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Original Research Article

DIAGNOSTIC ACCURACY OF ULTRASOUND-DERIVED LOWER UTERINE SEGMENT THICKNESS IN PREDICTING INTRAOPERATIVE UTERINE SCAR DEHISCENCE DURING REPEAT CESAREAN SECTION: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Uterine scar dehiscence is an important concern among women undergoing repeat cesarean section. Antenatal measurement of lower uterine segment thickness by ultrasonography may help identify women with a weakened uterine scar before surgery. This study evaluated the diagnostic accuracy of ultrasound-derived lower uterine segment thickness for predicting intraoperative scar dehiscence.

Materials and Methods: This prospective observational study included 150 pregnant women aged 20–35 years with at least one previous cesarean delivery who underwent repeat cesarean section at the Department of Obstetrics and Gynaecology, World College of Medical Sciences and Research and Hospital, between 1 March 2025 and 28 February 2026. Lower uterine segment thickness was measured by ultrasonography before delivery. Intraoperative scar assessment was independently performed and used as the reference standard. Receiver operating characteristic analysis was used to determine diagnostic performance and the optimal thickness cutoff.

Results: Intraoperative uterine scar dehiscence was identified in 24 women (16.0%). Mean lower uterine segment thickness was significantly lower among women with dehiscence than among those without scar dehiscence (1.82 ± 0.42 mm versus 3.12 ± 0.76 mm; $p<0.001$). The area under the receiver operating characteristic curve was 0.91 (95% confidence interval: 0.85–0.96). A cutoff of ≤2.3 mm provided 87.5% sensitivity, 87.3% specificity, 56.8% positive predictive value, 97.3% negative predictive value, and 87.3% overall diagnostic accuracy.

Conclusion: Ultrasound-derived lower uterine segment thickness demonstrated good diagnostic accuracy for predicting uterine scar dehiscence. Its high negative predictive value suggests that it may be particularly useful for identifying women at low risk of intraoperative dehiscence. Larger multicentre studies are required before adopting a universal cutoff.

Keywords: cesarean section; lower uterine segment; scar dehiscence; ultrasonography; diagnostic accuracy; uterine scar.

INTRODUCTION

Cesarean section is one of the most frequently performed obstetric operations. With the increasing number of women with a previous cesarean delivery, assessment of uterine scar integrity has become important. Uterine scar dehiscence is defined as incomplete separation of the uterine musculature with preservation of the overlying serosa and is often asymptomatic until repeat

cesarean section [1]. A weakened scar may increase intraoperative risk and may precede complete uterine rupture during a trial of labour. Antenatal identification may therefore support counselling, delivery planning, and appropriate surgical and neonatal preparedness.[1-3]

Ultrasonographic measurement of lower uterine segment thickness is a simple, non-invasive method of assessing cesarean scar integrity. The lower uterine segment may be examined transabdominally or transvaginally by measuring either its full thickness or the residual myometrial layer. Reduced thickness has consistently been associated with an increased likelihood of uterine scar defects.[3,4]

Clinical application remains limited by variations in gestational age, bladder filling, ultrasound approach, probe position, operator experience, measurement site, and outcome definition. A systematic review and meta-analysis reported cutoff values ranging from 1.5 to 4.05 mm, with pooled sensitivity and specificity of approximately 88% and 77%, respectively.[5] A multicentre prospective study classified lower uterine segment thickness as high risk below 2.0 mm, intermediate risk at 2.0–2.4 mm, and low risk at ≥2.5 mm.[6] Other studies have proposed thresholds of approximately 1.5–2.5 mm, depending on whether full or myometrial thickness was measured.[7-9] Thus, a universally accepted cutoff has not been established.

This study aimed to determine the diagnostic accuracy of ultrasound-derived lower uterine segment thickness for predicting intraoperative uterine scar dehiscence during repeat cesarean section. The secondary objective was to identify an optimal cutoff and estimate its sensitivity, specificity, predictive values, likelihood ratios, and overall discriminatory performance.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational diagnostic-accuracy study was conducted in the Department of Obstetrics and Gynaecology, World College of Medical Sciences and Research and Hospital, from 1 March 2025 to 28 February 2026. It evaluated the ability of antenatal ultrasound-derived lower uterine segment thickness to predict scar dehiscence identified during repeat cesarean section.

