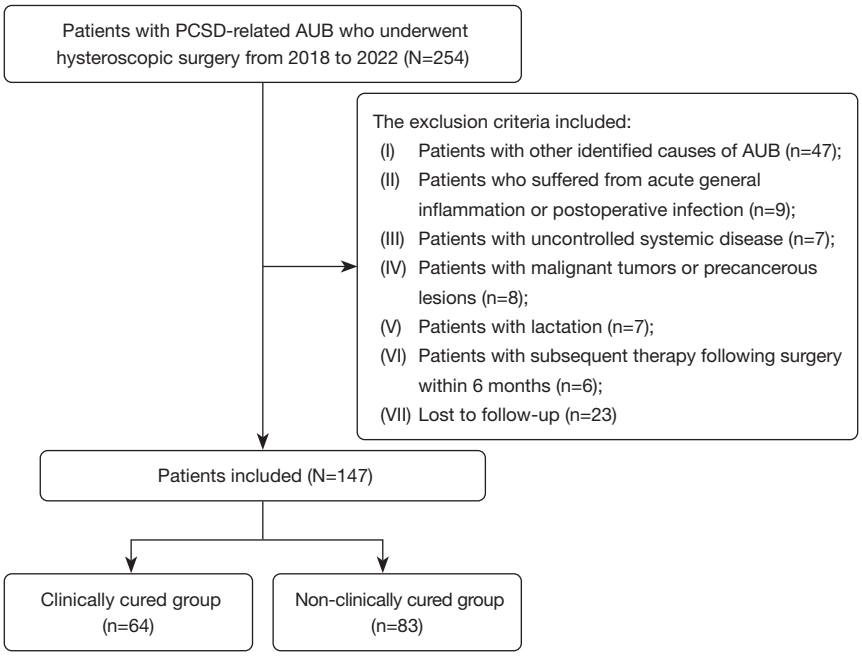

Figure 1 Flow chart of patient selection. PCSD, previous cesarean scar defect; AUB, abnormal uterine bleeding.

79 ms, slice thickness 5 mm, spacing 1.5 mm, acquisition time 1 min and 32 s). The parameters, involving the length, width, depth, thickness of the remaining muscle layer of the defect, myometrial thickness adjacent to the defect, and distance of the defect to the cervix external oral, were measured (detailed description in *Figure 2*) by the same 2 chief radiologists. If the measurement difference was greater than 2 mm, the senior radiologist would review the measurement. Length, depth, thickness of the remaining muscle layer of the defect, myometrial thickness adjacent to the defect, and distance of the defect to the external cervical os were measured in the sagittal plane, and the coronal plane was only used for width.

Hysteroscopic surgery procedures

All the participants underwent hysteroscopic surgery within 1 week after menstruation. Hysteroscopy was performed by a surgeon using a bipolar resectoscope (KARL STORZ SE & Co., Tuttlingen, Germany) with saline solution as the medium of distension. The scar tissue of the defect's inferior edge was removed until the wall was continuous with the cervical canal. The endometrium at the bottom of the diverticulum was electrocauterized afterwards. The operation was conducted under visual examination to make sure to achieve a complete hemostasis.

Follow-up method

All the participants were followed up 6 months post-operation. The data were collected from medical records and telephone interviews, including patients' age, clinical manifestations, gravidity and parity, history of cesarean section deliveries, MRI parameters (including the length, width, depth, thickness of the remaining muscle layer of the defect, myometrial thickness adjacent to the defect, and distance of the defect to the external cervical os), and duration of postoperative menstruation. The clinical efficacy of postoperative menstruation was assessed by clinical cure, improvement, and ineffectiveness. Clinical cure was defined as no postmenstrual spotting after the surgery. Improvement was defined as shortened postmenstrual spotting post-operation. Ineffectiveness was defined as no obvious change in menstruation after the surgery. Based on the duration of menstruation after surgery, the participants were divided into clinically cured and non-clinically cured (improvement or ineffectiveness) groups.

