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Sonographic Assessment of Cesarean Scars: Predicting Risks and Improving Outcomes

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HIGHLIGHTS

1. Sonographye valuatesintegrity of cesarean scartissue.
2. Measures scar thickness to assess rupture risk.
3. Identifies niche formation or scar dehiscence clearly.
4. Adhesive method may reduce complication rates.
5. Helps predict uterine rupture in future pregnancies.
6. Guides timing and mode of delivery decisions.
7. Improves maternal outcomes with early risk detection.
8. Essential tool in post-cesarean pregnancy management.

Key words:
Cesarean section
Scar defects
Transvaginal ultrasound
Myometrial thickness
Uterine isthmus
Obstetric imaging

ABSTRACT

Introduction: Cesarean section (CS) scars are recognized as potential sites of uterine weakness, which may contribute to significant obstetric complications in subsequent pregnancies, such as uterine rupture, dehiscence, or abnormal placental implantation. Timely and accurate evaluation of scar integrity is essential to predict these risks and ensure appropriate clinical management. **Aim:** This study aimed to evaluate the effectiveness of transvaginal ultrasound (TVS) in detecting cesarean scars, estimating the prevalence of scar defects, and assessing their size and anatomical location. **Materials and Method:** A prospective observational study was conducted over six months involving 182 postpartum women. Participants included 70 women with one prior CS, 32 with two CSs, 10 with three or more CSs, and 70 primiparous women who had delivered vaginally, serving as the control group. All subjects underwent TVS between 6 to 9 months following delivery. Sonographic parameters assessed included scar visibility, myometrial thickness at the uterine isthmus, and the presence, size, and position of any scar defects. **Results:** TVS successfully identified uterine scars in all women with a history of CS and none in the control group. A significant decline in median myometrial thickness was observed with increasing number of CSs: 8.4 mm after one, 6.6 mm after two, and 4.5 mm after three or more, compared to 11.5 mm following vaginal delivery ($P < 0.001$). Additionally, the prevalence and severity of scar defects were significantly higher among women with multiple CSs ($P = 0.003$). **Conclusion:**Transvaginal ultrasound is a reliable tool for cesarean scar assessment. Increased cesarean deliveries are associated with progressive myometrial thinning and a greater incidence of significant scar defects, underscoring the need for routine postpartum imaging in these patients.

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INTRODUCTION

The global rise in cesarean section (CS) rates has resulted in a growing number of women presenting with uterine scars in subsequent pregnancies. For these women, vaginal birth after cesarean (VBAC) offers a safe and effective alternative to repeat CS, associated with reduced maternal morbidity, shorter hospital stays, and improved neonatal outcomes [1,2]. However, accurately predicting which women are likely to achieve a successful VBAC remains a major clinical challenge.

Several predictive models have been developed to address this issue. One of the earliest was the Flamm and Geiger scoring system, which incorporated factors such as maternal age, previous vaginal delivery, the indication for the prior CS, and cervical status at admission for labor [3]. Their results showed that women scoring ≥6 had an 88% likelihood of VBAC, while those scoring ≤3 had less than a 60% chance. However, the model's clinical utility is limited, as only a minority of patients fell into these high-predictive categories. A subsequent validation study by Dinsmoor and Brock reported a 100% VBAC success rate for scores ≥7, and only 53% for scores ≤4 [4]. Still, these models are applicable only during labor and lack predictive value earlier in pregnancy, which restricts their use in long-term care planning. Given that failed VBAC attempts are associated with increased maternal and fetal morbidity [5], there is a growing interest in identifying earlier and more objective markers of uterine integrity. Emerging evidence suggests that the quality of CS scar healing-particularly the myometrial thickness at the lower uterine segment (LUS)-may be a key factor in predicting uterine performance in future pregnancies [6]. Over the past decade, several studies have investigated the ultrasonographic appearance of cesarean scars, reporting widely variable prevalence of visible defects (ranging from 19% to 88%) [7–10], largely due to inconsistencies in imaging techniques and definitions of scar abnormalities.