Study Population

Pregnant women with at least one previous cesarean section who were scheduled for repeat cesarean delivery were consecutively screened. Eligible women were enrolled after receiving an explanation of the study and providing written informed consent.

Inclusion Criteria

- Pregnant women aged 20–35 years.
- Singleton pregnancy.
- History of at least one previous lower-segment cesarean section.
- Gestational age of 36 weeks or more.
- Women scheduled for repeat cesarean delivery.
- Lower uterine segment thickness measured by ultrasonography within seven days before delivery.
- Women willing to participate and provide written informed consent.

Exclusion Criteria

- Previous classical or vertical uterine incision.
- Previous myomectomy involving entry into the uterine cavity.
- Multiple pregnancy.
- Major fetal congenital anomaly.
- Placenta previa.
- Placenta accreta spectrum.
- Congenital uterine malformation.
- Emergency cesarean delivery without sufficient time for lower uterine segment measurement.
- Incomplete ultrasound measurements or unavailable intraoperative scar findings.
- Women unwilling to participate or provide written informed consent.

Sample-Size Calculation

Assuming 85% sensitivity, 15% scar-dehiscence prevalence, 15% absolute precision, and a 95% confidence level, the minimum required sample size was approximately 145 participants. A total of 150 eligible women were included.

Clinical Assessment

Maternal age, parity, gestational age, body mass index, number and indication of previous cesarean deliveries, interpregnancy interval, history of vaginal delivery, onset of labour, and indication for the current cesarean delivery were recorded using a structured data-collection form. Antenatal records were reviewed for maternal medical conditions and pregnancy complications. Names, hospital registration numbers, and other personal identifiers were excluded from the study database.

Ultrasound Examination

Lower uterine segment thickness was assessed using a high-resolution ultrasound system with a 3.5–5.0 MHz curvilinear transabdominal probe. Participants were examined in the supine position with a moderately filled urinary bladder. A midsagittal view showing the maternal bladder, lower uterine segment, and presenting fetal part was obtained.

Full lower uterine segment thickness was measured at the thinnest clearly visualised portion of the previous scar, from the interface between the posterior bladder wall and uterine serosa to the myometrium–amniotic cavity interface. Measurements were avoided during focal uterine contractions. Three measurements were obtained in millimetres, and their mean was used for analysis.

All examinations were performed by an experienced obstetric sonologist who was unaware of the subsequent intraoperative findings. Ultrasound results were not used to alter the planned timing or mode of delivery.

Intraoperative Scar Assessment

During repeat cesarean section, the operating obstetrician inspected the lower uterine segment before extending the uterine incision and was blinded to the ultrasound measurement. The uterine scar was classified as follows:

- **Intact scar:** Continuous uterine wall without visible separation or defect.
- **Scar thinning:** Markedly thin lower uterine segment without separation of the myometrium.
- **Scar dehiscence:** Partial or complete separation of the myometrial layer at the previous cesarean scar with preservation of the overlying uterine serosa, with or without visible fetal membranes.
- **Complete uterine rupture:** Full-thickness disruption of the uterine wall, including the serosal layer.

Scar dehiscence was considered a positive reference-standard result. An intact scar or scar thinning without myometrial separation was considered negative, while complete uterine rupture was documented separately.

Outcome measures

The primary outcome was the diagnostic accuracy of ultrasound-derived lower uterine segment thickness for predicting intraoperative scar dehiscence. Secondary outcomes were mean thickness among women with and without dehiscence, the optimal cutoff, sensitivity, specificity, positive and negative predictive values, positive and negative likelihood ratios, overall accuracy, and the area under the receiver operating characteristic curve.

Statistical Analysis

Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics, version 26.0. Normally distributed continuous variables were presented as mean ± standard deviation, non-normally distributed variables as median with interquartile range, and categorical variables as frequencies and percentages. Welch's independent-samples t-test or the Mann–Whitney U test was used for continuous variables, while the chi-square test or Fisher's exact test was used for categorical variables, as appropriate.