Statistical analysis

Statistical analysis was performed with the software Statistical Analysis System 9.4 (SAS Institute, Cary, NC, USA). The 2-sided chi-square test was used to analyze

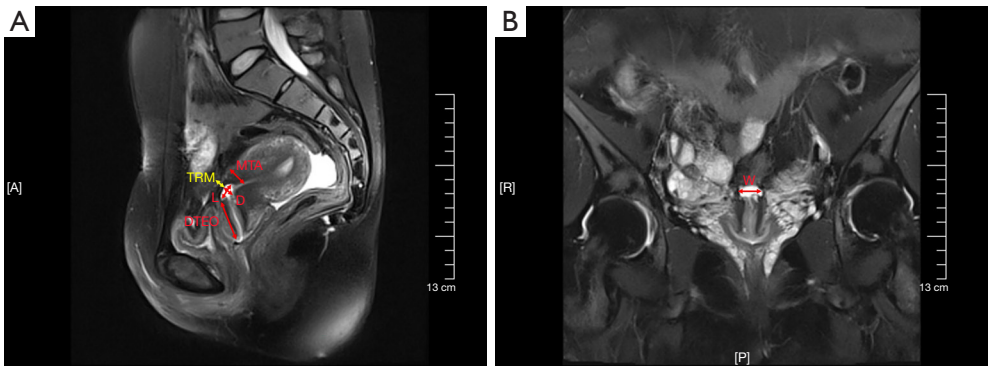

Figure 2 Defect measurement by T2-weighted MRI before surgery. (A) The L, the D, the TRM, the MTA, and the distance from the DTEO were measured in the sagittal view of the MRI; (B) the W was measured in the coronal plane of the same patient. L, length of the defect; D, depth of the defect; TRM, thickness of remaining muscle layer of the defect; MTA, myometrial thickness adjacent to the defect; DTEO, defect to the external cervical os; W, width of the defect; MRI, magnetic resonance imaging.

categorical data, which were expressed as frequency and percentage in each group. A 2-sided Student's *t*-test was used to analyze normally distributed data, which were presented as mean ± standard deviation (SD). The continuous variables of MRI parameters before the surgery are divided by median. A logistic regression analysis was applied to determine the dominant variables. A 2-sided P<0.05 was considered statistically significant.

Results

Patient characteristics

There were 64 clinically cured (43.5%) and 83 non-clinically cured (56.5%) patients comprising a total of 147 patients involved in the study. *Table 1* lists the 147 individuals' characteristics in detail. No significant differences were detected in age, menstrual duration before surgery, gravidity, parity, number of cesarean sections, or time since the previous cesarean section in the 2 groups. The menstrual duration after hysteroscopic surgery was improved in the clinically cured group (6.3 days), which was significantly shorter than the 12.1 days in the non-clinically cured group (P<0.001, *Table 1*). The time since AUB had appeared was significantly correlated with the clinical cure rate (P=0.028, *Table 1*), since the symptom lasted less time in the clinically cured group (49.7 months) than in the non-clinically cured group (62.6 months).

MRI parameters

Table 2 displays the T2-weighted MRI parameters of the defect before the surgery. No significant differences were shown in the uterus position, the width, depth, or thickness of the remaining muscle layer of the defect before hysteroscopic surgery. The length of the defect (P=0.045), myometrial thickness adjacent to the defect (P=0.019), and distance from the defect to the external cervical os (P=0.013) were significantly correlated with the clinical cure rate post-operation (*Table 2*).

Risk factors for PCSD prognosis

Tables 3 and *4* list univariate and multivariate logistic regression used to examine potential influences on the prognosis for PCSD following hysteroscopic surgery. *Table 3* shows the results of the univariate logistic regression analysis of the clinical cure rate risk factors. Compared with the clinically cured group, the length of the defect [P=0.034, odds ratio (OR) =2.049, 95% confidence interval (CI): 1.061–4.007], myometrial thickness adjacent to the defect (P=0.015, OR =2.310, 95% CI: 1.184–4.601), and distance from the defect to the external cervical os (P=0.013, OR =2.329, 95% CI: 1.203–4.578) displayed in the T2-weighted MRI parameters before the surgery are greater in the non-clinically cured group. The larger the length of the defect (≥8 mm), the myometrial thickness adjacent to the defect

