

Research Article

Diagnostic Accuracy of Trans-Abdominal Versus Trans-Vaginal 2- Dimensional Ultrasound in Assessment of Lower Uterine Segment Thickness in Women with Previous One Cesarean Section and its Correlation with the Actual Thickness during Cesarean Section

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Abstract

Objective: To compare the diagnostic accuracy of Trans-Abdominal Sonography (TAS) versus Trans Vaginal Sonography (TVS) in the prediction of Lower Uterine Segment (LUS) thickness in pregnant women with one previous Cesarean Section (CS) at term and its correlation with the actual thickness during CS.

Study design: A diagnostic accuracy study was conducted at Feto-Maternal Ultrasound Unit, Department of Obstetrics and Gynecology, Ain Shams Maternity Hospital. One hundred and forty four pregnant women aged 20-40 years with history of previous one lower segment CS at (37-40) week's gestation who were planned for elective CS were included in the study. The LUS thickness was evaluated by both TAS and TVS. Ultrasound examinations were performed within 48 hours before undergoing elective CS. Measurements were done by the same operator using both TAS and TVS and the results were hidden to the team who were performed the CS. At the time of surgery, the LUS was recognized as the part of the uterus below the loose vesico-uterine reflection. The thickness of the LUS was measured by the surgeon after delivery of the neonates using a sterile micrometer caliper which putted on the lower flap of the incision between the two Green-Armytage forceps.

Results: By comparison of the accuracy measures of TAS and TVS, we found that there was statistically significant difference between TAS and TVS measures as regards the signed percent difference ($P < 0.0001$), absolute error ($P < 0.0001$) and percentage of absolute. Error ($P < 0.0001$). As regards the agreement between both ultrasonic tools and actual measures, the bias of TAS (0.3 mm) was bigger than that of TVS (0.06 mm) and the range of limits of agreement for TAS is wider than that for TVS. Although, that agreement between both ultrasonic tools and actual measures was clinically acceptable, the agreement between TAS and TVS was poor (bias, 4.89 mm and range of the limits of agreement, -8.37 to 18.14 mm).

Conclusion: LUS thickness was measured most accurately with TVS indicating the practical advantages of TVS compared with TAS in measuring the lower uterine segment thickness. However, the combination of both parameters is better to be enrolled in guide lines for selection of women suitable for trial of Vaginal Birth after Cesarean Section (VBAC) and the best timing to perform the scan is at term.

INTRODUCTION

Vaginal Birth after Cesarean Section (VBAC) is one of the ways developed to decrease the rising rate of cesarean deliveries. It is

a trial of vaginal delivery in special cases of a previous Cesarean Section (CS) in a well-prepared hospital [1]. Rupture of uterine scar is an unusual complication of VBAC, however, the maternal and fetal complications of which can be grave and potentially life

threatening [2]. The outcome of VBAC depends mainly on the strength of the scar, which has been related to its thickness [3]. Dehiscence of the scar is directly related to the thickness of the Lower Uterine Segment (LUS) which can be assessed between 37 and 40 weeks of gestation [4]. So, sonographically assessed thickness of the LUS at term can be used as a tool for predicting scar dehiscence [5]. Thickness of the LUS can be assessed by either Trans Abdominal Sonography (TAS) or Trans vaginal Sonography (TVS) in the third trimester of pregnancy [5]. TVS provides better image resolution and identification of layers yet, patients discomfort and difficulty in performing the procedure remain the major obstacles [2]. Preoperative sonographic assessment of LUS at cesarean delivery has been investigated by many authors [6]. However, none have measured the actual thickness of the LUS during CS procedure [3]. The aim of the current study was to compare the diagnostic accuracy of TAS versus TVS in the prediction of LUS thickness in pregnant women with one previous CS at term and its correlation with the actual thickness during CS.

