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Prediction of the relationship of cesarean section scar niche and postmenstrual spotting: is there any relation?

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Abstract

Background: Postmenstrual spotting has recently been related to a discontinuation of the myometrium at the site of a previous cesarean section called "CS scar niche". There was no consensus regarding the gold standard method for the assessment of the niche. Recently, Magnetic resonance imaging (MRI) has shown promise in the evaluation of the niche. Our study aims to assess the role of MRI in the evaluation of the CS scar niche characters and its association with post-menstrual spotting.

Results: A total of 65 patients with CS niche were prospectively included in this study and subdivided into two groups, according to presence or absence of postmenstrual spotting (Group A; 34 patients with postmenstrual spotting and Group B; 31 patients without spotting). All patients were examined using a 1.5 T MRI unit. CS scar niche volume was significantly higher among women with post-menstrual spotting (0.57 ± 0.07 vs. 0.07 ± 0.05 (cm^3); $P < 0.001$). Also, women with post-menstrual spotting have significantly higher scar length (9.38 ± 3.06 vs. 5.02 ± 2.10 (mm); $P < 0.001$), scar depth (6.95 ± 3.16 vs. 3.23 ± 0.99 (mm); $P < 0.001$), scar width (15.78 ± 3.94 vs. 9.87 ± 1.84 (mm); $P < 0.001$) in comparison to those without post-menstrual spotting.

Scar depth (> 7.4 mm) had 81% sensitivity and 97% specificity for prediction of post-menstrual spotting with overall accuracy was 88.7%. While scar width (> 12.8 mm) had 71% sensitivity and 97% specificity for prediction of post-menstrual spotting with overall accuracy was 83.3%. Scar volume (> 0.15 cm^3) had 97% sensitivity and 100% specificity for prediction of post-menstrual spotting with overall accuracy was 98.4%.

Conclusion: MRI measures (CS scar volume, depth, and width) are predictors for postmenstrual spotting in patients with CS scar niche, and scar volume is the most powerful predictor.

Keywords: Cesarean section scar niche, Postmenstrual spotting, Cesarean section scar volume

Introduction

Cesarean section (CS) is a vital procedure if performed for the correct reasons. However; increasing rates of CS were associated with a growing number of complications [1]. Gynecological complaints like postmenstrual spotting, dysmenorrhea, chronic pelvic pain, and dyspareunia are frequently noticed after CS. These symptoms could be attributed to the incomplete uterine healing scar forming a CS scar niche or defect (CSD). That defect could be a reason for abnormal bleeding due to the recollection of menstrual blood in that defect resulting in postmenstrual spotting [2].

Abnormal uterine bleeding has been connected to the recollection of menstrual blood in that niche, which is periodically expelled after the end of menstruation, as

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well as the poor contractility of the myometrium around the scar bringing on postmenstrual spotting [3]. In addition, the fibrotic tissue below the niche may hinder the flow of menstrual passage through the cervix [4]. When the bloody fluid from the cesarean scar passes into the vagina it ends in abnormal bleeding but if it flows in the opposite direction toward the uterine cavity, it may result in implantation failure. The retention of blood in the uterine cavity may result in infertility via a mechanism resembling hydrosalpinx [5]. The management of the CS scar niche (isthmoplasty) is done either hysteroscopically or by other surgical procedures [6]. So proper assessment is mandatory before the decision of correction.

There is no consensus regarding the gold standard method for detection and measurement of the CS niche, however, morphological abnormalities in the CS can be assessed using transvaginal ultrasonography (TVUS), gel, or saline infusion sonohysterography, or hysteroscopy [7–10]. Although TVUS is the most used method for evaluation of the uterine wall, it is operator-dependent and allows evaluation of the scar in only one plane (midsagittal plane). Magnetic resonance imaging (MRI) is promising in the assessment of uterine scar thickness as it reduces the operator dependence with a superior multi-planar capability [6]. Our study aimed to assess the role of MRI in the evaluation of the CS scar niche characters and its association with post-menstrual spotting.