Table 1 Clinical characteristics of participants

Variables	Clinically cured group (n=64)	Non-clinically cured group (n=83)	P value
Age (years, mean ± SD)	34.5±3.8	35.1±4.0	0.184
Menstrual duration before surgery (days, mean ± SD)	14.1±2.7	14.5±2.5	0.148
Gravidity (n, %)			
1	17 (26.6)	17 (20.5)	0.405
2	21 (32.8)	36 (43.4)	
≥3	26 (40.6)	30 (36.1)	
Parity (n, %)			
1	31 (48.4)	35 (42.2)	0.505
≥2	33 (51.6)	48 (57.8)	
Number of cesarean section (n, %)			
1	33 (51.6)	38 (45.8)	0.510
≥2	31 (48.4)	45 (54.2)	
Time since the previous cesarean section (months, mean ± SD)	74.2±36.6	76.3±45.6	0.379
Time since AUB appeared (months, mean ± SD)	49.7±35.0	62.6±44.2	0.028
Menstrual duration after surgery (days, mean ± SD)	6.3±1.2	12.1±2.8	<0.001

SD, standard deviation; AUB, abnormal uterine bleeding.

(≥11 mm), and the distance from the defect to the external cervical os (≥30 mm), the worse the clinical cure rate. There were no significant differences in other variables between the 2 groups (P>0.05).

As displayed in *Table 4*, a multivariate logistic regression was examined using the meaningful variables from the univariate analysis. The data showed that myometrial thickness adjacent to the defect (P=0.038, OR =2.095, 95% CI: 1.047–4.261) and distance from the defect to the external cervical os (P=0.021, OR =2.254, 95% CI: 1.136–4.540) are risk factors for the clinical cure rate.

Discussion

As one of the long-term complications of cesarean delivery, the main clinical symptoms of PCSD are AUB, dysmenorrhea, chronic pelvic pain, and secondary infertility, according to previous literature (16,19). In various studies, the increasing number of cesarean deliveries, prolonged duration of active labor, single-layer myometrium closure without endometrial suture, and infection of the wound have been identified as risk factors for PCSD (11,20,21). In addition, maternal body mass index and gestational diabetes are also associated with PCSD (16,21,22). Postmenstrual spotting or prolonged menstrual duration is the predominant clinical symptom of PCSD-related AUB in patients (11,22), of which the mechanism is still unclear. The collection of menstrual blood in the uterine defect, resulting from the lack of muscle contractility around the scar and the poor drainage of menstrual flow through the fibrotic tissue below the niche, may explain the mechanism of PCSD-related AUB (11,23,24). Furthermore, retention of blood inside the uterine scar defect can also originate from endometriotic tissue due to inflammation, neovascularization, or adenomyosis (11,23-26).

Multiple surgical treatments have been applied to patients with PCSD-related AUB, including hysteroscopic, laparoscopic, and transvaginal surgery (16). Laparoscopic surgery could eliminate the uterine scar defect and strengthen the uterine wall at the same time (24). In addition, laparoscopic surgery could allow surgeons to explore the pelvis and remove adhesions (16,24). Different from the laparoscopic approach, hysteroscopic surgery for PCSD could correct the scar defect instead of strengthening the uterine wall (24,27). However, hysteroscopy is a minimally invasive procedure with similar clinical efficacy

Table 2 MRI parameters of participants before surgery

Variables	Clinically cured group (n=64)	Non-clinically cured group (n=83)	P value
Uterus position (n, %)			
Anteflexed	20 (31.3)	34 (41.0)	0.226
Retroflexed	44 (68.8)	49 (59.0)	
Length of defect (mm, n, %)			
<8	36 (56.3)	32 (38.6)	0.045
≥8	28 (43.8)	51 (61.4)	
Width of defect (mm, n, %)			
<17	30 (46.9)	45 (54.2)	0.409
≥17	34 (53.1)	38 (45.8)	
Depth of defect (mm, n, %)			
<6	29 (45.3)	37 (44.6)	0.999
≥6	35 (54.7)	46 (55.4)	
Thickness of the remaining muscle layer of defect (mm, n, %)			
<3	29 (45.3)	31 (37.3)	0.398
≥3	35 (54.7)	52 (62.7)	
Myometrial thickness adjacent to the defect (mm, n, %)			
<11	43 (67.2)	39 (47.0)	0.019
≥11	21 (32.8)	44 (53.0)	
Distance from the defect to the external cervical os (mm, n, %)			
<30	38 (59.4)	32 (38.6)	0.013
≥30	26 (40.6)	51 (61.4)	

