Sonographic assessment of lower uterine segment at term in women with previous cesarean delivery

Prahad Kushtagi - Suneeta Garepalli

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Abstract
Objective To correlate lower uterine segment (LUS) thickness measured by abdominal sonography at term pregnancy with that measured manually using caliper at cesarean delivery and to find out minimum LUS thickness indicative of its integrity in women with previous cesarean.
Methods In 106 women with previous cesarean delivery and 68 with unscarred uterus, abdominal sonographic assessment of LUS was carried out within a week of delivery. Sonographic measurements were correlated with manual measurement of lower flap of LUS using Vernier calipers in 96 of these women (64 with previous cesarean and 32 of unscarred uterus) who had elective cesarean delivery.
Results Sonographically determined LUS was thinner among women with previous cesarean delivery than in those without (4.58 SD 1.05 vs. 4.8 SD 0.8; t = 1.986; p = 0.049). Women with vaginal birth after cesarean had thicker LUS than women with repeat cesarean delivery (4.4 SD 0.97 vs. 4.48 SD 1.0). The findings were not influenced by engaged fetal head status or amount of bladder fullness. Directly measured LUS thickness using Vernier calipers before delivery of the baby confirmed ultrasound measurements, but showed smaller differences between them. There were eight cases with defective uterine scar at cesarean. LUS thickness at term of 3 mm provided 87.5% sensitivity and specificity, and was found to have negative predictive value of 98%. But in two of seven cases the actual LUS was not measurable despite sonographic measurement of 3 mm, and there were two records of scar dehiscence in those with 3 and 4 mm of LUS thickness.
Conclusion LUS thickness of 3 mm measured by abdominal ultrasonography prior to delivery at term in women with previous cesarean is suggestive of stronger LUS but is not a reliable safeguard for trial of labor.

Keywords Previous cesarean delivery - Lower uterine segment thickness - Sonographic measurement - Direct caliper measurement

Introduction
There is worldwide increase in the rates of cesarean births over the last two decades. Frequency of lower uterine segment (LUS) scar dehiscence is reported to be similar to the uterine rupture during labor in women with unscarred uterus. Yet, significant numbers of women with previous cesarean births and up having repeat cesarean deliveries. In parous women, previous cesarean has been found to be the most common indication for cesarean delivery in as high as 67% cases [1]. Unsecure prediction of the integrity of the scarred LUS during labor appears to be one of the reasons for high repeat cesarean rates [2].
Several methods ranging from postoperative echographic evaluation of uterine wound, interval hysterography, and magnetic resonance imaging to amniography have been employed to assess the integrity of scarred LUS. Several recent reports suggest that sonographic evaluation of LUS can be used effectively to assess its integrity to predict the risk of intrapartum uterine rupture [3–6].

S. Garepalli
Kasturba Medical College, Manipal 576104, India
P. Kushtagi (✉)
I. KMC Quarters Manipal University Campus, Manipal 576104, India
email: prahadkushtagi@hotmail.com
Different opinions are expressed regarding the period in pregnancy when the ultrasound assessment can be carried out and with regard to the cut off value for LUS thickness. About timing of sonographic assessment, Quereshi et al. [7] began assessment from as early as 16th week of gestation in their study. In contrast, Michaels et al. [8] thought it advantageous to assess between 28 and 36 weeks since it allowed for adequate LUS development, and avoided problems of diagnosis when the presenting part was deep in pelvis and when the amniotic fluid volume was physiologically reduced. Some [9, 10] have examined women between 36 and 39 weeks of gestation, at the time when mode of delivery will be discussed. Similarly, the cut off value of LUS thickness above which the intrapartum uterine rupture is less likely has varied from 2 to 3.5 mm [4, 6, 7, 9].

Present study is an attempt to determine the LUS thickness by trans-abdominal sonography at term pregnancy, correlate it with manual caliper measurements at cesarean delivery and find out predictive value of LUS thickness measurement in assessing integrity of LUS in women with previous cesarean delivery.