Despite this growing body of research, no longitudinal studies have systematically examined the relationship between scar morphology and pregnancy outcomes across all three trimesters. In particular, the predictive value of changes in scar dimensions or appearance throughout pregnancy for VBAC success remains largely unexplored.

This study aimed to evaluate the effectiveness of transvaginal ultrasound (TVS) in detecting cesarean scars, estimating the prevalence of scar defects, and assessing their size and anatomical location. By providing detailed scar characterization during pregnancy, this research seeks to contribute to improved risk stratification and clinical decision-making for women with prior cesarean deliveries.

MATERIALS AND METHODS

A prospective observational study was carried out over a six-month period, enrolling a total of 182 postpartum women to evaluate cesarean scar characteristics using transvaginal ultrasound (TVS). The study cohort consisted of 70 women with one previous cesarean section (CS), 32 women with two prior CSs, 10 women with three or more CSs, and 70 primiparous women who had delivered vaginally, serving as the control group. All participants underwent TVS between 6 to 9 months after delivery. The ultrasound examinations were performed using high-resolution transvaginal probes, with particular focus on the lower uterine segment. Sonographic parameters assessed included the visibility of the cesarean scar, measurement of myometrial thickness at the uterine isthmus, and identification of any scar defects. When present, the size (length, width, and depth) and location of these defects were recorded.

RESULTS

A prospective observational study was conducted over six months, enrolling a total of 182 postpartum women who underwent transvaginal sonography (TVS) between 6 to 9 months after delivery. Among them, 112 women had a history of Cesarean section (CS), distributed as follows: 70 with one prior CS, 32 with two prior CSs, and 10 with three or more CSs. The remaining 70 women, all primiparous and who had delivered vaginally, served as the control group.

TVS successfully identified uterine scars in 100% of women with a prior CS and none in the control group, confirming the specificity and sensitivity of TVS in detecting CS-related changes in the uterine wall. Scar visibility was consistent across all groups with prior CS, allowing subsequent measurement of sonographic parameters (Figure 1&2).

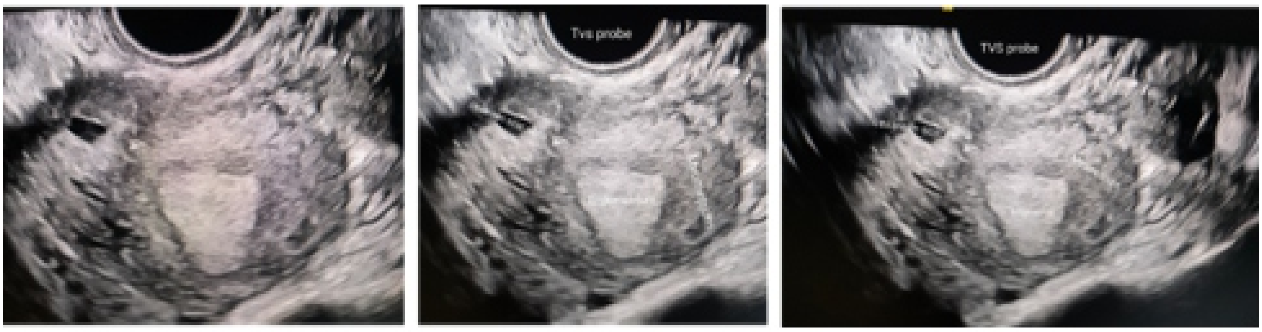

Figure 1: Transvaginal Ultrasound Image of Cesarean Scar in a Patient with a Previous Lower Segment Cesarean Section Performed 8 Months Ago, Showing Thinning of the Scar (Niche).