MRI, magnetic resonance imaging.

and less operative time, hospitalization time, expenses, and intra-operative blood loss than laparoscopy, as we previously reported (18). Some investigators have suggested that a hysteroscopic approach should not be applied when residual myometrium thickness is less than 3 mm on account of the increasing risk of uterine perforation, bladder injury, and uterine rupture in the subsequent delivery (23,24). However, previous studies have shown that the residual myometrium thickness value may be invariable or even increase after hysteroscopic PCSD surgery due to reduced internal pressure from the residue of menstrual fluid and the removal of inflammatory material (23,28). As a result of the careful operation, there were no severe complications in this patient cohort, such as perforation of the uterus, bladder injury, or postoperative hemorrhage.

So far, there are no standard guidelines for the treatment of PCSD-related AUB, especially regarding how to select an appropriate technique. In our previous study (18), the clinical efficacy of AUB after hysteroscopic surgery was 78.8%, but the clinical cure rate was only 24.2%. This can be explained by some of these patients being poorer candidates for hysteroscopic surgery. In this study, 43.5% of all the participants (n=64) with no more postmenstrual spotting after the surgery were classified as clinically cured. Simultaneously, 56.5% of the patients (n=83) showed shortened postmenstrual spotting or no obvious change in menstruation, who were classified within the non-clinically cured group. This raises the question of what the crucial factor for the prognosis of PCSD-related AUB patients could be.

In general, transvaginal ultrasonography (TVS) is the first suggested method for PCSD evaluation due to its

Table 3 Univariate analysis of clinically cured and non-clinically cured groups

Variables	Estimate	SE	Wald	P value	OR	95% CI
Age	0.039	0.043	0.820	0.365	1.040	0.956–1.132
Gravidity						
1						
2	0.539	0.439	1.506	0.220	1.714	0.725–4.092
≥3	0.143	0.435	0.108	0.742	1.154	0.490–2.722
Parity						
1						
≥2	0.253	0.335	0.573	0.449	1.288	0.669–2.490
Number of cesarean sections						
1						
≥2	0.232	0.333	0.483	0.487	1.261	0.656–2.431
Time since the last cesarean section	0.001	0.004	0.119	0.730	1.001	0.993–1.009
Time since AUB appeared	0.008	0.004	3.516	0.061	1.008	0.999–1.017
Uterus position						
Anteflexed						
Retroflexed	–0.423	0.350	1.459	0.227	0.655	0.326–1.293
Length of defect (mm)						
<8						
≥8	0.717	0.338	4.503	0.034	2.049	1.061–4.007
Width of defect (mm)						
<17						
≥17	–0.294	0.334	0.778	0.378	0.745	0.386–1.431
Depth of defect (mm)						
<6						
≥6	0.030	0.334	0.008	0.929	1.030	0.534–1.986
Thickness of the remaining muscle layer of defect (mm)						
<3						
≥3	0.329	0.338	0.946	0.331	1.390	0.716–2.707
Myometrial thickness adjacent to the defect (mm)						
<11						
≥11	0.837	0.345	5.881	0.015	2.310	1.184–4.601
Distance from the defect to the external cervical os (mm)						
<30						
≥30	0.846	0.340	6.185	0.013	2.329	1.203–4.578

SE, standard error; OR, odds ratio; CI, confidence interval; AUB, abnormal uterine bleeding.