Materials and methods

Prospective sonographic assessment of LUS was carried out in 174 women at term with singleton pregnancy presenting by vertex (cephalic presentation) having adequate liquor and not in labor. The study group with previous cesarean delivery contained 106 women. The control group included 68 women with no previous uterine surgery. Women recruited under control group were 32 of those in whom elective cesarean delivery was planned during the period of study and 36 low risk pregnancies who had vaginal delivery. Women with placenta previa, uterine surgery other than cesarean and fetal malformations were excluded from the study. The study hospital is a tertiary care center affiliated to medical university dealing mainly with high risk pregnancies.

Within a week before delivery antepartal abdominal sonography was performed with moderately full bladder. The woman was asked to void urine completely and drink 300 ml of water 1 hour before scheduled ultrasound. For the purpose of the study, bladder was considered to be 'moderately full' when abdominal scan revealed bladder length of 6-8 cm in vertical plane.

At abdominal sonography the LUS was considered abnormal if any of the following were present: abnormally thin (LUS ≤ 1 mm). asymmetry of LUS (when there was difference of at least 2 mm between two measurements), abnormal movement, ballooning or wedge defect in the LUS. Abnormal movement was considered when outer layer bulged out with amniotic fluid pressure caused by use of transducer as described by Michaels et al. [8] for ballooning.

Ultrasound examinations were performed by a single designated obstetrician-sonomologist who was not involved in the management of case. Ultramark 4 plus ultrasound unit equipped with 3.5 MHz curvilinear array transducer was used to measure the LUS thickness. The thickness of the anterior wall of LUS where it covers the fetal head was measured as a distance from urine–posterior bladder wall interface to uterine wall–amniotic fluid interface [4]. If there was no amniotic fluid, uterine wall–fetal head interface was taken. Four measurements of the thickness of anterior wall of LUS were taken: two each in vertical and transverse planes and the lowest value measured was used to describe the thickness of LUS.

Gentle pressure was applied by transducer against maternal abdomen to move LUS. Any movement that distorted the shape of the LUS was considered abnormal. Length of the cervix and bladder fullness indicated by maximum length in vertical plane was measured in all the cases. In women with previous cesarean, note was made of any asymmetry of the thickness resulting in wedge defect and anterior bulging of the fetal membranes with amniotic fluid suggestive of scar detorse.

The person performing the abdominal ultrasound for LUS thickness was aware of the history of cesarean delivery in a woman. The treating obstetricians were not informed of the LUS thickness measurements taken for the study. All women were followed up to the time of delivery. If she did not deliver within a week, ultrasound evaluation was repeated to replace the earlier observation.

In women who had elective cesarean (not in labor) the actual measurement of LUS thickness was recorded using Vernier calipers. Thickness of the lower flap of LUS at center measured before delivery of fetal head was used for correlating with sonographically measured LUS thickness. The LUS was labeled abnormal if it was thin ('thin' but not thin enough to visualize uterine contents), ballooning (area of bulge on the scar line), or window defect (subperitoneal separation of uterine scar through which fetal membrane could be seen).

In women who had vaginal delivery after previous cesarean, no attempt was made to feel for the scar trans-cervically, postpartum. In women with previous cesarean, indication for repeat cesarean, inter-delivery interval (time period between previous cesarean and present delivery), and neonatal birth weight were noted.

Findings at sonography, caliper measurements and direct observations at cesarean delivery were compared. The difference in the observations made in the two groups was analyzed by student’s t test and chi square test, as applicable to find out the significance (p < 0.05), if any.
Table 1: Same case characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unscreamed uterus (n = 68)</th>
<th>Previous cesarean (n = 106)</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>28.1 (4.49)</td>
<td>28.8 (4.96)</td>
<td>t = 0.99; p = 0.32</td>
</tr>
<tr>
<td>Gestational age in weeks</td>
<td>38.7 (0.97)</td>
<td>38.8 (0.97)</td>
<td>t = 0.296; p = 0.76</td>
</tr>
<tr>
<td>Neonatal birth weight in gram</td>
<td>2.970 (0.206)</td>
<td>2.960 (0.350)</td>
<td>t = 0.37; p = 0.7</td>
</tr>
</tbody>
</table>

Values are mean (1 SD)

Results

Age of the patient, gestational age and the neonatal weights were comparable in the two groups studied (Table 1).