MATERIALS AND METHODS

This diagnostic accuracy study was conducted at Feto-Maternal Ultrasound Unit, approved from the local hospital ethics and research committee. The study design and layout were explained for all registered women, and written informed consent was obtained from each participant. One hundred and forty four pregnant women aged 20-40 years with history of previous one lower segment CS at (37-40) week's gestation who were planned for elective CS were included in the study. Women with multiple pregnancies, in labor, have abnormal placentation, non vertex presentation oligohydramnios and/or polyhydramnios were excluded from the study. All women were exposed to full history taken, abdominal and pelvic examinations Ultrasound examination: The LUS thickness was evaluated by both TAS and TVS. The examinations were done with a partially full bladder, (waiting for 2 hours after the last voiding) as an over distended bladder may elongate the cervical length by stretching the LUS and, also performed in the absence of any uterine contraction which may alter the LUS. Ultrasound examinations were performed within 48 hours before undergoing elective CS. Examinations were performed using SONOACE X4, MEDISON® (Soul, South Korea) with a trans-abdominal convex array transducer with a frequency of 3-7 MHz and a trans vaginal probe with a frequency of 4-9 MHz. Abdominal Ultrasound was done for full obstetric assessment and LUS was visualized in sagittal section in the mid line and lateral plane. The measurement of LUS thickness was taken with the cursors at the urinary bladder wall-myometrium interface and the myometrium/ chorioamniotic membrane-amniotic fluid interface. Trans-vaginal Ultrasound was performed to measure LUS after identification of the urinary bladder in the longitudinal plane of the cervical canal. The LUS appears sonographically as a 2- layered construction that consists, from the urinary bladder inward, of the hyper-echoic visceral- parietal reflection, counting the mucosa and muscosa and of the urinary bladder (the outer layer), and the comparatively hypoechoic myometrial layer. The vaginal probe was applied into the posterior fornix with the women lying supine, knees quietly flexed and hips elevated somewhat on a pillow to permit free movement of the operator. With mild

rotation and angulation of the vaginal probe, both saggital and coronal views can be obtained. Measurements were done by the same operator using both TAS and TVS and the results were hidden to the team who were performed the CS. At the time of surgery, the LUS was recognized as the part of the uterus below the loose vesico-uterine reflection. The thickness of the LUS was measured by the surgeon after delivery of the neonates using a sterile MICROMETER in the following manner: Two Green-Armytage forceps were applied to grasp quietly the lower flap of the uterine defect about 2 inches separately on either side of the midline. The measurement was taken using a sterile micrometer caliper which putted on the lower flap of the incision between the two Green-Armytage forceps.

RESULTS AND DISCUSSION

Statistical analysis was done using MedCalc® version 12.5 (MedCalc® Software, Ostend, Belgium) and IBM® SPSS® Statistics version 21 (IBM® Corp., Armonk, NY). Numerical data were presented as, mean, SD, and Inter Quartile Range (IQR)]. Categorical data were presented as number and percentage. Comparison of paired numerical data was done non parametrically using the Wilcoxon signed ranks test. The whole data set was used to validate TAS and TVS for estimation of scar thickness. The following measures were calculated for each tool: Signed Percent Difference (SPD), where $SPD = [(scar\ thickness\ estimated\ with\ TAS\ or\ TVS\ minus\ actual\ scar\ thickness) / actual\ scar\ thickness] * 100$. Absolute (unsigned) Error (AE), where AE = absolute (unsigned) difference between estimated scar thickness and actual scar thickness in mm. Agreement between either ultrasonic tool (TAS or TVS) or actual scar thickness was examined using the Bland-Altman method. The difference between the two estimates was plotted (on the y axis) versus the average of the two estimates (on the x axis). The mean difference (bias) was then calculated, and its SD was determined. A series of horizontal lines were then plotted corresponding to the bias and to 1.96 times its SD, both above and below the bias. The 95% limits of agreement is the range bounded by the bias plus 1.96 SD and the bias minus 1.96 SD. If the upper and lower bounds of the 95% limits of agreement are not clinically important, it may be interpreted that the two methods could be used interchangeably (Bland & Altman, 1986 and 1999). Agreement between TAS and TVS was examined using the Bland-Altman method as described above. Besides, the ranking of the absolute error for both methods was examined by estimation of the weighted kappa statistic.

Results

I-General characteristics of included women: Patients' characteristics are shown in (Table 1) II- Descriptive analysis of actual lower uterine scar thickness and measures estimated with TAS or TVS: Actual lower uterine scar thickness and measures estimated with TAS or TVS are shown in (Table 2) III- Accuracy of TAS & TVS measures as contrasted with actual measures: The median (IQR) signed percent difference for TAS was 30 (0 to 60) %, the median (IQR) absolute error for TAS was 0.4 (0.2 to 0.6) mm and the median (IQR) percentage of absolute error by TAS was 7.0 (2.5 to 10.6) %. On the other hand, the median (IQR) signed percent difference for TVS was 10 (-10 to 20) %, the median (IQR) absolute error for TVS was 0.1 (0.1 to 0.2) mm and the median (IQR) percentage of absolute error by TVS was

