Can Residual Myometrial Thickness Measured by Transvaginal Ultrasound Predict Successful Vaginal Birth after Cesarean Section?

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Abstract: Objective: To predict successful vaginal birth after cesarean section (VBAC) based on measurement of residual myometrial thickness during second and third trimester of pregnancy. **Study Design:** Longitudinal observational study in the ultrasound and obstetrics units of Al-Azhar University hospital. **Patients and Methods:** Thirty women with history of previous one cesarean delivery were recruited from ante natal care outpatient clinic. They were examined by transvaginal sonography (7.5 MHz) at 3 visits: at first enrollment (20-26wks), during 3rd trimester (32-36wks), and during TOLAC intrapartum. **Results**: Successful VBAC group had 6 (20%) patients with augmented TOLAC and 12 (40%) patients with spontaneous TOLAC. Failed VBAC group had 7 (23.34%) patients with augmented TOLAC and 5 (16.66%) patients with CS. There were highly significant statistical differences of means between both groups as regard; 2nd trimester RMT and 3rd trimester RMT **(*p*=0.001 and 0.002)** respectively. There was insignificant statistical differences of means between both groups as regard; **Δ** RMT **(*p*=0.30)** and insignificant statistical differences of means between both groups as regard; Δ RMT between 2nd and 3rd trimesters with spontaneous and augmented TOLAC in successful VBAC and in failed VBAC; augmented TOLAC & CS **(*p*=0.74 & 0.40)** respectively. **Conclusion**: The optimal cut off value of RMT of LUS in 2nd trimester to predict successful VBAC is 2.9 mm; in 3rd trimester, it was 2.25 mm; both with high predictive value, while the cut off for ΔRMT of LUS to predict successful VBAC it was 0.45 mm, with low predictive value.
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1. Introduction:

The rate of vaginal birth after Cesarean section (VBAC) is defined as the number of vaginal births to women with one previous Cesarean section (CS) per 100 such deliveries **(**Naji *et al.,* 2013**)**. Attempts have been made to predict which patients are more likely to undergo successful VBAC using various parameters, including clinical history and physical examination at the time of admission for delivery **(**Eden *et al.,* 2010**).** Accurately predicting the outcome of a trial of VBAC is clinically useful as failure is associated with increased maternal and fetal morbidity **(**McMahon *et al.,* 1996**).**

There is a growing body of evidence to suggest that complete healing of the CS scar and myometrial thickness of the lower uterine segment are related to the chance of achieving a vaginal delivery in a subsequent pregnancy **(**Ozdemir *et al.,*2005**).**

Over the last 10 years there have been multiple attempts to study the prevalence and clinical significance of apparently 'defective' CS scars visualized using ultrasonography. Ultrasonography can be a useful tool for evaluation of the uterus in planning a normal delivery after previous CS. Ultrasound measurements of the CS scar expressed as residual myometrial thickness (RMT) and the change in RMT between the first and the second trimester of pregnancy, can accurately predict a successful trial of labour in patients with one previous CS **(**Naji *et al.,* 2012**).**

To better assess the risk of uterine rupture, some authors have proposed sonographic measurement of lower uterine segment thickness near term, assuming that there is an inverse correlation between LUS thickness and the risk of uterine scar defect **(**Rozenberg *et al.,* 1996**).** Therefore, this assessment for the management of women with prior CS may increase safety during labour by selecting women with the lowest risk of uterine rupture. However, while a large prospective study demonstrated that a full LUS thickness of less than 3.5 mm had a strong negative predictive value, the best cut-off values and the best measuring technique remain controversial **(**Cheung, 2005**).**

The present study was done to predict successful vaginal birth after cesarean section (VBAC) based on measurement of residual myometrial thickness during second and third trimester of pregnancy.

2. Material and Methods:

This longitudinal observational study was done in the ultrasound and obstetrics units of Al-Azhar University hospital. Thirty women with history of previous one cesarean delivery were recruited from ante natal care outpatient clinic. Consent was taken from all cases included in this study.