Methods

Study design

This cross-sectional study included patients who attended the gynecological outpatient clinic at our institution hospital in the period between February 2019 and October 2020. The inclusion criteria were (a) patients in the child-bearing period after at least 6 months from last cesarean section age ranged between 20 and 45 years, and (b) having CS scar niche diagnosed by TVUS; defined as any anechoic area at the site of CS scar with a depth of at least 1 mm. The exclusion criteria were (a) Pregnant women (b) patients with adenomyosis, uterine fibroids, or uterine congenital anomalies (c) patients with intrauterine devices, (d) patients with a bleeding tendency and (e) patients with any contraindication to MRI.

A total of 65 patients who fulfilled the inclusion criteria were included in the study and then grouped according to the presence of postmenstrual spotting into Group A (34 patients with spotting) and Group B (31 patients without spotting).

Sample size calculation

It was calculated using EPI info7, (considering the postmenstrual spotting was reported in (28.9%) women with a niche, compared to (6.9%) without a niche, with a two-sided confidence level of 95%, power 80%, the minimum calculated total sample size was 60 with 1:1 group ratio (30 cases in each group). The sample was raised by 20% to compensate for dropouts. After applying the eligibility criteria, the final sample was 65 patients Group A ($n=34$ patients) and Group B ($n=31$ patients).

Clinical assessment

History of postmenstrual spotting, its duration in days. Postmenstrual spotting was defined as more than 2 days of brownish discharge at the end of menstruation with a total length of menstruation (including spotting) of more than 7 days, or inter menstrual bleeding which starts within 5 days after the end of menstruation [1]. The patients were examined using trans vaginal ultrasound (GE B6 system, GE Healthcare) with an empty bladder using standard procedures. We evaluated the cesarean scars. On the midsagittal view, the scar was identified as a discontinuity in the architecture of the uterus and appeared as a hypoechoic line. A niche was defined as any anechoic area at the site of the cesarean scar with a depth of at least 1 mm [7].

Pelvic MRI technique

MRI was done using a 1.5 T imaging unit (Magnetom Sempra, Siemens, Erlangen, Germany). Patients were imaged in a supine position with moderately full urinary bladder. A localizer rapidly acquired coronal images of the entire pelvis was obtained to optimize the positioning of the multi-coil array over the area of interest.

Multiplanar Sagittal, coronal, and axial T2-weighted images were obtained to provide excellent contrast resolution for the depiction of the uterine, and cervical zonal anatomy with TR 4000 ms, TE 90 ms, 4 mm slice thickness, 150^0 flip angle, and 260×270 mm field of view. The duration of the complete examination was about 20–25 min.

Image interpretation

Different characters of the scar niche were evaluated as follow: The length (distance of CS niche along the long axis of the uterus in mm), width (distance of CS niche from right to left at axial images in mm), depth (vertical distance between the base and apex of CS niche in mm), and shape of the scar (droplet, semicircular, triangular, and irregular) (Fig. 1). The minimal residual myometrial thickness (RMT) at the site of the CS scar was measured from the uterine cavity to the uterine serosa in mm and compared to the myometrial thickness of the posterior uterine wall. CSD volume was assumed as a cuboid and calculated by multiplication of thickness, width, and length in cm^3 [11].

