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ORIGINAL ARTICLE

Transabdominal and Transvaginal Ultrasonographic Assessment of Lower Uterine Segment Thickness in Pregnant Women Before Repeat Cesarean Section

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Abstract

Introduction: The selection of repeat cesarean delivery instead of trial of labor after cesarean (TOLAC) has a great contribution to cesarean rate. Ultrasonographic measurement of lower uterine segment (LUS) thickness for prediction of real uterine thickness was investigated by several researchers. In this study, LUS transvaginal (TV) and transabdominal (TA) ultrasonography (USG) measurements were evaluated for usefulness in patients with the previous cesarean scar.

Methods: Pregnant patients between 37 and 40 weeks of gestational age who were admitted to our clinic with the decision of repeat cesarean delivery were evaluated by TV and TA USG by measuring the LUS full-thickness and myometrium before cesarean delivery. The patients were divided into two groups: Translucent LUS and intact myometrium. The real myometrial thickness also assessed by vernier caliper in the operation. Correlations between ultrasonographic and vernier caliper measurements were analyzed and cutoff values for the ultrasonographic measurements of LUS were evaluated.

Results: Manual caliper measurements had a correlation (r) of 0.347 with TA USG full thickness, 0.337 with myometrial measurements, 0.443 with TV USG full thickness, and 0.475 with myometrial measurements. The extremely thin LUS ratio was 7.07% (n=14). Receiver operating curve, cutoff values are 3.55 mm for TA USG full-thickness LUS measurements, 2.75 mm for TV USG full-thickness, and 1.35 mm for TV USG myometrial LUS measurements.

Discussion and Conclusion: LUS USG measurements are useful for predicting the intact LUS and can be used in clinical decision-making for TOLAC, but the low positive predictive value suggests that it cannot be recommended in the prediction of extremely thin LUS.

Keywords: Dehiscence; lower uterine segment; repeat cesarean section; ultrasonography.

Cesarean delivery in women with prior uterine scar is the largest contributor to the total cesarean delivery rate in most countries[1-3]. The promotion of vaginal birth after cesarean (VBAC) is an important option for reducing overall cesarean section numbers. The VBAC rate has been negatively influenced by clinical studies on the safety of trial of labor after the previous cesarean section. The biggest reason that prevents obstetricians from trial of labor after cesarean (TOLAC) is the risk of uterine rupture. The risk of uterine rupture is 0.52% for women who undergo sponta-

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neous labor after cesarean section, 0.77% for women with oxytocin induced labor, and 2.45% for labor induced with prostaglandins[4]. On the other hand, when VBAC is successful, it is associated with less morbidity than repeat cesarean delivery[5].

Accurate prediction of uterine rupture risk can be of significant value during management of subsequent pregnancies after previous caesarean delivery. Several prediction score methods were considered predicting successful VBAC based on clinical characteristics of patients, but none was found to be fully predictive[6].

Ultrasonographic measurement of lower uterine segment (LUS) thickness for prediction of uterine rupture using either transabdominal (TA) or transvaginal (TV) approaches was investigated by several studies. Strong association has been found between the level of LUS thickness and risk of uterine defects[7,8]. However, the sonographic methodology differs among studies with confounding factors and, therefore, recommended cutoff values commonly vary.[9]

The aim of this study was to evaluate the accuracy and benefit of TA and TV ultrasonography (USG) measurements for determining the LUS thickness in women with the previous caesarean section and to define a cutoff value of uterine thickness for prediction of extremely thin LUS.

Materials and Methods

This prospective study was conducted between April 2019 and September 2019 in a tertiary health-care center. Pregnant women with the previous cesarean section who were scheduled for elective repeat cesarean section or admitted with contraction to the delivery room between 37 and 41 week gestation were included in this study. Pregnant women with the previous cesarean section who were not in active labor were enrolled and written consents were obtained. The Institutional Ethical Committee approved the study (No: 2019/7). Pregnant women with the previous cesarean section are scheduled for repeat cesarean section as much as possible as a local clinical protocol. Patients with placental adhesion anomalies, placental abruption, uterine myomas, fetal anomalies, polyhydramnios, oligohydramnios, multiple gestation, abnormal presentation, and in active labor were excluded from the study. Patient's demographic characteristics including previous pregnancy, abortion, curratage history, labor history, last cesarean time, the previous highest fetal weight, former cesarean indications, body mass index, and smoking were recorded.