- **Inclusion criteria were:** age between 20-40 years, para one or more**,** previous one CS**,** gestational age from 20w-34w (second and third trimester)**,** singleton pregnancy, cephalic presentation, normal placental location**,** no congenital fetal anomalies**,** average amniotic fluid index according to gestational.
- **Exclusion criteria were:** more than one cesarean section, multiple pregnancies, abnormal fetal presentation, abnormal placental location (eg. placenta previa), presence of congenital fetal anomalies**,** cases with oligohydramnios or polyhydramnios.
- All participating women were subjected to: full history taking, physical examination, trans-abdominal ultrasound (to ensure gestational age, fetal weight, fetal position, biophysical profile and amniotic fluid index) and trans-vaginal ultrasound examination (using LOGIQ, PS transvaginal sonography (7.5 MHz) at 3 visits: at first enrollment (20-26wks), during 3rd trimester (32-36wks), and during TOLAC intrapartum (at the beginning of The transvaginal ultrasonography probe was placed within the introitus and manipulated in coronal and sagittal planes, anteriorly and posteriorly relative to the structures to be examined (lower uterine segment and cervix):
- The cesarean scar tissue and residual myometrium were identified with visualization of a hyperechoic, linear density through the stroma of the anterior uterine wall near the level of the internal os extending to the vesico-uterine interface in the sagittal plane. The maximal diameter in the sagittal view was used for comparison. Importantly, a scar defect was diagnosed if a fluid was displayed collection along this line and in continuity with the endocervical canal. The frequency of scar identification, as well as the presence of fluid within the scar ("scar defect"), was recorded and later compared with self-reported obstetric history. A prediction model for successful VBAC was constructed based upon patients age, time interval of last CS, RMT in 3rd trimester and Δ RMT for 2nd to 3rd trimester (RMT3 - RMT2).
- The internal validation of area under the curve (the ROC curve) was evaluated once for RMT3 and another time for Δ RMT (RMT3 - RMT2).
- A partogram is used to monitor the progress of labor once the labor is established**.** Data regarding delivery progression and neonatal outcome was collected in details.

3. Results:

The results are shown in Table 1-9.

Table 1. Representation of the studied groups according to results of TOLAC.

Course of delivery	**Group 1 Successful VBAC**		**Group 2 Failed VBAC**	
	n	**%**	**n**	**%**
Total outcome	18	60%	12	40%
Augmented	6	20%	7	23.34%
Spontaneous	12	40%		
CS			5	16.66%

Table 2. Comparison between demographic data in the studied groups.

	Group 1 (n=18) Successful VBAC			**Group 2 (n=12) Failed VBAC**		
	Spontaneous n=12	**Augmented n=6**	***P*-value**	**Augmented n=7**	**CS n=5**	***P*-value**
Age (years)	25.41±2.27	24.66±2.65	**0.54**	26 ±2.44	25.8±2.77	**0.81**
Maternal weight (kg)	67.6±6.5	66.6±5.68	**0.75**	73.0±5.1	67.2±6.37	**0.35**
Parity	1.16±0.38	1.5±0.54	**0.15**	1.28±0.75	1.4±0.54	**0.78**
Presence of gestational diabetes	1(8.3%)	0	**0.46**	1(8.3%)	1(8.3%)	**0.68**
PIH	1(8.3%)	0	**0.46**	1(8.3%)	1(8.3%)	**0.79**
HB levels	10.51±1.07	10.13±0.69	**0.30**	10.1±0.98	10.78±1.40	**0.47**

PIH= pregnancy induced hypertension, **HB**= haemoglobin

Table 3. Representation of residual lower uterine segment thickness (RMT) in the studied groups.

RMT		Group 1 Successful VBAC (n=18)	Group 2 Failed VBAC (n=12)	*p*-value
2nd trimesterRMT (mm)	Mean ±SD	3.93±0.418	3.34±0.460	**0.001***
	Min- max	3.20 - 4.70	2.80 - 4.30	
3rd trimesterRMT(mm)	Mean ±SD	3.21±0.404	2.66±0.422	**0.002***
	Min- max	2.70- 3.90	2.20 - 3.80	
Δ RMT(mm)	Mean ±SD	0.72±0.19	0.65±0.13	**0.30**
	Min – max	0.4- 1.10	0.50 - 0.90	

Table 4. Correlation between maternal age, Onset to delivery interval, gestational age at delivery, birth weight, haemoglobin (HB) level and Δ RMT.

	Parameter	r	*P*-value
Δ RMT between 2nd and 3rd Trimesters	**Maternal Age**	-0.073	**0.70**
	Onset to delivery interval	0.067	**0.72**
	Gestational age at delivery	-0.152	**0.42**
	Birth weight	-0.405	**0.027***
	HB	0.107	**0.57**

Table 5. Comparison between delivery outcomes in 2 studied groups.