Sixty four of 106 women with previous cesarean (60.38%) underwent elective cesarean delivery. Indications for previous cesarean delivery in these women were cephalopelvic disproportion/nonprogress of labor (46, 43.39%), nonpegsing fetal status (22, 20.75%), posterior placenta previa (4, 3.77%), breech (3, 2.83%), previous cesarean (6, 5.66%), failed induction (11, 10.37%) and others which included cases like severe preclampsia, uncontrolled diabetes, previous pregnancy in women after poor obstetric performance or assisted reproduction procedures.

Sonographically determined LUS was thinner in women with previous cesarean than those without (4.58 SD 1.05 vs. 4.8 SD 0.8, t = 1.98, p = 0.04); and those who had cesarean delivery after cesarean compared to those with vaginal birth after cesarean (4.4 SD 0.97 vs. 4.48 SD 1.0). Average lower uterine segment thickness did not show significant changes as the number of previous cesarean deliveries increased (LUS thickness of 4.52 SD 1.17 in 100 cases with one-, 4.6 SD 1.05 in five cases with two- and 4.6 mm in one case of three previous cesarean deliveries).

Full LUS thickness of up to 3 mm was recorded in 14 cases (13.2% of 106) by ultrasound. There were eight cases with defective scar at cesarean delivery. In 50% of cases with LUS thickness of up to 3 mm (7 of 14 cases), thin LUS was noted at cesarean delivery. Two cases in which asymmetry of LUS was seen, one had complete scar dehiscence and the other thin LUS. The case through sonographically to be having ballooning had measured 2 mm of thickness and was found to have thin LUS without ballooning at cesarean. A case with incomplete scar dehiscence was missed on ultrasound examination and was recorded to have LUS of 4 mm taken 6 days prior to cesarean delivery. In two of the cases LUS was too thin for taking direct caliper measurements but they were recorded to have 3 mm thick LUS antepartally by ultrasound (Table 2).

In an effort to study the ability of one value of LUS thickness to predict defective scars, cut off values were arrived at after deducting two times of standard deviation (SD) from the mean LUS for unscreamed uterus. With 3 mm (Mean - 2SD) as cut off value, 7 of 14 cases were found to have defective scar. When cut off of 2 mm (Mean - 2SD) was taken, of the two cases one had defective LUS at cesarean. LUS thickness at term of 3 mm was found to be associated with respectful sensitivity, specificity and high negative predictive value (Table 3).

Average height of bladder indicative of fullness was comparable in two subgroups of LUS thickness. Proportion of women with LUS thickness of up to 3 mm or those with higher thickness was similar in groups divided according to engaged/movable status of fetal head. A inter-delivery interval of more than 18 months was found to be attended with higher number of women among the group with LUS thickness more than 3 mm, it, however, was not statistically significant (Table 4).

Measured LUS thickness by calipers at cesarean delivery was significantly thinner in women with previous cesarean delivery (unscreamed uterus 4.34 SD 0.67; previous cesarean 4.2 SD 1.21; t = 2.92, p = 0.04).