Table 4 Logistic regression of significant variables in clinically cured and non-clinically cured groups

Variables	Estimate	SE	Wald	P value	OR	95% CI
Intercept	−0.946	0.383	6.111	0.014	0.388	0.179–0.808
Time since AUB appeared (months)	0.008	0.004	3.614	0.057	1.009	1.000–1.018
Myometrial thickness adjacent to the defect (≥11 mm)	0.740	0.357	4.297	0.038	2.095	1.047–4.261
Distance from the defect to the external cervical os (≥30 mm)	0.813	0.352	5.322	0.021	2.254	1.136–4.540

SE, standard error; OR, odds ratio; CI, confidence interval; AUB, abnormal uterine bleeding.

effectiveness and affordability (20,29). A TVS standardized guideline (a modified Delphi procedure) could be applied for detailed PCSD evaluation in non-pregnant women (30,31). However, MRI is able to scan larger areas of the pelvis for further scrutiny, so one of its advantages is a more accurate and clear view in the pre-operation evaluation. Besides, MRI is operator-independent and could provide reproducible measurements for gynecologists (32).

Using logistic regression models, we discovered that the myometrial thickness adjacent to the defect and the distance from the defect to the external cervical os in preoperative MRI evaluation are risk factors for clinical cure rate. It seems that the time since the appearance of AUB and the length of the defect are also correlated with the outcomes of surgery. The cause could be related to the fact that when the cesarean delivery site is too high, different myometrium recovery at the upper and lower segments of the uterine incision will lead to a greater difference in the thickness of the upper and lower myometrium of the incision, which will affect the healing of the uterine incision and lead to a larger diverticulum formation (33,34). In the meantime, the longer the time since the appearance of AUB, the increased formation of scar tissue around the scar, which leads to poor contractility of uterine muscles around the cesarean scar over time. As the length of the defect increases, it has a greater chance of having a larger diverticulum. According to a prior study, longer menstrual bleeding is associated with a deeper and larger MRI abnormality (35). The key point of hysteroscopic surgery is the removal of the inferior edge of the uterine scar defect and fulguration of the bottom of the defect in the meantime. Persistent post-surgical AUB may be due to abundant endometrium within the diverticulum, which makes it difficult to perform electrocoagulation. However, the specific mechanism still needs to be further studied.

In this study, we, for the first time, applied MRI to PCSD patients and examined the impact of several variables on the prognosis of PCSD patients undergoing hysteroscopic surgery. With high measuring precision, the MRI could scan the pelvic area from different perspectives to evaluate the defect's position, size, depth, shape, and relationship with surrounding tissues. In the meantime, the defect image of an MRI could be assessed by the surgeon without operating the imaging machine, as the TVS. Therefore, preoperative MRI evaluation is probably of great reference value in clinical cure rate prediction. Based on our research, the myometrial thickness adjacent to the defect and the distance from the defect to the external cervical os are 2 crucial indicators in preoperative MRI evaluation that are likely to become important indices in the choice of treatment. Our research shows that preoperative MRI evaluation may become one of the most valuable assessment methods for surgery method selection and clinical cure rate prediction.

As our study was retrospective in design, one of its limitations is that more cases and stratifications based on the basic characteristics of patients are required to provide more information.

Conclusions

The myometrial thickness adjacent to the defect and the distance from the defect to the external cervical os in preoperative MRI are risk factors for clinical cure rate in patients with PCSD-related AUB after hysteroscopic treatment, which is helpful for evaluating the prognosis of disease.

Acknowledgments

Funding: This work was supported by the Changsha Natural Science Foundation (Grant No. kq2202425).

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://qims.amegroups.com/article/view/10.21037/qims-23-1205/rc

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-23-1205/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. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The protocol of this study was approved by the Ethics Committee of the Third Xiangya Hospital of Central South University (No. 2020-S625). All participants provided informed consent.

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Cite this article as: Zhang Q, Yi S, Yang Y, Xiao S, Xu D, Wu J, Jiang B. Clinical analysis of uterine parameters evaluated by preoperative magnetic resonance imaging in patients treated by hysteroscopic approach with previous cesarean scar defect-related abnormal uterine bleeding: a retrospective cohort study. Quant Imaging Med Surg 2024;14(3):2334-2344. doi: 10.21037/qims-23-1205