2.3 (1.9 to 4.2) %. (Tables 3&4, Figures 1,2&3). By comparison of the accuracy measures of TAS and TVS, we found that there was statistically significant difference between TAS and TVS measures as regards the signed percent difference ($P < 0.0001$), absolute error ($P < 0.0001$) and percentage of absolute error ($P < 0.0001$) (Table 5). As regards the agreement between both ultrasonic tools and actual measures, the bias of TAS (0.3 mm) was bigger than that of TVS (0.06 mm) and the range of limits of agreement for TAS is wider than that for TVS. Although, that agreement between both ultrasonic tools and actual measures was clinically acceptable, the agreement between TAS and TVS was poor (bias, 4.89 mm and range of the limits of agreement, -8.37 to 18.14 mm). This may be explained by the additive bias inherent in either tool. Besides, the ranking of the absolute error

for both methods that revealed poor agreement between them as evidenced by the low Weighted Kappa Coefficient (weighted $\kappa = 0.102$; 95% CI, 0.02 to 0.18).

Discussion

Kushtagi et al. conducted a study to correlate LUS thickness measured by TAS at term gestation with that measured manually using Vernier caliper at CS and to detect minimum LUS thickness indicative of its integrity in patients with previous one CS. Thickness of LUS was measured before and after fetal head delivery. They reported that, manual measurement of the lower flap of the LUS was correlated with sonographic measurements. They recommended that, LUS thickness of ≥ 3 mm measured by prior to delivery at term in patients with previous CS is suggestive

Table 1: Patients characteristics.

Variable	Mean	SD	Med.	IQR
Age (yr)	25.5	3.3	26	22 to 28
Interval since last CS (yr)	2.2	0.9	2	2 to 3
Gestational age at current CS (wk)	38.2	0.8	38	38 to 39
Body mass index(BMI)	26	1.2	25	20 to 30

SD: Standard Deviation; Med: Median; IQR: Inter Quartile Range

Table 2: Descriptive analysis of actual lower uterine scar thickness and measures estimated with TAS or TVS.

Variable	Min.	Max.	Mean	SD	Med.	IQR
Actual LUS thickness (mm)	4	10.5	5.4	1.5	5	4.5 to 5.8
Thickness of LUS by TAS (mm)	4	12.5	5.8	1.7	5.2	4.8 to 5.9
Thickness of LUS by TVS (mm)	3.9	10.7	5.5	1.5	5	4.6 to 5.8

SD: Standard Deviation; Med: Median; IQR: Inter Quartile Range

Table 3: Accuracy of TAS measures as contrasted with actual measures.

Accuracy measure	Min.	Max.	Mean	SD	Med.	IQR
Signed percent difference for TAS (%)	-60	200	35.8	49.6	30	0 to 60
Absolute error for TAS (mm)	0	2	0.5	0.4	0.4	0.2 to 0.6
Percentage of absolute error by TAS (%)	0	37.5	8.1	6.8	7.0	2.5 to 10.6

Min: Minimum; Max: Maximum; SD: Standard Deviation; Med: Median; IQR: Inter Quartile Range

Table 4: Accuracy of TVS measures as contrasted with actual measures.

Accuracy measure	Min.	Max.	Mean	SD	Med.	IQR
Signed percent difference for TVS (%)	-100	90	5.6	22.1	10	-10 to 20
Absolute error for TVS (mm)	0	1	0.2	0.2	0.1	0.1 to 0.2
Percentage of absolute error by TVS	0	22.5	3.2	2.8	2.3	1.9 to 4.2

Min: Minimum; Max: Maximum; SD: Standard Deviation; Med: Median; IQR: Inter Quartile Range

Table 5: Comparison of the accuracy measures of TAS and TVS.

Accuracy measure	Tool	Median	IQR	p-value
Signed percent difference (%)	TAS	30	0 to 60	< 0.0001
	TVS	10	-10 to 20	
Absolute error (mm)	TAS	0.4	0.2 to 0.6	< 0.0001
	TVS	0.1	0.1 to 0.2	
Percentage of absolute error (%)	TAS	7.0	2.5 to 10.6	< 0.0001
	TVS	2.3	1.9 to 4.2	

IQR: Inter Quartile Range.