	Group 1 (n=18) Successful VBAC			Group 2 (n=12) Failed VBAC		
	Spontaneous n=12	Augmented n=6	*P*-Value	Failed Augmentation n=7	CS n=5	*P*-value
Gestational age at delivery (weeks)	38.75±1.05	39.3±0.81	**0.25**	38.8±1.21	38.4±0.89	**0.49**
Fetal weight at delivery (Kg)	3.52±0.22	3.7±0.29	**0.17**	3.62±0.36	3.61±0.33	**0.95**
Causes of failed TOLAC						
1. Confirmed scar rupture				0	1 (8.3%)	
2. Antepartum hemorrhage				1 (8.3%)	2 (16.4%)	
3. Placenta previa				2 (16.4%)	0	**0.25**
4. Fetal distress				2 (16.4%)	0	
5. Failure to progress				1 (8.3%)	0	
6. PET/GDM/PROM				1 (8.3%)	2 (16.4%)	

Table 6. Multivariate regression analysis for delivery outcome of VBAC

Variable	Odd's Ratio	(C. I 95%)	*p*-value
Age >25.46 (year)	0.88	(0.136-5.77)	**0.76**
Time interval between CS and VBAC (year)	0.61	(0.097- 3.86)	**0.45**
RMT in 3rd trimester>2.25	8.14	(1.297-51.19)	**0.025***
Δ RMT between 2nd and 3rd Trimesters >0.45	3.45	(0.54-21.88)	**0.361**

Table 7. The ROC curve for RMT of LUS in 2nd Trimester as a predictor of successful or failed VBAC

AUC		CI (95%)	Cut off	Sensitivity	Specificity	Accuracy	PPV	NPV	*P*-value
2nd TM	0.83	0.66 - 0.99	2.9 Mm	90 %	100 %	95 %	100 %	83.33 %	**0.003***

Table 8. The ROC for RMT of LUS in 3rd Trimester as a predictor of successful or failed VBAC

AUC		CI (95%)	Cut off	Sensitivity	Specificity	Accuracy	PPV	NPV	*P*-value
3rd RMT	0.86	0.7- 1.0	2.25 Mm	94.73 %	100 %	97.36 %	100 %	91.66%	**0.001***

Table 9. The ROC curve for **Δ RMT** as a predictor of successful or failed VBAC.

AUC		CI (95%)	Cut off	Sensitivity	Specificity	Accuracy	PPV	NPV	*P*-value
ΔRMT	0.61	0.40 – 0.81	0.45 Mm	57.14 %	85.71 %	71.42 %	88.9%	100 %	0.31

4. Discussion:

During the present study, transvaginal ultrasound measurement of residual myoetrial thickness was performed and patients were divided, according to delivery results, into two groups (successful and failed VBAC groups).

The age of the studied group ranged from 22 to 31years with a mean of 25.46±2.38 years which was comparable to studies performed by Singh *et al.* (2014). Birth weight ranged from 3.15 to 4.20 Kg with a mean of 3.62±0.28 Kg. Gestational age at delivery ranged from 37 to 41weeks with a mean of 38.83±1.019 weeks. Parity ranged from 1 to 3 times with a mean of 1.3±0.53 times. Hb levels ranged from 8.20 to 12.20 mg/dl with a mean of 10.38±1.029 mg/dl. Also, the study shows that means of patient's age, maternal weight, Parity, and haemoglobin level, and distribution of gestational diabetes and pregnancy induced hypertension (PIH) have insignificant statistical differences between both groups as regard; spontaneous and augmented TOLAC in successful VBAC and in failed VBAC (augmented TOLAC & CS) **(*p*>0.05)**.

The number of pregnant women with successful VBAC more than Failed VBAC, delivery outcome in the two groups was 18 patients (60%) and 12 patients (40%) for successful and failed VBAC respectively. Successful VBAC group had 6 (20%) patients with augmented TOLAC and 12 (40%) patients with spontaneous TOLAC. Failed VBAC group had 7 (23.34%) patients with augmented TOLAC and 5 (16.66%) patients with CS.

