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Nada Moaide Ragheb
AL Emamian Al-Kadymiain Hospital/Um Albanin Infertility and IVF Center, Iraq

Shereen Abdulhussien Kzar Al-essami
Department of Obstetrics and Gynecology, Imamein Khadhimein Medical City, Iraq

Ataa abd Aljawad Murad
AL Emamian Al-Kadymiain Hospital, Baghdad, Iraq

Corresponding Author:
Nada Moaide Ragheb
AL Emamian Al-Kadymiain Hospital/Um Albanin Infertility and IVF Center, Iraq

Ultrasonographic evaluation of lower uterine segment thickness in patients of previous cesarean section

Nada Moaide Ragheb, Shereen Abdulhussien Kzar Al-essami and Ataa abd Aljawad Murad

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Abstract
Introduction: There is significant public and professional concern over the rising rate of caesarean section deliveries.
Objective: To evaluate lower uterine segment thickness by transvaginal and abdominal ultrasound in women with a previous cesarean delivery and to determine a critical thickness above which safe vaginal delivery is predictable.
Methods: A case-control study included 50 pregnant women with a history of previous one cesarean delivery constitute the case group and 50 pregnant women without history of previous cesarean section constitute the controls. Gestational age was between 38-40 weeks of gestation. TA and TV ultrasonography were used in both groups to evaluate LUS thickness, in the study group, >2 mm of thickness of the LUS was considered as good healing and <2 mm of thickness as poor healing, women were categorized for the mode of delivery into either trial of VBAC (unless an obstetrical indication for CS existed) or ERCS. All the intraoperative LUS appearance and delivery outcome were correlated with U/S measurements.
Result: The overall VBAC was 84% and VBAC success rate was 52%, the incidence of dehiscence was 4%, and there was no uterine rupture. There was a 95% correlation between TA ultrasonography and TV ultrasonography. The critical cut off value for safe LUS thickness, derived from the ROC curve, was 2.5 mm.
Conclusion: Sonography permits accurate assessment of the LUS thickness in women with previous cesarean section and therefore can potentially is used to predict the risk of uterine rupture during trial of vaginal birth.

Keywords: Ultrasonographic, lower uterine segment, thickness, previous cesarean section

Introduction

There is significant public and professional concern over the rising rate of caesarean section deliveries [1]. Increasing rates of primary caesarean section have resulted in an increase in the proportion of the obstetric population with prior caesarean delivery experience. Women having a prior caesarean delivery may be offered either a planned VBAC or an ERCS. In turn, the proportion of women who refuse VBAC is a major driver of total caesarean birth rates [2-5]. When considering the mode of delivery, all women who have had a previous caesarean section should be advised about the maternal and perinatal risks and advantages of planned VBAC and ERCS. The risks and benefits should be discussed in the context of the woman's individual circumstances, such as her personal motivation and preferences to achieve vaginal birth or ERCS, her attitudes towards the risk of rare but serious adverse outcomes, her plans for future pregnancies, and her likelihood of a successful VBAC (principally whether she has previously had a vaginal birth). In addition, if feasible, the operating records of the prior caesarean should be reviewed to determine the indication, kind of uterine incision, and any preoperative problems. 72-76% of planned VBACs following a single prior caesarean are successful [6-8]. Several variables are connected with VBAC success. Previous vaginal delivery, particularly previous VBAC, is the strongest predictor of successful VBAC and is related with an 87-90% success rate for planned VBAC [6-9]. Diagnostic ultrasonography can assess LUS scar integrity. Obstetrics uses diagnostic ultrasonography. Ultrasonic transducers send low-intensity, high-frequency (3-7.5 kHz) sound waves into the abdomen or pelvis. The transducer has curved piezoelectric crystals. Sequentially activating small groups of crystals produces a focused ultrasonic beam in pulses.