The study cohort was planned to be included all cesarean section patients with the previous cesarean section between 37 and 41 gestational weeks in 6-month period.

TV and TA ultrasound evaluation was carried out right before cesarean section by an educated clinician with Mindray DC-8 PRO V11-3BE TV transducer and SC5-1E TA probe. The total uterine wall and myometrial thickness of LUS were measured by TA and TV approaches separately 3 times with a half-full bladder (as defined with a bladder length of 4–6 cm in vertical plane) and the thinnest measurement was noted. According to Michaels et al.,[10] three layers can be identified ultrasonographically in a well-developed LUS in a midline section of sagittal view. They are as follows: (1) chorioamniotic membrane with decidualized endometrium, (2) middle layer of myometrium, and (3) utero-vesical peritoneal reflection juxtaposed to muscularis and mucosa of the bladder. The full thickness of the LUS (total LUS) was defined by the smallest measurement between the amniotic fluid and urine in the maternal bladder.[11] The myometrial layer of LUS (myometrial LUS) was defined by the smallest hypoechoic portion of the LUS between maternal urinary bladder wall-myometrium interface and the myometrium/chorioamniotic membrane-amniotik fluid interface[12].

In the operation, the uterus was visualized by the operator and patients were divided into two groups using classification by Qureshi[13]. We modified the classification for the statistical reasons as; Group 1: Uterine contents were not visible (intact myometrium) and Group 2: Translucent lower segment, uterine content visible (extremely thin LUS). After delivery of the neonate, the thickness of the LUS was measured by the surgeon with a sterile vernier caliper up to the nearest millimeter in the following manner: Two Green-Armytage forceps were used to hold the lower flap of the uterine defect about 2 inches apart on either side of the midline. The vernier caliper was placed on the LUS in the middle between the two Green-Armytage forceps and the measurement was taken[14]. Measurements were taken 3 times from the thinnest part of the lower segment and the thinnest measurement was recorded (Fig. 1).

Pre-operative ultrasound measurements were compared with the intraoperative visual findings and intraoperative manual measurements of the LUS during the cesarean section. Fetal weight, APGAR, neonatal and maternal outcomes, and blood transfusion requirements were recorded after cesarean section.

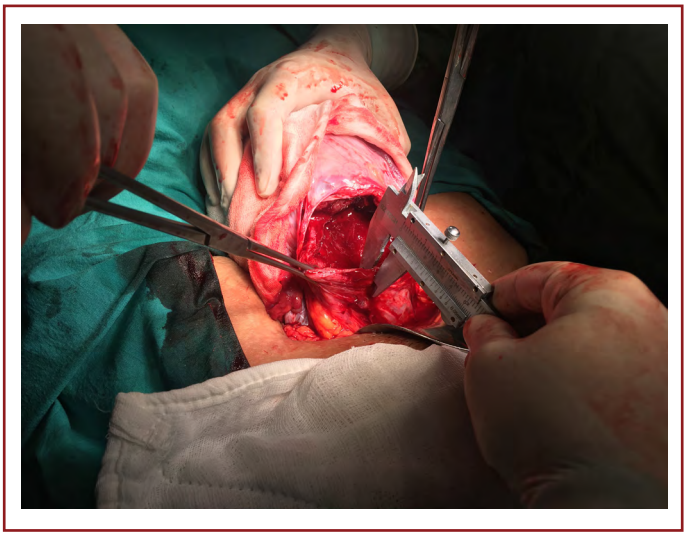

Figure 1. Vernier caliper measurement.

Statistical Analysis

The data were analyzed by SPSS version 22. Descriptive statistical analyses were performed. Differences between mean values of measurements in groups were analyzed by Independent Samples t test. Categorical variables that could affect LUS thickness were compared by Chi-square test and Fisher's exact test. Receiver operating characteristic (ROC) curve for optimal cutoff point values in the studied groups was assessed. The sensitivity, specificity, positive, and negative predictive values were calculated for assessed cutoff values. $p<0.05$ was considered to be statistically significant.