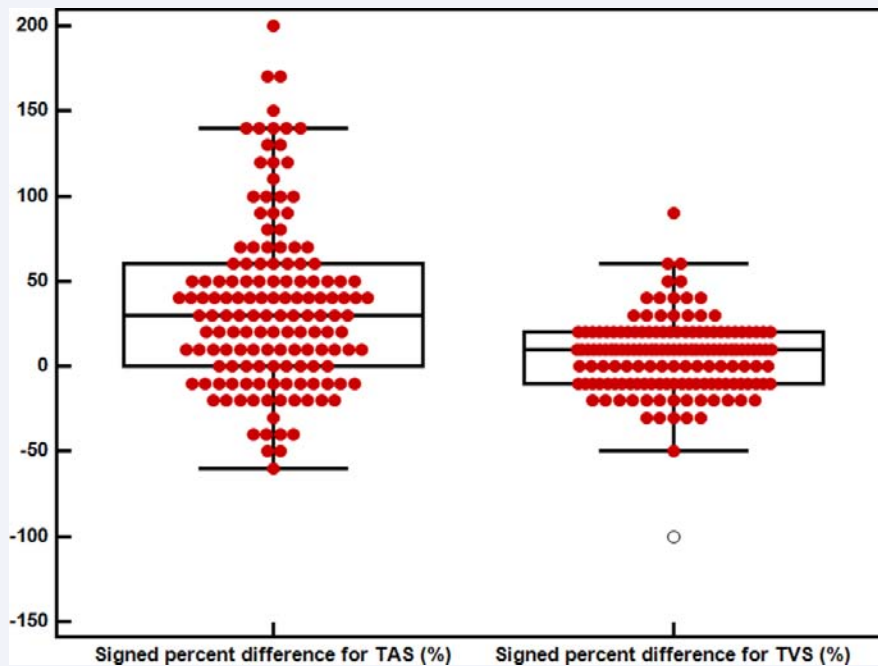


Figure 1 Box plot showing signed percent difference for Trans-Abdominal Sonography (TAS) And Trans-Vaginal Sonography (TVS) measures.

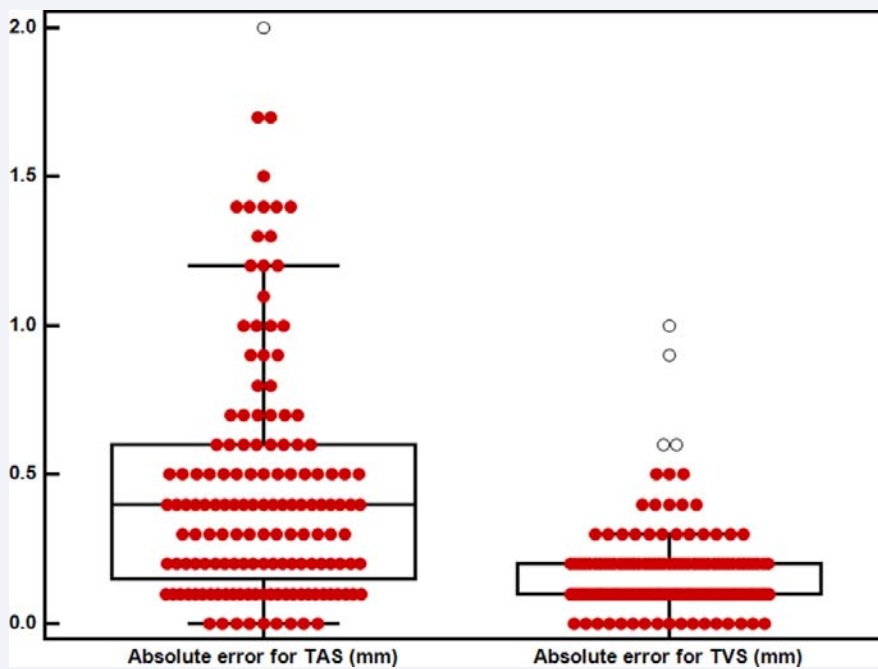


Figure 2 Box plot showing absolute error for Trans-Abdominal Sonography (TAS) and Trans-Vaginal Sonography (TVS) measures.

of stronger LUS but is not a dependable safeguard for trial of VBAC [7]. Other investigators conducted a study to compare the accuracy of TVS versus TAS to evaluate the thickness of LUS before CS. Eighty-three pregnant women who underwent elective CS were included in this study. LUS thickness was measured using both TVS and TAS. The actual thickness of the LUS was measured after the neonate had been delivered using a sterile metal ruler. The actual thickness of the LUS showed a significant

correlation with TVS among the total, with unscarred uteri, with 1 CS and 2 CS, while with TAS, the correlations were significant only with the total and 2 previous CS. They reported that, although the thickness of the LUS measured with TAS showed a good correlation with the actual thickness, the correlation with TVS was better [3]. In contrast to the previous two studies as regards the methodology of data analysis, we used the agreement analysis to validate and compare TAS and TVS for estimation of