Uterus signals reach the crystals between pulses. Piezoelectricity from these returning impulses creates visual signals for a cathode ray tube or video screen. A water-soluble gel on the skin acts as a coupling agent, allowing the operator to move the transducer about the abdomen. High-quality photos require operator skill. The probe and transducer are crucial for foetal and uterine diagnostics [10]. Transabdominal examination with a curved-array 3- to 5-MHz transducer identifies all pelvic organs, making it the first method. A full bladder pulls the uterus up from behind the pubic symphysis and removes the small bowel, allowing for better visibility. The bladder improves sound transmission like an acoustic window. To locate the thinnest location, we examined LUS thickness in the sagittal slice under magnification. The lateral LUS was scanned for symptomatic dehiscence, ballooning, or funneling. Higher-frequency (5- to 10-MHz) transducers improve sensitivity and spatial picture resolution. Before a transvaginal investigation, the bladder is emptied to focus on pelvic organs and ensure patient comfort. After locating the bladder in the cervical canal longitudinal plane with the vaginal probe in the posterior vaginal fornix, the LUS thickness was determined. Sagittal images are produced with modest transducer rotation and angulation [11]. To evaluate lower uterine segment thickness by transvaginal and abdominal ultrasound in women with a previous cesarean delivery and to determine a critical thickness above which safe vaginal delivery is predictable.

Method

In present study we have prospectively measured the thickness of LUS in a woman with a previous cesarean section by TA and TV U/S. With this thickness we categorized the quality of the healed scar and selected patients for mode of delivery to avoid undue repetition of a cesarean scar or a hazardous uterine rupture. This Prospective comparison study was carried out from beginning of May 2010 to the end of June 2011 at the department of obstetrics and gynecology in AL-Kadhimiya Teaching Hospital. Baghdad-IRAQ. Patients were recruited from both outpatient clinic and the inpatient wards. The study included 100 pregnant women; they were divided into 2 groups: Study group: 50 randomly selected pregnant women with history of previous one transverse cesarean delivery. Control group: 50 pregnant women without previous history of caesarean delivery. The study and control groups were similar in parity and period of gestation (38-40) weeks of gestation. Inclusion criteria: History of previous one caesarean scar, with single fetus, at 37-40 weeks of gestation, without labor or in the latent phase of labor. Exclusion criteria: Being in active labor, Previous scar with low lying placenta, Twin pregnancy, Previous 2 scars or more, Previous repair of rupture uterus or other gynecology surgery (myomectomy). Three layers can be identified ultrasonographically in a well-developed LUS in a midline section of saggital view. They are as follows from inside outwards: Chorioamniotic membrane with decasualized endometrial, deep, less echogenic layer, A middle layer of myometrium, superficial, very echogenic layer, Utero-vesical peritoneal reflection juxtaposed to muscularis and mucosa of the bladder. According to the quality of the healed scar, pregnant women were categorized for the mode of delivery into either a trial for VBAC (if LUS is > 2 mm and in the absence of other indication for cesarean section) or an ERCS (if LUS thickness is < 2 mm, the presence of ballooning, funneling, or defect in the LUS, the presence of a recurrent indications for CS such as contracted pelvis, malpresentation, or cephalopelvic disproportion (CPD). The LUS was assessed intraoperatively during the cesarean delivery and graded according to the system developed by Qureshi *et al*. [12]. Statistical analysis done by SPSS 22, frequency and percentage used for categorical data, mean, median and SD for continuous data. Chi-square used for assessed association between variables, person correlation shows the correlation between continuous data. T test used for evaluation differences between mean and median of continues variables. ROC curve also used to show more specific and sensitive cutoff point. P-value less or equal to 0.05 is consider significant.

Results

Clinical characteristics of patients in control and study groups, the parameters (age, gestational age, inter-delivery interval, U/S thickness) were compared with each other among both groups using one-way p value. there was no significant difference in mean age of study and control groups (24.28±4.36 and 23.92±3.71 years respectively) (p>0.05), also there was no significant difference in the mean gestational age among groups (38.80±0.80 and 38.84±0.79 weeks respectively) (p>0.05), but there was a significant difference in inter-delivery interval (2.81±0.87and 2.38±0.72 years respectively) (p<0.05). There was a significant positive correlation between TA and TV U/S in the measurement of LUS thickness (mm) in each of the study and the control groups (p<0.001, p<0.001respectively) (p<0.05). as shown in table 1.

Table 1: Clinical characteristics of patients in control and study groups, the parameters (age, gestational age, inter-delivery interval, U/S thickness).