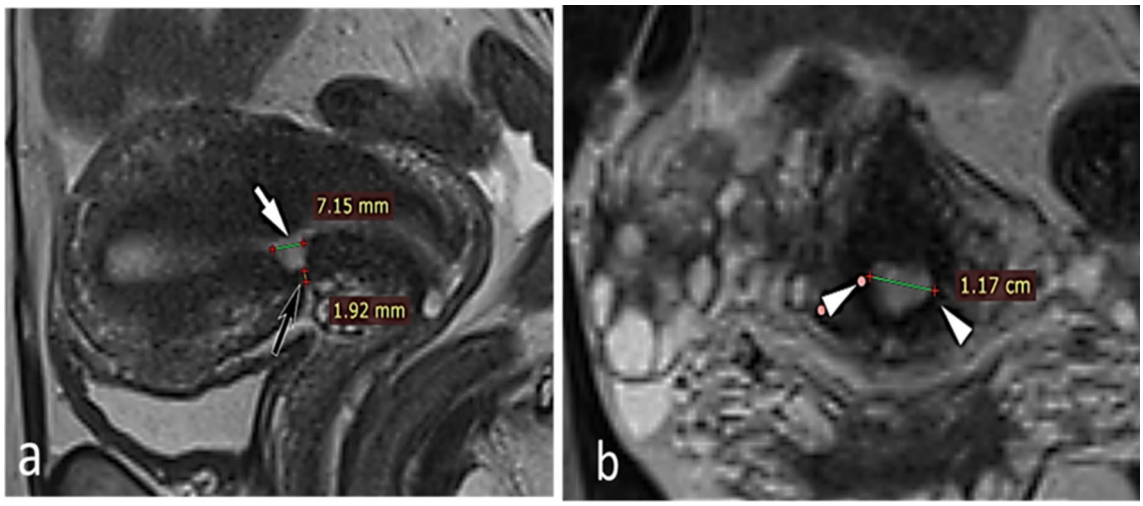

Fig. 1 38 years patient, underwent 2 previous CS, last CS 3 years ago, she complained from postmenstrual spotting, the duration of the period increased from 5 to 10 days since the last CS. **a** The black arrow points to the minimal residual myometrial thickness at the site of the scar measured the uterine cavity to the uterine serosa in mm, the white arrow points to the scar length measured as the distance of CS niche along the long axis of the uterus in mm. **b** The white arrowheads point to scar width measured as a distance from right to left in cm

Statistical analysis

Data was collected and analyzed using SPSS (Statistical Package for Social Science, version 20, IBM, and Armonk, New York). Continuous data were expressed in form of mean ± SD or median (range) while nominal data were expressed in form of frequency (percentage). Test of normality was performed for the main quantitative variables using Shapiro-Kolmogorov test, yielded non-significant results, indicating normality of these variables. Chi^2-test was used to compare the nominal data of different groups in the study while the student t-test was used to compare the mean of different two groups. Correlation between the duration of spotting with radiological data of the scar was determined by the Pearson correlation.

Multivariate regression analysis was used to evaluate different predictors of spotting in women with CS scar. Also, the diagnostic accuracy of these predictors was assessed by the ROC curve. The level of confidence was kept at 95% and hence, the p-value was significant if < 0.05. Inter-rater reliability as regards the CS scar niche volume was estimated by calculating the intra-class correlation coefficient (ICC) based on a mean rating ($K = 3$), absolute agreement, two ways mixed–effect model. The level of confidence was kept at 95% and hence, the P-value was significant if < 0.05.

Results

The mean age of women with post-menstrual spotting was 32 ± 5.75 years (ranged from 25 to 45 years) while the mean age of women without post-menstrual bleeding was 32.12 ± 5.34 years (ranged from 25 to 43 years) (Fig. 2).

Cesarean scar niche features on MRI

About half of ($n = 16$) women without post-menstrual spotting had a droplet shape of the CS scar niche while 18 patients (53%) of women with post-menstrual spotting have semi-circular CS scar ($P = 0.02$). Women without post-menstrual spotting have significantly lower scar length (5.02 ± 2.10 vs. 9.38 ± 3.06 (mm); $P < 0.001$), scar depth (3.23 ± 0.99 vs. 6.95 ± 3.16 (mm); $P < 0.001$),