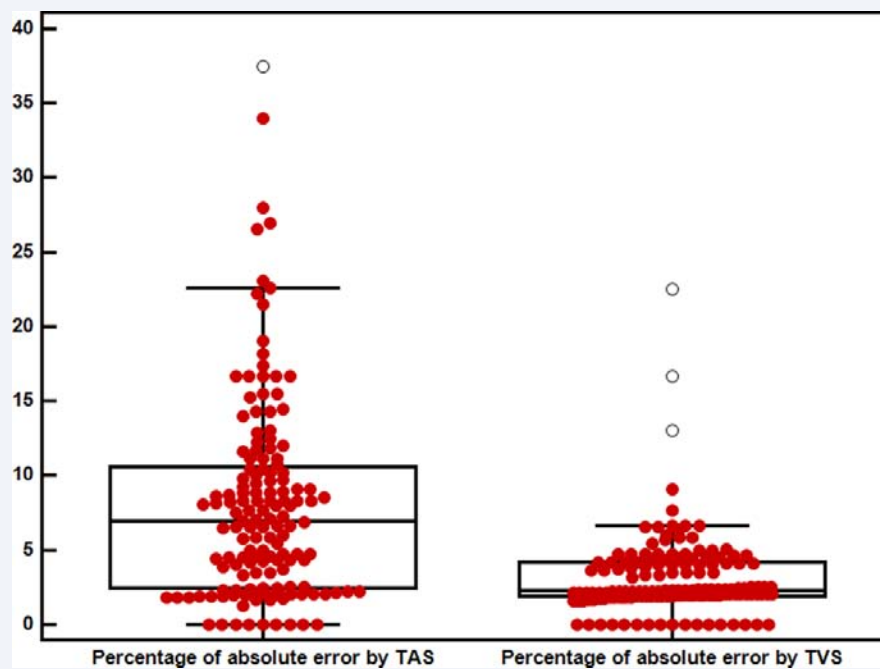


Figure 3 Box plot showing percentage of absolute error for Trans-Abdominal Sonography (TAS) and Trans-Vaginal Sonography (TVS) measures.

scar thickness at term. Although the TVS technique does give good descriptions of the LUS near the pericervical area, it appears to give more accurate and reproducible measurements, thus being considered the ideal approach by some authors [8], others suppose the TAS approach is better, as TAS allows assessment of most of the LUS and permits us to recognize and measure the site of the thinnest LUS. TVS technique might not stand for the whole LUS and could be rather distant from the site of the previous CS so appear to be less trustworthy [2]. So evaluation of LUS using TVS can fail to notice significant uterine scar defects and TAS measurement may be supportive when the scar is situated on the upper part of the LUS [9]. In other type of studies, investigators assessed the usefulness of measuring LUS thickness by ultrasound in anticipating dehiscence of the previous CS scar by giving group of patients a trial of VBAC and predicting cut off value of LUS thickness above which LUS thickness is considered strong, such a result may persuade obstetricians to think about VBAC, two examples of these studies discussed as follows [10,11]. Investigators conducted a study on pregnant women with history of previous C.S. LUS thickness was measured by TAS. TVS was done when LUS was not well-visualized by TAS. TVS was required in 50% of women; this supports the more reliability of TVS than TAS in measuring the thickness of LUS. In this study, a trial of VBAC was allowed for women with no contraindication for vaginal delivery. Moreover, the incidence of scar dehiscence in women who underwent trial of vaginal delivery was (2.4%). This study reported an association between uterine scar dehiscence and myometrial LUS thickness. They authenticated that, the best cutoff point of full LUS thickness as predictor of scar dehiscence was 2.3 mm [10]. Another study was conducted on pregnant women with history of previous CS, at 37- 40 weeks gestation. The LUS thickness was evaluated by both TAS and TVS. There was a positive correlation between intraoperative grading of the LUS and its thickness by US; the critical cutoff value of the LUS

thickness was 2.5 mm above which harmless vaginal delivery can be obtained [11]. Nevertheless, Cheung, reported that, the clinical relevance of LUS measurement in the management of VBAC remains controversial [12]. Assessment of LUS thickness using TAS and/or TVS is increasingly known as a useful clinical method in the prediction of uterine rupture. Although, information from the present study authenticated the advantage of TVS over TAS for measurement of LUS thickness, it also reported that the upper and lower bounds of the 95% limits of agreement are not clinically important, so it means that the two tools could be used interchangeably. Moreover, the combination of both methods for assessment of LUS thickness, if integrated into guidelines on the management of women who underwent a previous CS, could afford precious information in planning for VBAC by anticipating its safety and success.

CONCLUSION

LUS thickness was measured most accurately with TVS indicating the practical advantages of TVS compared with TAS in measuring the lower uterine segment thickness. However, the combination of both parameters is better to be enrolled in guide lines for selection of women suitable for trial of VBAC and the best timing to perform the scan is at term.

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