Variable	Study group Means ± SD*[1] N = 50	Control group Means ± SD N = 50	P-value
Age (years)	24.28±4.36	23.92±3.71	0.658
Gestational age (weeks)	38.80±0.80	38.84±0.79	0.803
Inter-delivery interval (years)	2.81±0.87	2.38±0.72	0.009
LUS thickness (mm)			
TAU/S	3.08±0.70	4.03±0.52	<0.001
TVU/S	2.78±0.68	3.66±0.47	<0.001

*[1] SD: standard deviation

The mode of delivery of patients in the study and control groups in current pregnancy. In study group, out of 50, 8 (16%) cases delivered by ERCS, 16 (32%) cases delivered by emergency CS, 26 (52%) delivered by successful VBAC. In control group, out of 50, 0 case delivered by to ERCS, 4 (8%) cases delivered by emergency C/S, 46 (92) cases successful VD. The frequency of VD was high in control group than in study group. As shown in table 2.

Table 2: The mode of delivery of patients in the study and control groups in current pregnancy.

Groups (n=100)	ERCS*[1]	Emergency CS*[2]	Successful VD*[3]	P value
Study (n=50)	8 (16%)	16 (32%)	26 (52%)	<0.001
Control(n=50)	0 (0%)	4 (8%)	46 (92%)	<0.001

*[1]ERCS: elective repeat cesarean scar
*[2]CS: cesarean scar
*[3]VD: vaginal delivery

Distribution of delivery mode by LUS thickness in the study group (n=50).3 groups were divided:
1st: >3 mm, 20(64.51%) of 31women had successful VBAC. 2nd: 2-3mm had equal number of women with successful VBAC and emergency CS 6 of 13 women (46.15%).
3rd: <2mm, all had elective CS 6 women (100%). As shown in table 3.

Table 3: Distribution of delivery mode by LUS thickness in the study group.

LUS thickness	Number of cases	Elective CS	Successful TOL*[1]	Emergency CS*[2]
>3 mm	31	1 (3.22%)	20 (64.51%)	10 (32.25%)
2_3 mm	13	1 (7.69%)	6 (46.15%)	6 (46.15%)
<2 mm	6	6 (100%)	0 (0%)	0 (0%)
Total	50	8	26	16

p<0.001
*1 TOL: trial of labor
*2 CS: cesarean scar

Preoperative and intraoperative assessment of scarred LUS thickness in the study group (n=50). Preoperative 3 groups: 1st >3 mm, 2nd 2-3 mm, 3rd <2 mm. Intraoperative 4 classes I, II, III, IV. Cases with well-developed LUS during the operation were all assessed preoperatively with >3 mm LUS thickness. Conversely the thin and translucent intraoperative LUS were all measured ≤2 mm preoperatively. There was a high correlation between intraoperative grading of the LUS and it is thickness measured by ultrasonography. As shown in table 4.

Table 4: Preoperative and intraoperative assessment of scarred LUS thickness in the study group.

USG* Thickness of LUS	Total umber Of cases	Number of cases with TOL	Number of cases with CS	Assessment of LUS			
				Class I	Class II	Class III	Class IV
>3 mm	31	30 (71.42%)	11 (45.84%)	9 (81.81%)	2 (18.18%)	0 (0%)	0 (0%)
2_3 mm	13	12 (28.57%)	7 (29.16%)	0 (0%)	5 (71.42%)	2 (28.58%)	0 (0%)
<2 mm	6	0 (0%)	6 (25%)	0 (0%)	0 (0%)	5 (83.33%)	1 (16.67%)
Total	50	42	24	9 (37.5)	7 (29.18%)	7 (29.18%)	1 (8.33%)

*ultrasonography

Predictive values for LUS thickness in TA US and TV U/S in both control and study group (n=100): show that a high specificity and a PPV for TA and TV US patients with LUS thickness ≤2 mm. in addition, we can notice a high sensitivity and a NPV for patient with LUS thickness ≤ 5 mm. the same thing is applicable regarding LUS thickness≤ 2.5, 3, 3.5, 4, 4.5 respectively. The PPV of the U/S measurement was weak in our study, suggesting that all thin LUS are not abnormal. On the other hand, the US measurement had a good NPV confirming that a thick LUS is generally strong. As shown in table 5.

Table 5: Predictive values for LUS thickness in TA US and TV U/S in both control and study group.