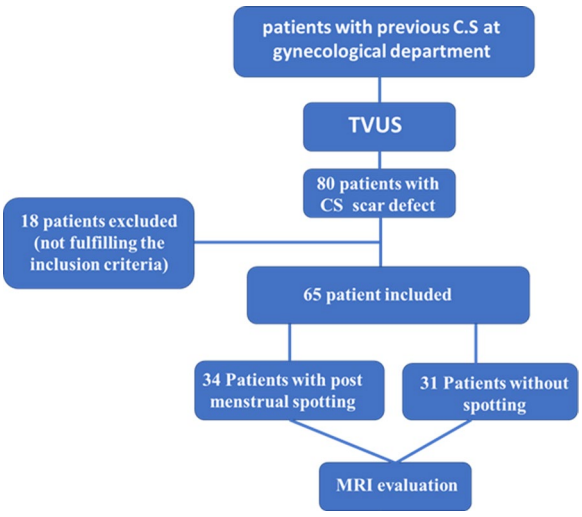

Fig. 2 Demonstrating the methodology plan used in our study

scar width (9.87 ± 1.84 vs. 15.78 ± 3.94 (mm); $P < 0.001$) in comparison to those with post-menstrual spotting (Figs. 3, 4).

CS scar niche volume was significantly higher among women with post-menstrual spotting (0.57 ± 0.07 vs. 0.07 ± 0.05 (cm^3); $P < 0.001$). Women with post-menstrual spotting had significantly lower minimal residual myometrial thickness (mean ± SD = 2.58 ± 1.30 vs. 6.26 ± 3.97 (mm); (Median (IQR) = 2 (1) vs. 6.5 (2); $P < 0.001$) and significantly higher relative change percentage in the residual myometrial thickness (79.84 ± 9.24 vs. 57.26 ± 10.84 (%); $P < 0.001$) in comparison to those without post-menstrual spotting (Fig. 5).

Correlation of postmenstrual spotting duration with the radiological evaluation of the scar nich

Table 1 showed that the duration of post-menstrual bleeding had positive significant correlation with the scar depth ($r = 0.41$, $P < 0.001$), scar width ($r = 0.51$, $P < 0.001$), scar volume ($r = 0.49$, $P < 0.001$).

Multivariate regression analysis of the CSD features and their diagnostic accuracy

Table 2 demonstrated the presence of a statistically significant association of scar depth, scar width, and scar volume for the prediction of post-menstrual spotting. The scar depth (> 7.4 mm) had 81% sensitivity and 97% specificity with 88.7% overall accuracy while scar width (> 12.8 mm) had 71% sensitivity and 97% specificity with 83.3%overall accuracy and scar volume (> 0.15 cm^3) had 97% sensitivity and 100% specificity with 98.4%overall accuracy (Fig. 6).

Inter-rater reliability

There was an excellent agreement between observers regarding (scar volume) with ICC = 0.97 (95% CI = 0.94–0.99) for women with postmenstrual spotting and ICC = 0.99 (95% CI = 0.96–0.99) for women without spotting.

Discussion

MRI is a non-invasive method for the assessment of CS scar niche, scar volume, depth, and width represent good predictors of the development of post menstrual spotting.

Multiple previous studies reported that there is a relationship between CS scar niche and multiple gynecological symptoms [7, 10, 12–15]. The most common complaints related to CSD are prolonged menstrual bleeding and postmenstrual spotting (in up to three-quarters of women with CSD), followed by pelvic pain (39.6%), dysmenorrhea (53.1%), dyspareunia (18.3%), and secondary infertility [10]. The retention of the blood products inside the defect and poor contractility of the uterine wall related to decreased myometrial thickness and fibrosis explained the relation between cesarean scar defects and postmenstrual spotting [7].