Results

One hundred and ninety-eight patients were enrolled in this study and demographic characteristics of patients were presented at Table 1. No patients were excluded from the analysis.

The rate of translucent LUS, as defined where the uterine content was visible over the thin LUS, was 7.07% (n=14). There were no cases with uterine rupture or evident uterine dehiscence. The comparison of the pre-operative ultrasound and intraoperative vernier caliper measurements between the patients grouped by the visualization of LUS was given in Table 2.

The ROC curve was used for cutoff value prediction (Fig. 2). Area under curve values with 95% confidence interval (lower-upper bound) and p values for TA USG total LUS, TA USG myometrial LUS, TV USG total LUS, and TV USG myometrial LUS measurements were 0.666 (0.542–0.791) with p=0.038, 0.598 (0.449–0.748) with p=0.221, 0.725 (0.600–0.850) with p=0.005, and 0.749 (0.645–0.852) with p=0.002, respectively. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of cutoff values for full thickness (total) LUS and myometrium measurements either with TV and TA ultrasound were reported in Table 3.

Mean values of LUS USG measurements were low to moderately correlated with vernier caliper measurements. We evaluated means±standard deviations of TA USG total LUS, TA USG myometrial LUS, TV USG total LUS, TV USG myometrial LUS, and caliper measurements were, respectively, 4.0±1.6, 1.9±0.9, 3.2±1.4, 1.6±0.9, and 1.8±1.0 mm. Correlation coefficients between caliper and USG measurements were 0.347 for TA USG total measurement, 0.337 for TA USG myometrial measurement, 0.443 for TV USG total measurement, and 0.475 for TV USG myometrium.

Smoking, the presence of chronic diseases of the mother, the history of curettage, the previous cesarean count, the previous normal birth history, the highest fetal weight, fetal sex, fetal, and maternal complication numbers were compared in visible or invisible LUS groups of patients. It was found that only the fetal weight significantly differed between invisible and visible LUS groups (p=0.041, Fisher's exact test, Table 4).

Discussion

In the present study, the use of sonographic measurements of LUS thickness was evaluated in women with the previous cesarean section preoperatively and TV USG myome-

Table 1. Demographic characteristics

n=198	Mean±SD	Median	Minimum-maximum
Age	30.16±5.001	30	19–44
Body mass index	30.42±5.01	30	20.7–50.4
Gestational age (week)	38.87±0.65	39	37–40
Former cesarean section number	1.42±0.61	1 (1)	1–5
Time between cesarean sections (year)	5.1±3.21	4	1–19
Neonatal weight (gram)	3332.55±387.89	3305.00	2360–4870

Table 2. Comparison of ultrasonography measurements and caliper measurement between invisible and visible group of patients

						95% CI of the Diff		
	N	Mean	SD	Mean Diff	SE Diff	Lower	Upper	p
TA USG total LUS meas								
Invisible	184	4.07	1.60	0.87	0.44	0.01	1.73	0.046
Visible	14	3.19	1.00					
TA USG myometrial LUS meas								
Invisible	184	1.96	0.90	0.30	0.25	-0.18	0.79	0.216
Visible	14	1.66	0.71					
TV USG total LUS meas								
Invisible	184	3.28	1.39	0.95	0.38	0.20	1.69	0.013
Visible	14	2.34	0.73					
TV USG myometrial LUS meas								
Invisible	184	1.61	0.88	0.62	0.11	0.41	0.84	0.000
Visible	14	1.02	0.31					
Caliper meas								
Invisible	184	1.91	1.04	0.96	0.28	0.40	1.52	0.000
Visible	14	0.95	0.70					

TA: Transabdominal; TV: Transvaginal; USG: Ultrasonography; LUS: Lower uterine segment; Meas: measurement; SD: Standard deviation; SE: Standard error; Diff: Difference; CI: Confidence interval.