LUS thickness	Sensitivity		Specificity		PPV*[1]		NPV*[2]	
	TAUS	TVUS	TAUS	TVUS	TAUS	TVUS	TAUS	TVUS
≤ 2 mm	14.3	47.9	100	98.6	100	100	73.5	75
≤ 2.5 mm	74.3	78.6	85.1	80.4	80.1	65.1	93.7	90.9
≤ 3 mm	82.1	85.7	91.7	72.2	87.1	73.7	98.6	100
≤ 3.5 mm	92.9	96.4	63.9	50	58.3	45.2	100	100
≤ 4 mm	99.4	98.8	31.6	8.3	42.4	33.3	100	100
≤ 4.5 mm	99.9	100	11.1	5.6	31.8	29.2	100	100
≤ 5 mm	100	100	5.6	2.8	29.2	28.6	100	100

*1PPV: positive predictive value
*2 NPV: negative predictive value

The ROC curve illustrating sensitivity and 1-specificity for different cut *off* levels of LUS thickness. The critical cut *off* value of the LUS thickness was considered 2.5 mm. Comparison of ROC curve for TA and TV U/S in prediction of LUS thickness scar. Area under curve (AUC) did not differ significantly for prediction of LUS thickness (0.932, 0.930, p=0.001) respectively.

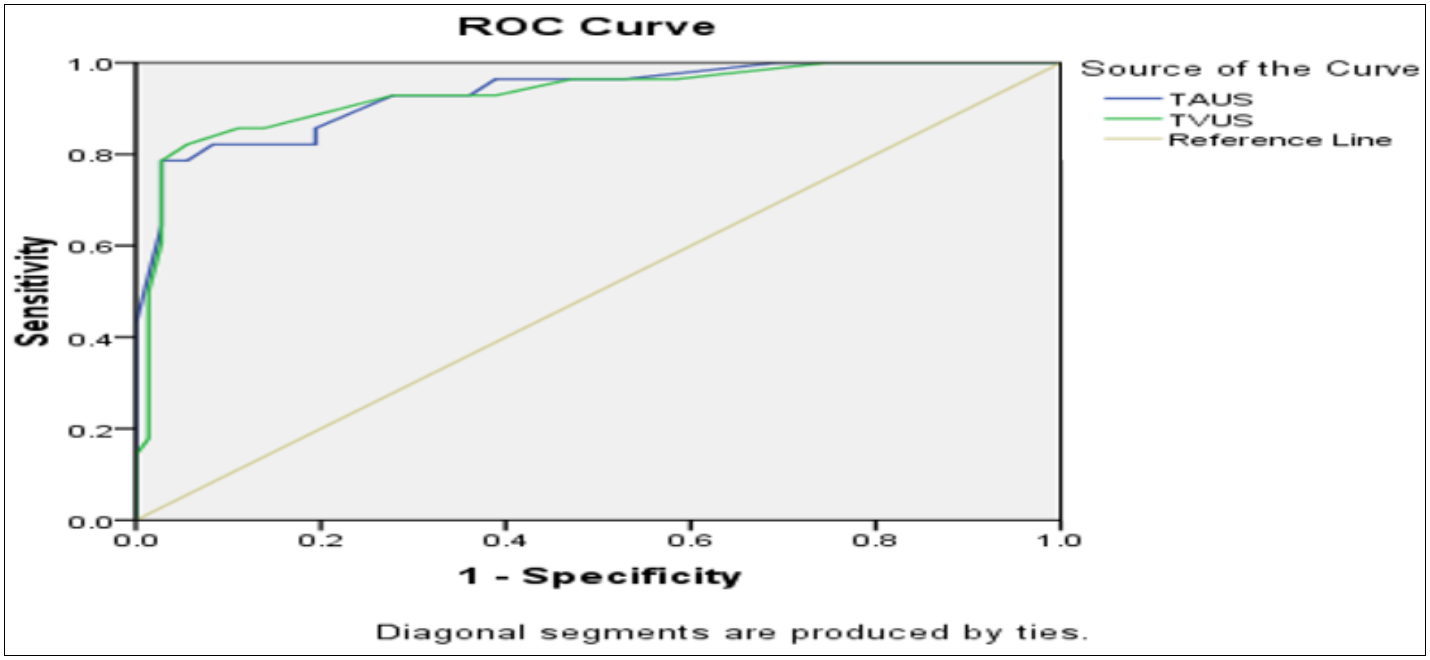

Fig 1: ROC curve between TA and TV U/S.