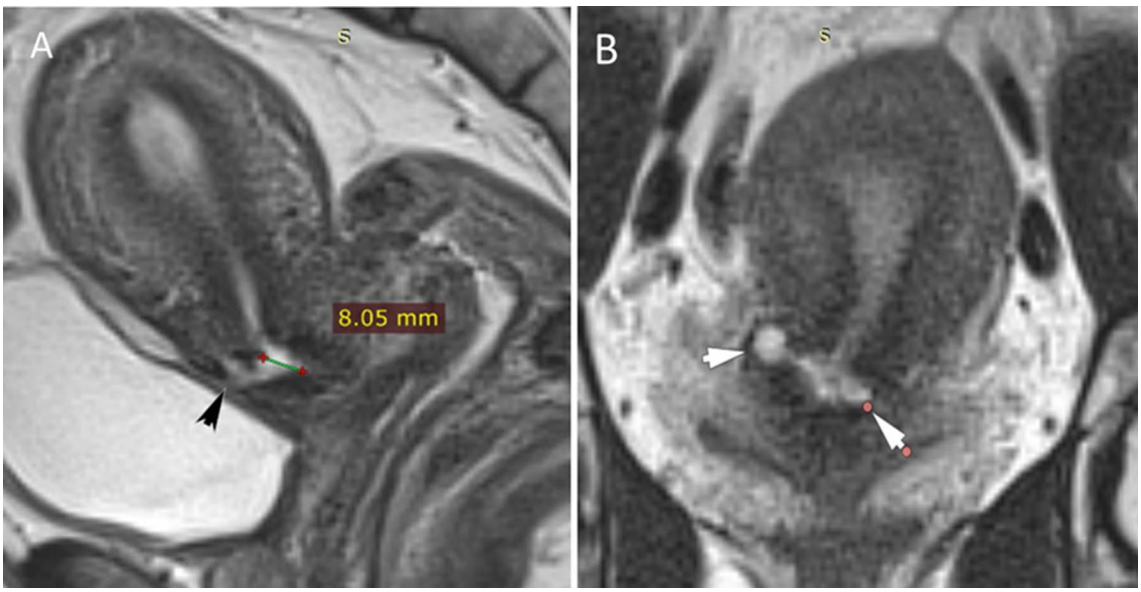

Fig. 3 37 years female patient underwent 3 previous CS, last CS 3 years ago complained from postmenstrual spotting, the duration of the period increased from 4 to 11 days since the last CS. **A** Sagittal T2WI image of the pelvis demonstrating the cesarean section scar niche of 8 mm length with a very thin residual myometrial thickness (black arrow). **B** coronal T2W image demonstrating the scar width (white arrowheads)