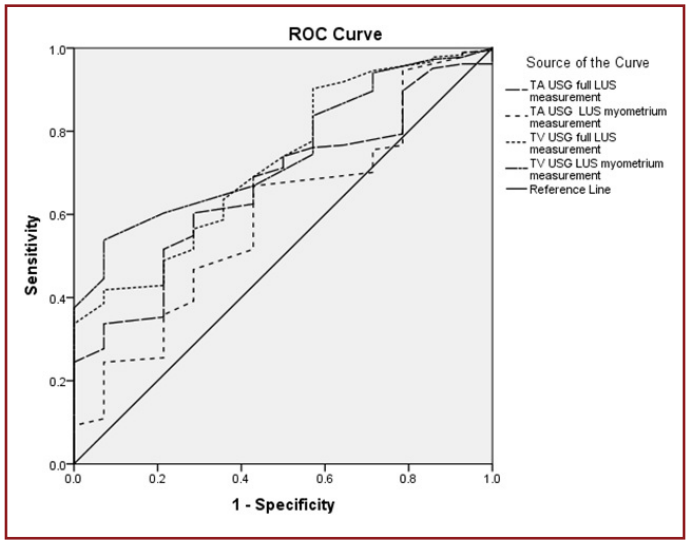

Figure 2. Receiver operating characteristic curve.

trial LUS measurements were found more accurate for intact uterine wall prediction than the other measurement ways with USG. LUS sonographic measurements especially TV USG myometrial LUS measurements can be used for prediction of intact uterine wall with high NPV. Therefore, we can trust thicker measurements. However, the PPV was found to be low for all sonographic measurements and not enough to be used for the prediction of translucent LUS or extremely thin LUS preoperatively.

The analyzed cutoff value 3.55 mm with 96.3% NPV for TA USG total LUS thickness was evaluated in this study. The previous uterine scar causes much thinner LUS for subsequent pregnancies[15]. Several studies have been conducted to evaluate the relevance between sonographic LUS measurements and the thickness of LUS. In a recent meta-analysis, TA USG total LUS thickness cutoff value was reported as 3.65 mm to be safe regarding TOLAC and the range between 2 and 3.65 mm would probably be safe[9].

The rate of extremely thin LUS was 7.07% in this study. In the present study, there were no ruptures; therefore, our results cannot be generalized to predict uterine rupture. The fact that the included patients were not in labor might

Table 3. Cutoff values of sonographic measurements to predict the uterine dehiscence

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
TA USG total LUS cutoff: 3.55mm	71.4%	60.3%	12%	96.5%
TV USG total LUS cutoff: 2.75 mm	71.4%	57%	11.1%	96.3%
TV USG myometrial LUS cutoff: 1.35 mm	92.9%	53.8%	13.3%	99%

TA: Transabdominal; TV: Transvaginal; USG: Ultrasonography; LUS: Lower uterine segment.

Table 4. Comparison of patient's features between invisible and visible groups

	Lower uterine segment		
	Invisible	Visible	p
Smoking			
smoker	20	2	
Non-smoker	164	12	0.658[a]
Chronic disease			
positive	24	1	
negative	160	13	1[a]
Curretage			
positive	19	1	
negative	165	13	1[a]
Former cesarean number			
Only one	117	8	
Two and more	67	6	0.630[b]
Former vaginal delivery			
positive	32	0	
negative	152	14	0.132[a]
Former fetal weight			
> 3500 gr	90	5	
≤0350 gr	93	9	0.331[b]
Fetal weight			
> 3500 gr	62	1	
≤2350 gr	122	13	0.041[a]
Fetal sex			
girl	94	7	
boy	90	7	0.937[b]
Maternal complication			
positive	12	2	
negative	172	12	0.259[a]
Fetal complication			
positive	30	0	
negative	154	14	0.134[a]

[a]Fisher's exact test; [b]Pearson Chi-square.

be the most possible reason for the absence of uterine rupture. In our clinic, TOLAC is not used routinely. In addition, the patients who had uterine rupture were mostly in an emergency situation (fetal distress and vaginal bleeding) at the admission to hospital and could not be enrolled in this study. As mostly accepted, uterine dehiscence may have a potential hazard for uterine rupture in active labor in women with the previous cesarean section. In studies investigating the efficacy of sonographic LUS measurements, the main outcome was either uterine rupture or uterine dehiscence[9]. There is a wide variation in the reported incidences of uterine dehiscence in the literature. Due to rarity of uterine rupture cases, the most of the studies about LUS ultrasound were considered uterine dehiscence. The incidence of defective scars was high and heterogeneous in the different studies (from 1% to 46%)[16]. In a study including 716 elective repeat cesarean section cases, the uterine dehiscence rate was found as 10.1%, this study emphasized that these cases were not predicted clinically before surgery and 10.1% includes both extremely thin LUS and evident uterine dehiscence cases[17].