The results of the present study were in agreement with Grobman *et al.* (2011) study where the vaginal birth after cesarean section (VBAC) success rate was 67.3%. This rate corresponds with present literature, in which the rate of successful Trial of labor (TOL) varies from 43% to 80%, and increases to almost 90% after a preceding vaginal birth**.**

There were highly significant statistical differences of means between both groups as regard; 2nd trimester RMT and 3rd trimester RMT **(*p*=0.001 and 0.002)** respectively. There was insignificant statistical differences of means between both groups as regard; **Δ** RMT **(p=0.30)** and insignificant statistical differences of means between both groups as regard; Δ RMT between 2nd and 3rd trimesters with spontaneous and augmented TOLAC in successful VBAC and in failed VBAC; augmented TOLAC & CS **(*p*=0.74 & 0.40)** respectively.

The means of gestational age at delivery and fetal weight at delivery had insignificant statistical differences between both groups as regard; spontaneous and augmented TOLAC in successful VBAC and in failed VBAC (augmented TOLAC & CS) **(*p*>0.05)**. Also, the distribution of causes of failed TOLAC in group 2 between patients with failed augmented TOLAC and patients with CS had insignificant statistical differences **(*p*>0.05)**. the correlation between means of RMT between 2nd and 3rd Trimesters (Δ RMT) and, age, onset to delivery interval, gestational age at delivery and HB levels in successful and failed VBAC of the studied pregnant women had insignificant statistical correlation between them (*p*>0.05) but had a significant statistical correlation with mean birth weight at delivery **(*p*=0.027)**.

The area under the curve (AUC) for RMT of LUS in 2nd trimester was statistically significant (83%) The optimal cut off value of RMT of LUS in 2nd trimester to predict successful VBAC is 2.9 mm. AUC for RMT of LUS in 3rd trimester was statistically significant (86%), the optimal cut off value of RMT of LUS in 3rd trimester to predict successful VBAC is 2.25 mm. The area under the curve (AUC) for ΔRMT of LUS (61%) and the optimal cut off value of ΔRMT of LUS to predict successful VBAC is 0.45 mm.

The present study is in consistent with Qureshi *et al.* (2004); transvaginal ultrasound of LUS thickness was found to be 2.5 mm above which safe VBAC is possible. At 2.5 mm sensitivity, specificity, PPV and NPV was 81.8%, 84%, 69.2% and 91.3% respectively. There was very high correlation between preoperative grading of LUS and LUS thickness measured on USG. All dehiscence in study group occurred at <2 mm. The LUS thickness in control were all greater than 2 mm similar to that observed by Qureshi *et al.* **(10).** Cut-off values proposed in previous studies range from 2.0 to 3.5mm for the entire LUS thickness**.**

Rozenberg *et al.* (1996) reported that the risk of uterine rupture is directly related to the degree of LUS thinning, with a 20-fold higher risk when the thickness of the LUS is ≤3.5 mm with a sensitivity of 88.0%, the specificity 73.2%, positive predictive value 11.8%, and negative predictive value 93.3%**.** Jastrow *et al.* (2010) determined this cut-off value to have a sensitivity of 88%, a specificity of 73%, a PPV of 12%, and an NPV of 99%. Using a cut-off of 3.0mm for full LUS thickness they achieved a sensitivity of

100%, a specificity of 85%, a PPV of 45%, and an NPV of 100%**.**

The present findings show that multivariate regression analysis for delivery outcome of successful VBAC based on maternal age>25.46, Time interval between CS and VBAC (>2.48year), RMT in 3rd trimester>2.25, and Δ RMT>0.45 mm between 2nd and 3rd trimesters. Only RMT in 3rd trimester was independent predictor for successful VBAC **(Odd's Ratio=8.14**, ***p*=0.025)**.

The present model partly to some extent was consistent with many studies, as in study of Naji *et al.* (2012) reported previously that LUS thickness of<2.3mm is associated with a higher risk of complete uterine rupture and a systematic review by Jastrow *et al.* (2010) on the diagnostic accuracy of sonographic LUS measurements at 36–39 weeks to predict uterine scar rupture revealed that the optimal cut-off values for partial thickness ranged from 1.4–2.0 mm**.**

Naji *et al.* (2012) have shown in their study that there is good interobserver agreement for measurement of both the hypoechoic part of CS scars and RMT in all three trimesters of pregnancy, Therefore, should either the scar measurements at a specific gestational age or the rate of change in scar size be a predictor of scar integrity, it may be possible to develop a reproducible ultrasound-based test that might contribute to selection of women suitable for a trial of VBAC**.**

Limitation of the study:

Small size sample study, another important limitation is the fact that the measurement of LUS thickness has not yet been standardized. There is no consensus among studies regarding which layer(s) of the LUS should be measured or by which route, and intraobserver variability in LUS measurements.

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