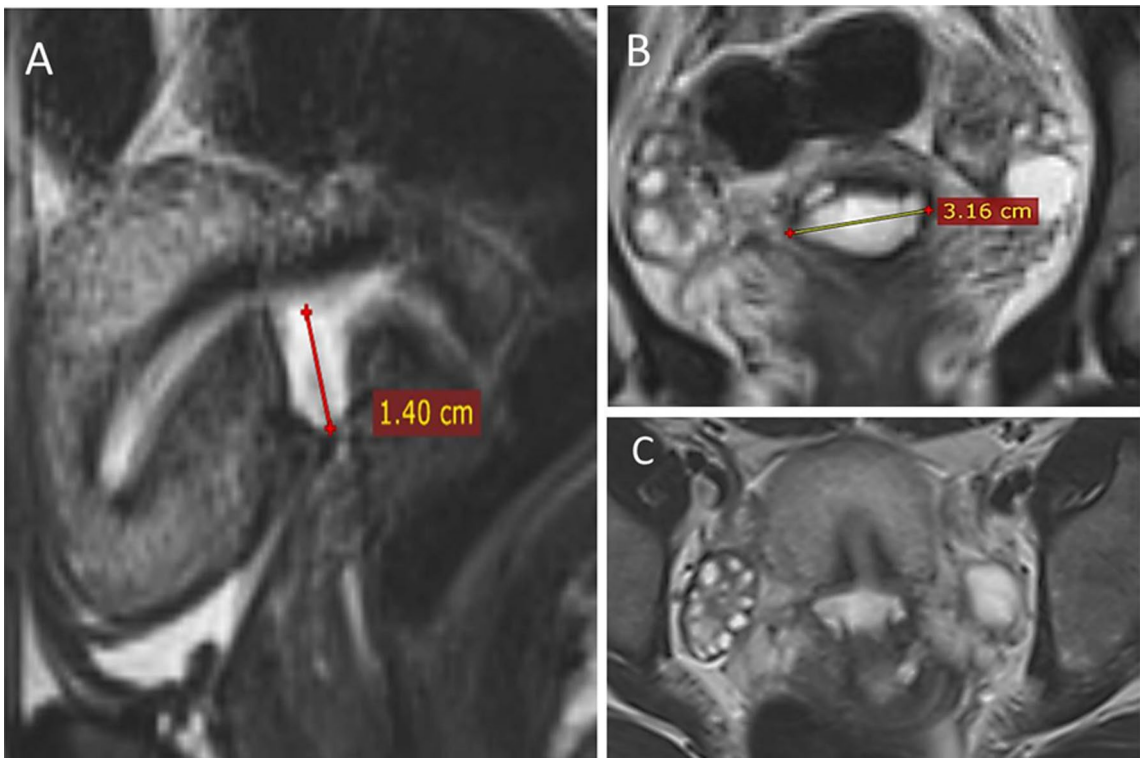

Fig. 4 27 years patient underwent 1 previous CS 5 years ago, she complained from postmenstrual spotting as the period increases from 3 to 13 days since her CS. **A** Sagittal T2WI image of the pelvis shows CS niche depth of 1.4 cm. **B** Coronal T2WI image shows CS niche width of 3.16 cm. C-Axial T2WI image of the CS niche

MRI can easily define CSD and can also be reviewed retrospectively. Tang et al., has compared the use of TVUS with MRI and concluded that MRI is better than TVUS for the measurement of CSD which may help to improve the therapeutic strategy for CSD. Measurements by MRI showed a better prediction of the clinical symptoms of CSD, and more reflective of the severity of clinical manifestations [10]. However, MRI was not commonly used for CSD imaging due to its relatively high cost [14].

Multiple previous studies have postulated that there is a relation between CSD volume, residual adjacent myometrial thickness, and development of postmenstrual spotting based on the transvaginal ultrasound as a diagnostic method [7, 10, 16–18], however, a limited number of studies utilized MRI as a method for the evaluation of the CS scar defects [10, 14, 15].

Bij de Vate et al., reported that the semicircular scar defect shape is the most prevalent [7]. In this study, the most prevalent shape was droplet followed by semicircular defect shape in 43% and 40% of patients respectively. However, post menstrual spotting was significantly related to semicircular scar defect shape than other shapes which may be related to the higher volume of the defect in semicircular scar shape.

Previous studies concluded that residual myometrial thickness (RMT) at the cesarean section scar is one of the major parameters correlated with menstrual bleeding. They defined large niches as those with a residual myometrium thickness of < 50% of that of the adjacent myometrium. Reduced myometrial thickness in combination with lower contractility because of fibrosis would induce the development of postmenstrual spotting. Also, these publications reported required residual myometrium of 2–3 mm for hysteroscopic niche resection, given the risk of perforation and/or bladder injury [7, 10, 14, 18]. In the present study, women with post-menstrual spotting had significantly lower RMT than those without post-menstrual spotting. However, RMT was insignificantly correlated with the duration of postmenstrual spotting.

He et al., used posterior wall thickness at the same level of scar center to represent anterior wall thickness before the prior cesarean section because the normal anterior and posterior uterine wall thickness is similar to one another in the normal woman [19]. In the current study, the relative reduction in anterior wall myometrial

