Sonographic Lower Uterine Segment Thickness to Predict Cesarean Scar Defect in Term Pregnancy

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ABSTRACT

Objective: To study the validity of abdominal sonographic lower uterine segment (LUS) thickness in predicting intraoperative cesarean scar defect (CSD) and thin incision-site uterine wall thickness in term pregnancy.

Methods: This was a cross-sectional study involving 111 full-term pregnant women who were scheduled for repeat cesarean delivery from April, 2019 to January, 2020. The abdominal sonographic myometrial LUS thickness was measured prior to surgery. The cesarean scar was assessed using the morphologic classification system as either grade 1 (a normally formed LUS), grade 2 (a thin LUS, but without visible content), or grade 3 (a thin LUS with visible content). Then, the ophthalmic calipers was used to measure the incision-site uterine wall thickness. The correlations between the abdominal sonographic measurements and intraoperative findings were reported. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated.

Results: There were two cases (1.8%) of grade 3 CSD. The overall correlation between the abdominal sonographic and intraoperative incision-site uterine wall thickness showed r=0.559 with p value < 0.001. The sonographic cut-off value of 1.5 mm could predict CSD and a thin incision-site uterine wall thickness with sensitivity, specificity, PPV, NPV of 50.0%, 90.8%, 9.1%, 99.0%, and 37.5%, 94.6%, 54.5%, 90.0%, respectively. A receiver operating characteristic curve was generated to determine the optimum cut-off value at 2.5 mm with a sensitivity of 76.5% and a specificity of 73.3%. The area under the curve was 0.8 (a 95% confidence interval, 0.718-0.885).

Conclusion: Abdominal sonography is a valuable tool for the preoperative predicting of CSD. A myometrial LUS thickness of more than 1.5 mm is associated with a lower likelihood of cesarean scar dehiscence.

Keywords: Sonography; lower uterine segment; cesarean scar; term pregnancy (Siriraj Med J 2021; 73: 330-336)

INTRODUCTION

Uterine rupture is a devastating complication of cesarean scar defect (CSD). Several factors influence cesarean scar healing, such as the suturing technique, the suture materials, the anatomical site, and the apposition of the myometrium.[1,2] The prevalence of a niche in a cesarean scar at six-weeks postpartum was 64.5% and continued rising.[3] Previous studies demonstrated CSD by using various methods, such as vaginal sonography[3], 3-dimensional (D) abdominal sonography[4], and pelvic magnetic resonance imaging.[5] But these methods are inconvenient, expensive, and require expertise on the part of the operators. Two-dimensional (2D) abdominal sonography is a simple, less invasive, more affordable and readily available method.

There was a high relationship between the sonographic LUS thickness and the risk of CSD.[6] Earlier researchers measured the entire layer of the LUS, including the

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bladder wall, uterine scar fibrosis, the myometrial layer, and the chorio-amniotic membranes, without a good comparator.[7,8] Sen, et al.[9] reported that a cut-off value of 2.5 mm full LUS thickness is associated with uterine dehiscence. Recent studies focused only the myometrial layer of the LUS, with a higher accuracy in detecting CSD.[10] There still is no consensus on using antepartum LUS thickness to evaluate CSD.[11] So, the objective of this study was to assess the validity of 2D abdominal sonography in predicting CSD and the thin incision-site uterine wall thickness in term pregnancy.

MATERIALS AND METHODS

This cross-sectional study was conducted at HRH Princess Maha Chakri Sirindhorn Medical Center, Srinakharinwirot University, Thailand from April, 2019 to January, 2020. The study was approved by the Institute's Ethical Review Board (SWUEC/F 386/2018) and registered to Thai Clinical Trials Registry number 20190718001. Participants were the singleton term pregnant women with at least a prior cesarean section, aged 18 years and up, and who were scheduled for repeat cesarean delivery between 38 and 40 weeks of gestation. The exclusion criteria were women who had labor symptoms, abnormal placentation, leiomyoma at the LUS, and prior classical uterine incision. Consent was obtained from all the participants. Their maternal age, gestational age, body mass index, parity number, miscarriage number, and number of previous cesarean sections were recorded.