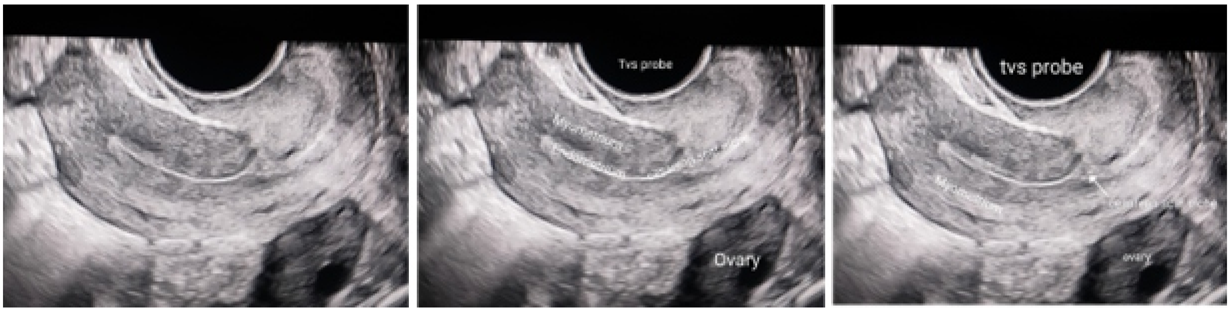

Figure 2: Transvaginal Ultrasound Image of Cesarean Scar in a Patient With a Previous Lower Segment Cesarean Section Performed 7 Months Ago, Showing Thinning of the Scar.

A statistically significant decrease in median residual myometrial thickness (RMT) at the uterine isthmus was observed with increasing number of Cesarean deliveries ($P < 0.001$). Women with one CS had a median RMT of 8.4 mm (IQR: 7.2–9.3 mm), those with two CSs had a median RMT of 6.6 mm (IQR: 5.3 –7.1 mm), and those with three or more CSs had a markedly thinner RMT of 4.5 mm (IQR: 3.4–5.2 mm). In comparison, the control group with no prior CS and vaginal delivery had significantly higher myometrial thickness, with a median of 11.5 mm (IQR: 10.2–12.7 mm) (Table 1)

Table 1: Discharge from Suture Line at Day 1

Group	N	Median Myometrial Thickness (MM)	IQR (25th–75th Percentile)
One Previous CS	70	8.4	7.2–9.3
Two Previous CSs	32	6.6	5.3–7.1
Three or More Previous CSs	10	4.5	3.4–5.2
Vaginal Delivery (Control)	70	11.5	10.2–12.7
P value		**< 0.001**	

The prevalence of scar defects (defined as measurable niche-like thinning or disruption in the myometrial contour at the scar site) increased significantly with the number of prior CSs. Scar defects were identified in 17% of women with one CS, 41% of those with two, and 70% in women with three or more CSs ($P = 0.003$). No scar defects were detected in the vaginal delivery group (Table 2).

Table 2: Prevalence of CS Scar Defects by Number of Previous Cesarean Sections

Group	N	Scar Defect Present, N (%)
One Previous CS	70	12 (17%)
Two Previous CSs	32	13 (41%)
Three or More Previous CSs	10	7 (70%)
Vaginal Delivery (Control)	70	0 (0%)
P value		**0.003**

In addition to scar-related parameters, birth-related outcomes were recorded and analyzed. A trend of decreasing neonatal birth weight was observed in association with increasing number of CSs. The average birth weight was highest in the control group (mean: 3480□g), followed by women with one prior CS (mean: 3280□ g), two prior CSs (mean: 3160□ g), and lowest in those with three or more CSs (mean: 2980□g) (Table 3).

Table 3: Neonatal Birth Weight According to Delivery Group

Group	N	Mean Birth Weight (g)	SD
One Previous CS	70	3280	320
Two Previous CSs	32	3596 160	310
Three or More Previous CSs	10	2980	295
Vaginal Delivery (Control)	70	3480	330

There were no adverse maternal outcomes noted during the TVS procedure. All scans were tolerated well, and no significant differences were observed in the position of the scar (anterior vs. lower segment) between the CS groups.

DISCUSSION

This study demonstrated that transvaginal sonography (TVS) performed 6 to 9 months postpartum is a reliable tool for evaluating Cesarean section (CS) scar morphology. TVS successfully identified uterine scars in all women with a prior CS and none in the control group, confirming its diagnostic specificity. A key finding was the inverse relationship between the number of previous CSs and residual myometrial thickness (RMT). Our results revealed a progressive decline in median RMT from 8.4 mm after one CS, to 6.6 mm after two CSs, and 4.5 mm after three or more CSs, compared to 11.5 mm in the control group with vaginal delivery ($P < 0.001$). This thinning has significant clinical implications, as RMT has been strongly associated with the integrity of the uterine wall and risk of complications in subsequent pregnancies [11].