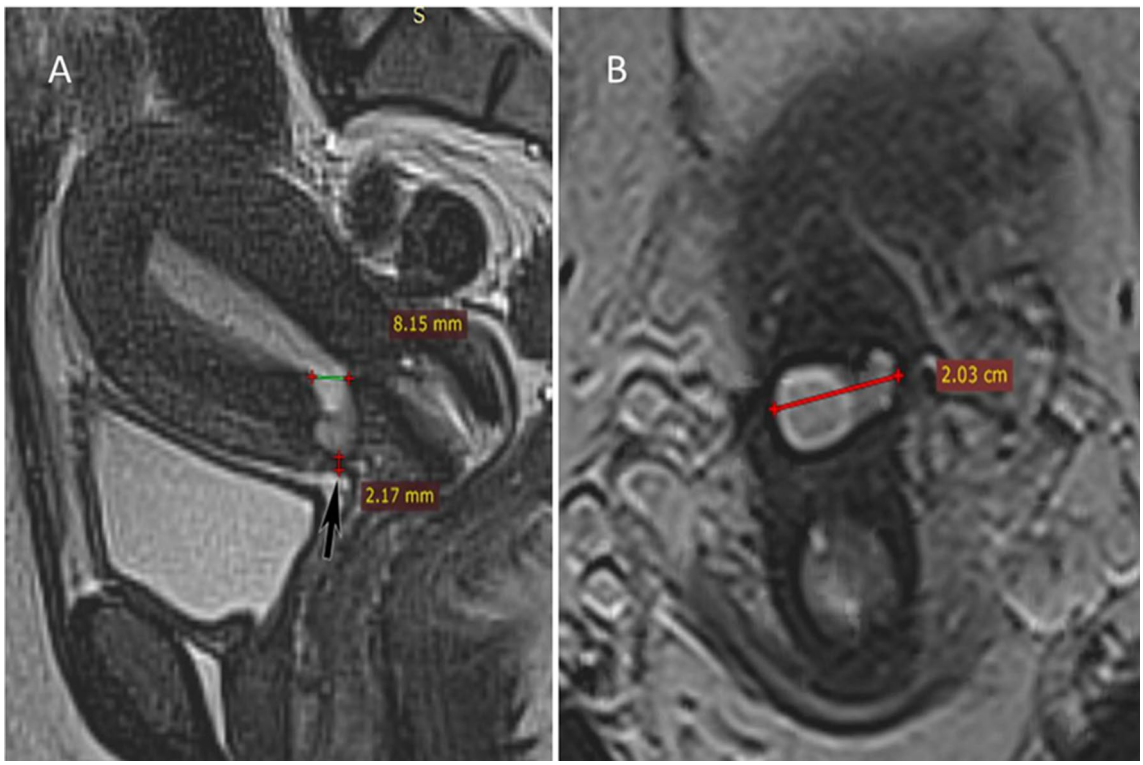

Fig. 5 37 years old patient with a history of 2 previous CS, last one 4 years ago, she complained from postmenstrual spotting, the duration of the period increased from 4 to 11 days. **A** Sagittal T2WI view of droplet-shaped CS scar niche of 8.15 mm length with a residual myometrial thickness of 2.17 mm (black arrow). **B** Axial T2WI shows CS scar niche width (2.03 cm)

Table 1 Correlation of spotting duration with the radiological evaluation of the scar niche

Correlation of post-menstrual spotting duration with	*r* value	*P* value
CS scar length (mm)	0.16	0.37
CS scar depth (mm)	0.41	< 0.001**
CS width (mm)	0.51	< 0.001**
Distance of CS scar (cm)		
From cervix	0.11	0.54
From fundus	0.25	0.16
CS scar volume (cm^3)	0.49	< 0.001**
Minimal scar thickness (mm)	0.01	0.92
Relative change (%)	0.18	0.32

CS: Cesarean section

**Statistically significant

Table 2 Predictors of post-menstrual spotting in women with CS scar niche

	Odds ratio	95% CI	P-value
Scar length (mm)	0.76	0.33–3.45	0.12
Scar depth (mm)	3.47	2.33–7.98	< 0.001**
Scar width (mm)	2.5	2.11–5.55	< 0.001**
Scar volume (cm3)	7	3.40–11.40	< 0.001**
Minimal scar thickness (mm)	1.03	0.40–2.11	0.11
Relative change (%)	2.11	0.23–3.11	0.09

CS: cesarean section; CI: confidence interval

**Statistically significant

thickness at the scar area in comparison to the posterior uterine wall was significantly higher in women with postmenstrual spotting with an average reduction of 79% in comparison to 57% without postmenstrual spotting.