Preoperative LUS sonography

Two-dimension abdominal sonography was performed by a well-trained sonographer (NP) within 24 hours before the operation. An Accuvix XG (Samsung Medison Co Ltd., Seoul, Korea) ultrasound machine was used in the study. The participants were prepared in a supine position with a full bladder. The convex probe (frequency of 1-4 MHz) was placed at the suprapubic area in the midsagittal plane. A two-layer structure between the urinary bladder and uterine cavity was identified, consisting of a hyperechogenic layer (bladder wall) and a hypoechogenic layer (myometrium).[7] The area of interest was magnified to occupy up to two-thirds of the screen. For the myometrial-thickness measurement, the first marker was placed at the interface between the urinary bladder wall and the myometrial layer. The second marker was placed at the interface between the myometrial layer and the amniotic membranes (or fetal scalp) (Fig 1).[10] The same procedures were repeated at 1 cm laterally apart from the first measurement on both sides. Three values were calculated into an average value. The thin sonographic myometrial LUS was defined as having thickness < 1.5 mm.[12]

Intraoperative LUS assessment

In the operative field, cesarean scar morphology was classified into three groups by direct visualization (Fig 2): grade 1= normal-formed LUS; grade 2= thin LUS without visible content; and grade 3= thin LUS with visible content or an absence of LUS continuity.[13] The cesarean scar dehiscence was defined as cesarean scar morphologic grade 3. Then, a low-transverse uterine incision was made until the amniotic membrane was exposed. The CASTROVIEJO ophthalmic calipers was applied to the upper uterine flap at the midpoint of the uterine incision site for measurement, and reapplied at 1 cm apart on both sides (Fig 3). The average value of the incision-site uterine wall thickness was calculated. A thin LUS was defined as a uterine wall thickness equal to or less than 1.0 mm.[10] All obstetricians were trained for the caliper measurement and blinded from the preoperative results. If this procedure could not be accomplished, they were excluded from the study.

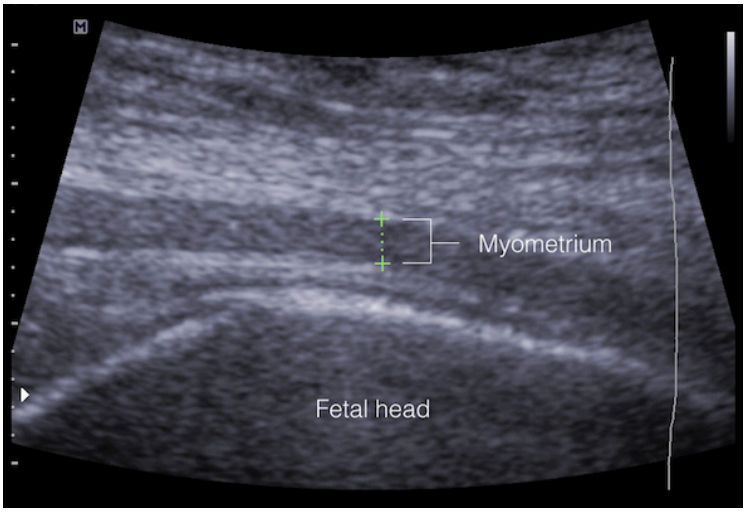
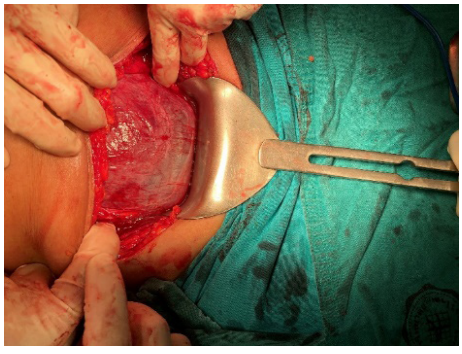