Discussion

"Once a caesarean, always a caesarean" no longer applies. If a woman had one CS delivery, all others had to be the same. Many women can deliver vaginally following CS. VBAC. LUS thickness indicates LUS quality and integrity. Ultrasonography is used to quantify LUS thickness, which is crucial to the obstetrician's delivery route choice, however its application in VBAC care is contentious [13].

On one line with our study Sen *et al*., [14] and Mohammed *et al*., [15] measured the LUS thickness using both TA and TV U/S. On the contrary to our study, other studies as Rozenberg *et al*., [16] 1996 and Kushtagi *et al*., [17] reported a significant relationship between TA sonographic measurement of the entire LUS thickness in women near term who had had a previous cesarean section and the risk of uterine rupture or dehiscence. While Gotoh *et al*., [18] Fukuda *et al*., [19] Qureshi *et al*., [12] and Asakura *et al*., [20] measured the LUS thickness using TVU/S. Armstrong *et al*. [21] Valenzano *et al*., [22] Osser *et al*., [23] and Marasinghe *et al*., [24] made comparison between TA versus TV U/S to measure thickness of the LUS at term and found TV U/S is a more accurate method of assessing the thickness of the LUS. Although the LUS measurement can potentially be used as a tool to determine the risk of uterine rupture, other factors may operate to influence the accuracy of this tool. In the present study, it is shown that the risk of scar dehiscence was higher with short period of inter-delivery interval. This is agreeing with Shipp *et al*., [25] and Bujold *et al*. [26] concluded that inter-delivery interval of up to 18 months were associated with increased risk of symptomatic uterine rupture during a trial of labor after cesarean. In the same theme, Suzuki *et al*., [27] Reported derived cut *off* value was 2mm above which no surgical finding of dehiscence in the LUS. On the contrary, Rozenberg *et al*., [16] 1996 in their study examined the scarred uterus and found that the risk of uterine rupture was highest when the LUS thickness was between 1.6-2.5 mm. While Papov *et al*. [28] also described a thickness of < 3 mm as an insufficient scar and confirmed the assessment according to the mode of delivery. And Bujold *et al*., [26] found that full LUS thickness of <2.3 mm was the optimal cut *off* for the prediction of the uterine rupture. Our study had a high NPV value, implying that a thick LUS is generally strong. This may encourage obstetricians to offer trial of labor to women with LUS thickness of 2.5 mm or greater. This study is consistent with the study done by Fukuda *et al*., [19] Sen *et al*., [14] Mohammed *et al*., [15] and found the derived cut *off* was 2.5 mm. With a high NPV value. While in comparsiom to our study, other studies as Rozenberg *et al*., [16] 1996 and Montanari *et al*., [29] Kushtagi *et al*., [17] and CheungVY, [30] 2OO5 with different cut off values but with a high NPV. Rozenberg *et al*., [16] 1996 and Montanari *et al*, [29] were found the derived cut off value was 3.5mm, with a high NPV value of 95.3% and 100% respectively. Kushtagi *et al*., [17] reported the cut off value of the LUS thickness of 3mm, with a high a NPV value of 98%. Cheung VY, [30] 2005 reported the cut off value of the LUS thickness of 1.5mm, with a high NPV of 96.2%. While Gotoh *et al*. [18] and Qureshi *et al*., [12] analyzed women with previous scar underwent serial TV ultrasonographic measurement of the thickness of the LUS in the late second trimester, the studies found an inverse relationship between thickness of the LUS and uterine rupture. On the contrary to our study Qureshi *et al*. [12] found ≤ 2 mm as a criterion for poor healing, with a high PPV of 100%. Thus, LUS thickness and uterine defect detection methods vary across studies.

Ultrasonography does not appear to increase the rate of uterine ruptures, and it may even decrease it. This ultrasound examination should encourage obstetricians who frequently perform repeat CS, even for women with a single scar, to suggest a trial of labor by providing an additional risk factor. This new approach's experience would enrich the debate.

Conclusion

LUS thinning appears to be strongly associated with uterine scar defect risk. Thus, LUS thickness can indicate uterine scar defect in VBAC candidates. Optimum cut off paired with cautious intrapartum treatment; we felt that well-investigated parameters for measuring LUS thickness might lead to fresh guidelines for women considering a VBAC, with a very low risk of uterine rupture.

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