Additionally, several previous studies concluded that postmenstrual spotting is related to niche volume [7, 10, 14]. The current work was in agreement with them regarding this point, also CSD volume (> 0.15 cm^3) is the most important predictor for the development of postmenstrual spotting. with 97% sensitivity and about 100% specificity and 98.4% overall accuracy. In this study, scar depth and width represent other predictors for the development of postmenstrual spotting. These three parameters (depth, width, and volume) have a significant relationship with the duration of postmenstrual spotting as the increase in the defect depth, width and

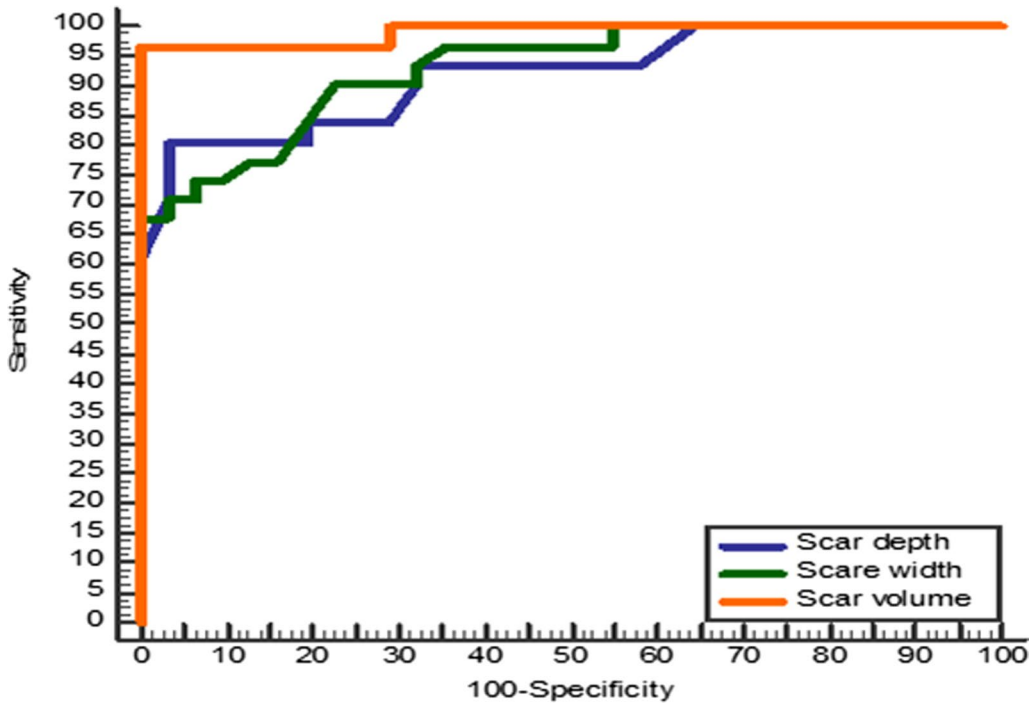

Fig. 6 ROC-curve for the accuracy of different predictors in the diagnosis of spotting

volume were accompanied by an increase in the duration of the postmenstrual spotting.

Limitations of this study included the cross-sectional nature of the study that jeopardize the external validity of the study and the possibility of selection bias in the control group i.e., women without postmenstrual bleeding as they are not selected from the normal population but women attending the gynecological outpatient clinic.

Conclusion

MRI is a reliable non-invasive method for the assessment of CS scar defects. MRI measures (CSD volume, depth, and width) are good predictor factors for postmenstrual spotting in those patients with scar volume is the most powerful predictor factor. Further multicenter comparative and validating studies against other diagnostic methods such as Ultrasound are recommended.

Abbreviations

CS: Cesarean section; CSD: Cesarean section scar defect; MRI: Magnetic resonance imaging; TVUS: Transvaginal ultrasonography; RMT: Residual myometrial thickness.

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Authors' contributions

KB and GS designed the research. KB performed the research; and wrote the manuscript. GS and HA analyzed the collected data. OQ, MT, and HA revised data and manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Available on request with the corresponding author.

Declarations

Ethics approval and consent to participate

The study was conducted after approval of the Ethical Committee of Faculty of Medicine, (Approval Number 17100784) and after clinical trial approval (NCT03911622). Informed written consent was obtained from each participant.

Consent for publication

All patients included in this study gave a written informed consent to publish the data contained in this study.

Competing interests

The authors declare that they have no competing interests.

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