Receiver operating characteristic analysis assessed the ability of lower uterine segment thickness to distinguish women with and without scar dehiscence. The optimal cutoff was selected using the maximum Youden index. Sensitivity, specificity, predictive values, likelihood ratios, and overall accuracy were calculated from a 2 × 2 table and reported with 95% confidence intervals. A two-sided p value <0.05 was considered statistically significant.

Ethical considerations

The study was approved by the Institutional Ethics Committee of World College of Medical Sciences and Research and Hospital. Written informed consent was obtained from all participants before enrolment.

RESULTS

Participant flow and baseline characteristics

Of 164 women assessed for eligibility, 14 were excluded: five lacked lower uterine segment measurement within seven days before delivery, three required immediate emergency cesarean delivery before ultrasound, two had placenta previa, and four had incomplete intraoperative scar documentation. Therefore, 150 women were included.

Mean maternal age was 28.5 ± 3.4 years, and mean gestational age at delivery was 38.1 ± 0.8 weeks. Overall, 104 women (69.3%) had one previous cesarean delivery, 46 (30.7%) had two or more, and 39 (26.0%) had an interpregnancy interval <24 months. Scar dehiscence was identified in 24 women (16.0%; 95% CI: 11.0%–22.7%); 96 (64.0%) had an intact scar and 30 (20.0%) had scar thinning without myometrial separation. No complete uterine rupture occurred.

Two or more previous cesarean deliveries (54.2% versus 26.2%; p=0.006) and an interpregnancy interval <24 months (45.8% versus 22.2%; p=0.016) were more frequent among women with dehiscence. Maternal age, gestational age, body mass index, labour before cesarean delivery, and anterior placental location did not differ significantly between groups. [Table 1]

Table 1: Maternal and obstetric characteristics according to intraoperative scar findings

Characteristic	No dehiscence (n=126)	Scar dehiscence (n=24)	*p* value
Maternal age, years	28.4 ± 3.4	29.1 ± 3.1	0.325
Gestational age at delivery, weeks	38.1 ± 0.8	37.8 ± 0.9	0.138
Body mass index, kg/m²	27.3 ± 3.2	28.1 ± 3.6	0.318
One previous cesarean section	93 (73.8)	11 (45.8)	0.006
Two or more previous cesarean sections	33 (26.2)	13 (54.2)	—
Interpregnancy interval <24 months	28 (22.2)	11 (45.8)	0.016
Labour before cesarean delivery	39 (31.0)	12 (50.0)	0.071
Anterior placental location	72 (57.1)	12 (50.0)	0.518

Table note: Data are presented as mean ± standard deviation or number (percentage). Continuous variables were compared using welch's independent-samples *t*-test. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. The *p* value for the number of previous cesarean sections represents the overall comparison between the two categories.

Lower uterine segment thickness and scar dehiscence

Mean lower uterine segment thickness was 2.91 ± 0.86 mm overall and was significantly lower among women with dehiscence than among those without dehiscence (1.82 ± 0.42 mm versus 3.12 ± 0.76 mm; mean difference, 1.30 mm; p<0.001). Dehiscence occurred in 17 of 24 women with thickness ≤2.0 mm, with four additional cases between 2.1 and 2.3 mm. None of the 57 women with thickness >3.0 mm had dehiscence. [Table 2]

Table 2: Distribution of intraoperative scar findings according to lower uterine segment thickness

LUS thickness category	No dehiscence (n=126)	Scar dehiscence (n=24)	Total (n=150)
≤2.0 mm	7 (5.6)	17 (70.8)	24
2.1–2.3 mm	9 (7.1)	4 (16.7)	13
2.4–3.0 mm	53 (42.1)	3 (12.5)	56
>3.0 mm	57 (45.2)	0 (0.0)	57
Total	**126 (100.0)**	**24 (100.0)**	**150**

Table note: Values are presented as number (column percentage). LUS, lower uterine segment**.**