In the present study, TA USG myometrial LUS measurements were found as not related with visible and invisible LUS. TV USG myometrial LUS measurements were well correlated and significant between visible and invisible LUS groups. Sensitivity (92.9%) and NPV (99%) of TV USG myometrial LUS measurements for cutoff 1.35 mm were the highest among the four measurement ways. This was probably due to the fact that TV USG is more precise because of high resolution and image quality in comparison with TA USG. Indeed, myometrial thickness majorly contributes to the LUS thickness, due to the thickness of the decidua and serosa is likely unchanged[18]. However, myometrial ultrasound measurement is technically difficult especially regarding TA USG. The data of the measurement of myometrial thickness are conflicting and heterogeneous in the literature because of the wide thickness ranges, varied cutoff values, and different measurement techniques[9].

In the present study, correlations between caliper measurements and USG measurements were found as low-to-moderate. These findings might be due to the measurements made after the baby was born and after the amniotic membrane and posterior wall of the bladder was dissected from the uterine wall. Not to delay the birth of the baby following the instructions from the Ethical Committee, the intraoperative manual vernier caliper measurement was performed after the fetal extraction in this study. In other studies where caliper measurement was compared to pre-operative ultrasound assessment, the vernier caliper measurement was found thinner than TA USG total LUS thickness[19]. Singh et al.[20] found good correlation between pre-operative TV myometrial USG measurements and intraoperative manual caliper measurements. However, in those studies, intraoperative caliper measurements were performed before the fetal head extraction. In the present study, mean values of myometrial ultrasound measurements were closer to the intraoperative manual vernier caliper measurements when compared to the total LUS thickness. It has been thought that the caliper measurements were taken after bladder dissection as in the routine course of cesarean operation could be the reason.

In our sample, only fetal weight above the 3500 gr was related to the extremely thin LUS. Several factors are known to be related to uterine dehiscence. These factors are uterine anomalies, type of uterine closure during previous cesareans, number of previous cesareans, induction of labor, short interpregnancy interval time, postpartum fever during previous deliveries, being more than 30 years of age, and birth weight in the literature[4,14,18,21,22].

The main limitation of this study absence of uterine rupture or dehiscence cases, since the study cohort of 6-month period did not include any uterine rupture, the safe cutoff value for LUS thickness in USG was analyzed based on extremely thin LUS. Another limitation of this study was about intraoperative manual vernier caliper measurements. These measurements were made after the fetal extraction and bladder dissection; therefore, the correlation of these measurements with the USG LUS thickness measurements was low-to-moderate.

Conclusion

The pre-operative sonographic measurement of LUS thickness and more recommended TV USG myometrial LUS thickness is usable tools for prediction of an intact LUS wall but on the contrary, it is not efficient tool to predict the extremely thin LUS in repeat cesarean deliveries in this study. There is a need for studies with larger series especially including uterine rupture cases. Ultrasonographic LUS measurements may not be used alone for the decision of TOLAC. Nevertheless, these results can be used for detailed counseling to assist clinical decisions.

Ethics Committee Approval: The Institutional Ethical Committee approved the study (No: 2019/7).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: A.B.T., B.D.T., N.T., G.T.; Design: A.B.T., B.D.T, P.B., N.T., G.T.; Data Collection or Processing: A.B.T., B.D.T., P.B., E.Y., İ.K., C.U., N.T., M.Y.; Analysis or Interpretation: A.B.T., M.Y., N.T., C.U., E.Y.; Literature Search: A.B.T., B.D.T., M.Y., N.T., E.Y., C.U., İ.K.; Writing: A.B.T., M.Y., N.T., C.U.

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