Fig 1. The longitudinal abdominal sonogram showing the myometrial LUS thickness measurement.
Abbreviation: LUS: lower uterine segment

2A



2B

Fig 2. The Intraoperative cesarean scar morphology: grade 1 normal LUS (A) and grade 3 thin LUS with visible content (B)
Abbreviation: LUS: lower uterine segment

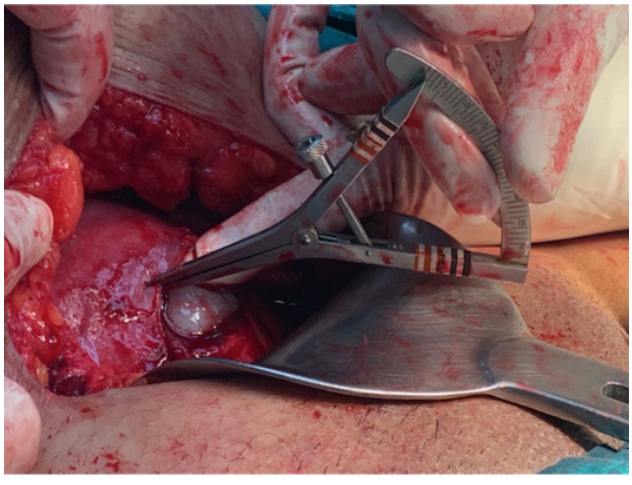


Fig 3. The intraoperative incision-site uterine wall thickness measurement using the CASTROVIEJO ophthalmic calipers.

Statistical analysis

The sample-size calculation was done by using a prevalence of CSD at 8.5%[6] with an expected sensitivity of 90%, a confidence interval at 95%, and an allowable number of errors of 15%. The number of participants needed in this study was 92 pregnant women.

The baseline characteristics were analyzed using descriptive statistics - namely, mean ± standard deviation (SD), median with an interquartile range, and percentage, as appropriate. The calculation for sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were made. The authors used the Chi-square test to find the relationship between the two parameters. A p-value of less than 0.05 was considered statistically significant.

RESULTS

120 pregnant women were enrolled in this study. Nine were excluded from the study (two women had labor pain and seven couldn't go through the intraoperative assessment). The baseline characteristics of the 111 participants are presented in Table 1.

There was a statistically significant correlation between the sonographic LUS thickness and the cesarean scar morphology in grade 1, grade 2, and all grades (Table 2). There were two cases in the grade 3 CSD group that did not correlate with the incision-site uterine wall thickness.

A cut-off level at 1.5 mm for the abdominal sonographic myometrial LUS could predict uterine dehiscence (grade 3 morphology) and a thin incision-site uterine wall thickness with validity, as shown in Table 3. Based on our data, a receiver operating characteristic graph was generated (Fig 4). The authors suggested that using a cut-off point at 2.5 mm sonographic LUS thickness could predict an intraoperative thin-incision site with a sensitivity of 76.5% and a specificity of 73.3%.

DISCUSSION

The CSD is an abnormal finding manifested during a repeat cesarean section. The CSD spectrum can present with scar dehiscence or a uterine scar rupture during labor. This devastating complication can be prevented. To do so, a good screening tool for the early detection of CSD is needed.

TABLE 1. Patient's characteristics (n=111).

Characteristics	Values
Age (years) (mean±SD)	29 ± 6
Gestational age (weeks) (mean±SD)	38.5 ± 0.6
BMI (kg/m^2) (number (%))	
< 18.5	9 (8.1)
18.5 - 22.9	45 (40.5)
23.0 - 24.9	13 (11.7)
25.0 - 29.9	29 (26.1)
> 30	15 (13.5)
Parity (number (%))	
1	93 (83.8)
2	16 (14.4)
> 3	2 (1.8)
Miscarriages (number (%))	
0	80 (72.1)
1	28 (25.2)
> 2	3 (2.7)
Number of previous cesarean sections (number (%))	
1	101 (91.0)
> 1	10 (9.0)

Data are presented as mean ± standard deviation (SD), or number (%)
Abbreviation: BMI, body mass index

TABLE 2. The correlations between the abdominal sonographic LUS thickness and the incision-site uterine wall thickness in each cesarean-scar morphologic grading.