Receiver operating characteristic analysis

Receiver operating characteristic analysis showed excellent discriminatory ability, with an area under the curve of 0.91 (95% CI: 0.85–0.96; p<0.001). The maximum Youden index identified ≤2.3 mm as the optimal cutoff. A cutoff of ≤2.0 mm had greater specificity but lower sensitivity, whereas ≤2.5 mm increased sensitivity but reduced specificity and positive predictive value. A cutoff of ≤3.0 mm detected all cases but produced more false-positive results. The ≤2.3 mm cutoff provided the best balance between sensitivity and specificity. [Table 3]

Table 3: Diagnostic performance at different lower uterine segment thickness cutoffs

LUS cutoff	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	Youden index
≤2.0 mm	70.8	94.4	70.8	94.4	90.7	0.65
≤2.3 mm	87.5	87.3	56.8	97.3	87.3	0.75
≤2.5 mm	95.8	77.8	45.1	99.0	80.7	0.74
≤3.0 mm	100.0	45.2	25.8	100.0	54.0	0.45

Table note: The optimal cutoff was selected using the maximum Youden index. A lower uterine segment thickness of ≤2.3 mm provided the best balance between sensitivity and specificity. LUS, lower uterine segment; PPV, positive predictive value; NPV, negative predictive value.

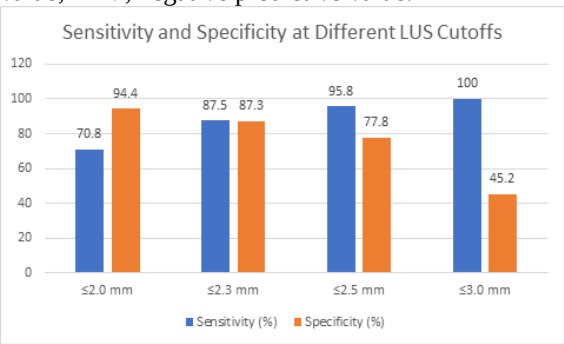

Figure 1: Sensitivity and specificity of ultrasound-derived lower uterine segment thickness at selected diagnostic cutoffs

Figure note: Bars represent the sensitivity and specificity of ultrasound-derived lower uterine segment thickness at each selected cutoff. The cutoff of ≤2.3 mm achieved the highest Youden index of 0.75 and was selected as the optimal diagnostic threshold. LUS, lower uterine segment.

Diagnostic accuracy at the optimal cutoff

At the ≤2.3 mm cutoff, 37 women had a positive ultrasound result, comprising 21 true-positive and 16 false-positive results. Among 113 women with a negative result, 110 were true negative and three were false negative. [Table 4]

Table 4: Diagnostic 2 × 2 table at a lower uterine segment thickness cutoff of ≤2.3 mm

Ultrasound result	Dehiscence present	Dehiscence absent	Total
Positive: LUS thickness ≤2.3 mm	21	16	37
Negative: LUS thickness >2.3 mm	3	110	113
Total	**24**	**126**	**150**

Table note: Intraoperative scar assessment was used as the reference standard. LUS, lower uterine segment.

The ≤2.3 mm cutoff provided 87.5% sensitivity (95% CI: 69.0%–95.7%), 87.3% specificity (95% CI: 80.4%–92.0%), 56.8% positive predictive value, 97.3% negative predictive value, and 87.3% overall accuracy. The positive and negative likelihood ratios were 6.89 and 0.14, respectively. [Table 5]

Table 5: Diagnostic performance of lower uterine segment thickness ≤2.3 mm

Diagnostic measure	Estimate	95% confidence interval
Sensitivity	87.50%	69.0%–95.7%
Specificity	87.30%	80.4%–92.0%
Positive predictive value	56.80%	40.9%–71.3%
Negative predictive value	97.30%	92.5%–99.1%
Positive likelihood ratio	6.89	4.25–11.16
Negative likelihood ratio	0.14	0.05–0.41
Overall diagnostic accuracy	87.30%	81.1%–91.7%
Area under the ROC curve	0.91	0.85–0.96

Table note: Confidence intervals for sensitivity, specificity, predictive values, and overall accuracy were calculated using the Wilson method. ROC, receiver operating characteristic.