Our findings align with previous research showing that women who had successful vaginal birth after Cesarean (VBAC) exhibited thicker second-trimester RMT and minimal reduction in RMT over time compared with those who had failed VBAC attempts [12]. This supports the notion that RMT is a more predictive metric of uterine integrity than the size or visibility of a hypoechoic scar defect or niche, which alone may not indicate poor healing. As shown by Bujold et al., even in the presence of a large hypoechoic segment, adequate RMT (>3 mm) can correlate with good uterine function during labor [13].

Interestingly, in women where the scar was not visible, 82% of those who attempted VBAC achieved a successful vaginal delivery. This aligns with the hypothesis proposed by Ofili-Yebovi et al. that a non-visible scar may reflect well-healed tissue with no hypoechoic segment, rather than a deficiency [14]. In clinical practice, however, some providers continue to interpret large scar niches as indicators of weakness, potentially leading to unnecessary repeat CS-a trend our data do not support.

Several prediction models for VBAC have been previously proposed, most of which rely heavily on clinical and demographic factors [2]. However, our study-and others incorporating imaging-demonstrate that adding objective sonographic measurements, such as RMT and ΔRMT (change in RMT), significantly improves predictive accuracy. For example, in a study developing a logistic regression model, adding scar measurements increased VBAC prediction sensitivity from 33% to 90% at a 0.7 cut-off [15].

In our population, we also noted a trend toward lower birth weights in women with multiple CSs, consistent with previous studies suggesting that poor scar remodeling can negatively impact placental development, fetal growth, and uterine contractility [16]. The combination of fetal distress (29.8%) and failure to progress (42.6%) as leading causes of failed VBAC in our data could plausibly stem from underlying scar-related uterine dysfunction.

From a public health perspective, these findings are particularly relevant in China, where CS rates remain among the highest globally. Despite a high TOLAC success rate (84%) and low uterine rupture risk (~0.3%), repeat CS is still the default recommendation for many women due to fear of complications and medico-legal concerns [17]. In our view, objective tools like scar-based prediction models can help overcome these barriers by providing both clinicians and patients with evidence-based, individualized delivery planning.

A nomogram model developed in a recent Chinese study included predictors such as gestational age <41 weeks, previous vaginal delivery, lower estimated birth weight, BMI, spontaneous labor onset, and Bishop score ≥6-all of which have also been widely reported as VBAC success factors in the international literature [18,16]. Our findings corroborate many of these clinical associations but uniquely contribute postpartum imaging-based evidence linking scar morphology and future obstetric outcomes.

However, this study has several limitations. First, although TVS was effective at assessing scar Integrity, we did not follow participants into subsequent pregnancies to correlate RMT with actual delivery outcomes. Longitudinal research is needed to assess the predictive validity of postpartum scar thickness for future TOLAC outcomes. Secondly, while we excluded women who self-selected repeat CS from prediction modeling, the high opt-out rate (44.4%) suggests that cultural and psychosocial factors remain key barriers to broader TOLAC adoption [19,20]. Lastly, our cohort was from a limited geographic region and may not represent more diverse or rural populations.

CONCLUSION

This study confirms that transvaginal ultrasound (TVS) is an effective, non-invasive tool for assessing cesarean section (CS) scar integrity postpartum. A clear inverse relationship between the number of prior CSs and residual myometrial thickness (RMT) was observed, with increased scar defects in women with multiple CSs. These findings underscore the clinical value of scar morphology in predicting uterine healing and guiding decisions regarding trial of labor after cesarean (TOLAC). Incorporating sonographic markers like RMT into VBAC prediction models may improve counseling, reduce unnecessary repeat CSs, and promote safer, individualized obstetric care, especially in high-CS settings such as China.

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