		LUS thickness (mm) measured by			
Cesarean scar morphology	Number	Sonography	Ophthalmic calipers	Correlation coefficient	P-value
Grade 1	55	3.1 ± 1.0	3.3 ± 0.8	r = 0.559*	0.001
Grade 2	54	2.3 (1.8-2.9)	2.3 (1.7-2.3)	r = 0.407**	0.002
Grade 3	2	Case A= 1.4 Case B= 3.4	Case A=1.2 Case B=0.7	-	-
Overall	111	2.6 ± 1.0	2.5 ± 1.1	r = 0.559*	0.001

Data are presented as mean±standard deviation or median (interquartile range).
*Pearson correlation, **Spearman correlation
Abbreviation: LUS, lower uterine segment.

TABLE 3. The validity of the abdominal sonographic LUS thickness to detect cesarean scar dehiscence (grade 3 morphology) and thin incision-site uterine wall thickness.

		Sonographic LUS thickness(mm)		Total	Sensitivity		Specificity		PPV	NPV
		<1.5	>1.5	number	(%)	95%CI	(%)	95%CI	(%)	(%)
Cesarean scar	Yes	1	1	2	50.5	40-59	90.8	85-96	9.1	99.0
dehiscence	No	10	99	109						
Total number		11	100	111						
Thin incision-site	Yes	3	5	8	37.5	4-71	92.2	87-94	27.3	95.0
uterine wall	No	8	95	103						
thickness										
Total number		11	100	111						

Abbreviations: LUS: lower uterine segment; CI: confidence interval; PPV: positive predictive value; NPV: negative predictive value

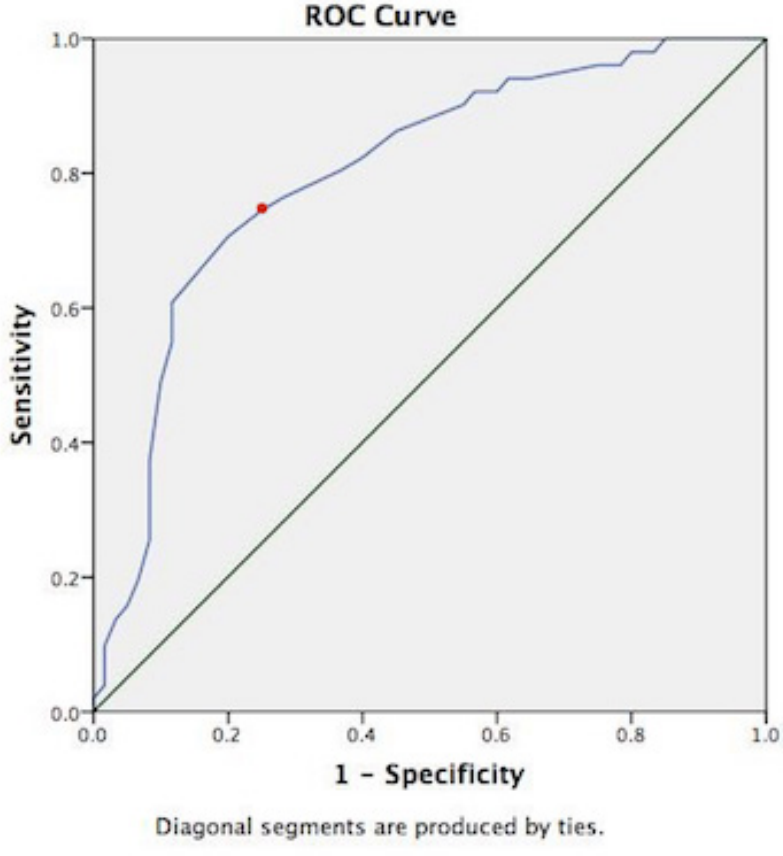


Fig 4. Receiver operating characteristic curve showing the optimal cut-off value for thin LUS (2.5 mm): the area under the curve was 0.8 (95% CI, 0.718-0.885).
Abbreviations: LUS: lower uterine segment; CI: confidence interval