DISCUSSION

The present study evaluated the diagnostic accuracy of ultrasound-derived lower uterine segment thickness for predicting intraoperative scar dehiscence among women undergoing repeat cesarean section. Scar dehiscence was identified in 16.0% of participants. Women with dehiscence had a significantly thinner lower uterine segment than women without dehiscence. A cutoff of ≤2.3 mm provided good sensitivity, specificity, and overall discriminatory performance.

The observed association between reduced lower uterine segment thickness and scar dehiscence is consistent with earlier studies.[2-4] The sensitivity of 87.5% observed in the present study was comparable to the pooled estimate reported by Swift et al., whereas the specificity of 87.3% was slightly higher than their pooled finding.[5] These results support the use of antenatal lower uterine segment measurement as a clinically useful marker of uterine scar integrity.

The optimal cutoff identified in this study falls within the range reported in previous investigations. Cheung reported that women with paper-thin or dehiscent scars had significantly lower sonographic measurements and proposed a threshold of approximately 1.5 mm..[7] Sen et al. identified 2.5 mm as a clinically useful cutoff in an Indian population.[8] Asakura et al., using transvaginal measurement of the muscular layer, reported an optimal threshold of 1.6 mm.[9] These differences reinforce the difficulty of applying a single cutoff across different ultrasound methods and populations.

The variation in proposed cutoff values may be partly explained by differences in ultrasound approach and by whether full lower uterine segment thickness or isolated myometrial thickness was measured.[3-6] Previous labour characteristics may also influence lower uterine segment thickness in a subsequent pregnancy.[10] Measurement reliability depends on the imaging method and observer consistency. Boutin et al. demonstrated good intraobserver and interobserver reliability for three-dimensional transvaginal measurements, although agreement between two- and three-dimensional techniques was not complete.[11] Standardisation of ultrasound technique is therefore essential before a universal threshold can be recommended.

The negative predictive value of 97.3% was one of the most clinically relevant findings. It suggests that women with a lower uterine segment thickness greater than 2.3 mm are unlikely to have intraoperative dehiscence. Similar high negative predictive values have been documented in previous studies.[7,9,14] However, the positive predictive value was only 56.8%, indicating that a thin lower uterine segment does not invariably represent true scar separation. Ultrasound findings should therefore complement clinical assessment rather than independently determine management.

Women with two or more previous cesarean deliveries and those with an interpregnancy interval shorter than 24 months had a higher frequency of dehiscence. Short interdelivery intervals have previously been associated with uterine scar complications, possibly because uterine healing and remodelling remain incomplete.[12] Previous uterine closure technique may also influence subsequent scar integrity, with double-layer closure associated with a thicker lower uterine segment and fewer scar defects.[13]

Ultrasonography is practical and non-invasive, but false-positive and false-negative findings remain possible.[14] Combining lower uterine segment measurements with relevant clinical characteristics may improve predictive performance, as demonstrated by recent multivariable and machine-learning approaches.[15] Larger multicentre studies using standardised measurement protocols are required to validate the proposed cutoff and determine its role in individualised delivery planning.

Limitations

This study has several limitations. It was conducted at a single tertiary-care institution with a relatively modest sample size, which may limit the generalisability of the findings. Lower uterine segment thickness was assessed using only the transabdominal approach, and interobserver variability was not formally evaluated. Intraoperative scar classification was based on visual assessment and may therefore have been subjective. The number of women with dehiscence was small, resulting in wider confidence intervals for sensitivity. Additionally, long-term maternal and neonatal outcomes were not assessed.

CONCLUSION

Ultrasound-derived lower uterine segment thickness demonstrated good diagnostic accuracy for predicting intraoperative uterine scar dehiscence during repeat cesarean section. A cutoff of ≤2.3 mm provided an appropriate balance between sensitivity and specificity, while its high negative predictive value made it particularly useful for excluding dehiscence. Lower uterine segment measurement may support antenatal risk assessment but should be interpreted alongside clinical and obstetric factors. Larger multicentre studies using standardised ultrasound protocols are required to validate this cutoff before routine clinical adoption.

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Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The anonymised data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to institutional and ethical restrictions.

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