The 2D abdominal sonography is a simple, noninvasive, widely used, and readily available device in most hospitals. The abdominal sonographic LUS thickness can be used for antepartum CSD screening. Theoretically, a thinner LUS will result in a more severe degree of CSD.[14] In this study, the authors evaluated only the myometrial layer of the LUS, which directly represents the uterine scar's integrity. The overall mean sonographic myometrial LUS thickness was 2.6+1.0 mm, which is comparable to the Tazion, et al study.[15] Other studies have reported a thinner sonographic measurement.[10,12] The differences involving the sonographic LUS thickness may be caused by the variation of participants' characteristics, gestational age, uterine-closure techniques, scar-fibrosis formation, uterine healing process, and the sonographic protocol used. However, the number of grade 3 CSD found in this study was 1.8%, which is comparable to what was reported in those' studies.[10,12]

There is a significant correlation between the overall sonographic LUS thickness and the incision-site uterine wall thickness, and that is consistent with a prior study[6] which had a high level of correlation. Surprisingly, one case in the grade 3 group had a sonographic LUS thickness of 3.4 mm, while the incision-site uterine wall thickness was only 0.7 mm. This unexpected result may be caused by a poor imaging technique used on the thick abdominal wall; less urine in the bladder; or abnormal focal myometrial thickening. The authors intend to use the specific sonographic protocol and three-point measurement technique to maximize the correspondence between the sonographic area of interest and the cesarean scar site, but mislocation may still occur.

With regard to any prediction of scar dehiscence, the use of a sonographic myometrial LUS thickness of less than 1.5 mm had a sensitivity of 50.0% and a specificity of 90.8%, which is quite different from what Gizzo, et al.[12] Specifically, they reported a high sensitivity of 100% and a specificity of 85%. A possible reason for the differences is the different characteristics of the participants, especially the higher number of previous cesareans. The thicker sonographic LUS in this study results in a lower number of positive tests, which can lead to less sensitivity and more specificity. Our results showed a high NPV of 99.0%; thus, when the sonographic LUS thickness is more than 1.5 mm, it is less likely to have CSD.

With regard to the detection of a thin incision-site uterine wall thickness, a sonographic myometrial LUS thickness of less than 1.5 mm had a sensitivity of 37.5%. So, there is a need to redefine the optimum cut-off point. Based on this study, the authors suggest a cut-off level at 2.5 mm.

Strengths and limitations

The strengths of this study are that only one sonographer was used, so as to minimize interobserver variations[16]; all assessors were blinded from the sonographic results; and an ophthalmic calipers was employed for objective measurement.

The limitation of this study was the small number of cesarean scar dehiscence cases. Also, there was a possible error during the incision-site uterine wall thickness measurement, as the ophthalmic calipers jaws have to grasp a certain amount of tissue deep from the incisional edge, which may result in abnormally thick uterine walls. There are different types of ophthalmic calipers used for LUS measurement, such as Castroviejo ophthalmic calipers[6] or Vernier calipers[10], and this may affect the results.

Further study with more participants and a longer duration of follow-up should be carried out to achieve the most accurate method for antepartum CSD prediction.

CONCLUSION

Preoperative abdominal sonography is a simple tool for CSD prediction. A myometrial LUS thickness of more than 1.5 mm is associated with a lower likelihood of cesarean scar dehiscence.

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