The thickness of LUS measured by abdominal ultrasound correlated with the direct caliper measurement before extraction of the baby with minimum difference of

Table 2: LUS thickness in cases with defective scar

<table>
<thead>
<tr>
<th>Intravenous anomaly</th>
<th>Size of defect (mm)</th>
<th>Caliper LUS thickness before extraction (mm)</th>
<th>LUS thickness by USG (mm)</th>
<th>Other USG findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete scar dehiscence</td>
<td>Complete</td>
<td>2</td>
<td>3</td>
<td>LUS asymmetry</td>
</tr>
<tr>
<td>Incomplete scar dehiscence</td>
<td>4-1.3</td>
<td>3.5</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Thin LUS</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Thin LUS</td>
<td>-</td>
<td>2</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Thin LUS</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>Ballooning</td>
</tr>
<tr>
<td>Thin LUS</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Thin LUS</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>LUS asymmetry</td>
</tr>
<tr>
<td>Ballooning</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 3 Predictability of sonographic lower uterine segment thickness in women who had repeat cesarean delivery

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Sonographic LUS thickness at term (N = 64)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 mm (Mean ± 2.35SD)</td>
</tr>
<tr>
<td></td>
<td>3 mm (Mean ± 2.5SD)</td>
</tr>
</tbody>
</table>

Number of observations up to the cutoff measurement
- 2 mm: 14
- 3 mm: 7

Cases with defective scar
- 1

Sensitivity (%) 15.3 87.5
Specificity (%) 98.2 87.5
Positive predictive value (%) 50 50
Negative predictive value (%) 90.3 98

LUS lower uterine segment. SD standard deviation

Table 1 LUS thickness measurement and influencing variables in women with previous cesarean delivery

<table>
<thead>
<tr>
<th>LUS thickness by USG</th>
<th>≥3 mm (N = 92)</th>
<th>≤3 mm (N = 16)</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fetal head status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engaged cases (%)</td>
<td>40 (43.48)</td>
<td>8 (57.14)</td>
<td>( X^2 = 0.45; p &gt; 0.5 )</td>
</tr>
<tr>
<td>Mobile cases (%)</td>
<td>52 (56.52)</td>
<td>6 (42.86)</td>
<td></td>
</tr>
<tr>
<td>Average bladder fullness in cm; mean (SD)</td>
<td>6.5 (0.48)</td>
<td>6.7 (0.66)</td>
<td>( t = 1.61; p &gt; 0.11 )</td>
</tr>
<tr>
<td>Inter-delivery interval</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;18 months cases (%)</td>
<td>32 (34.78)</td>
<td>8 (57.14)</td>
<td>( X^2 = 1.72; p &gt; 0.18 )</td>
</tr>
<tr>
<td>&gt;18 months cases (%)</td>
<td>60 (65.22)</td>
<td>6 (42.86)</td>
<td></td>
</tr>
</tbody>
</table>

LUS lower uterine segment. USG ultrasound. SD standard deviation

0.03 mm in unscarred group (32 cases; 4.87 SD 0.93 by ultrasound and 4.84 SD 0.67 by calipers) and 0.2 mm in previous cesarean group (64 cases; 4.4 SD 1.05 by ultrasound and 4.2 SD 1.21 by calipers).

Discussion

One of the challenging concerns in modern obstetric practice is to offer trial of labor to women with previous cesarean delivery. The estimated frequency of uterine scar rupture in trial of labor is reported to be varying between 0.3 and 3.8% mainly due to lack of awareness of the integrity of scarred LUS [11]. Cesarean rate in the university hospital center reported here remains higher since it caters mainly to high risk pregnancies. In addition to the contributions by need for tubal ligation procedure, on demand and low threshold for cesarean by obstetricians in certain situations, the uncertainty about prediction of the integrity of the scarred LUS during labor continues to be undisclosed reason for high repeat cesareans rates.

Poorly healed uterine scar might affect the regeneration of isthmus of uterus and make it thinner [3], resulting in much thinner LUS in subsequent pregnancies. Thin LUS with scar is likely to rupture during labor. Assessment of the LUS integrity thus becomes important and it has become possible with the availability of ultrasonography.

Several studies using various methods have been conducted to evaluate the correlation of LUS measurement with the risk of uterine rupture or dehiscence, with variable success. In some studies, the entire LUS by transabdominal ultrasound was measured [4-6], while in others, only the middle muscle layer was assessed using transvaginal ultrasound [12-14] and some studies used both approaches [13].

Rozenberg et al. [4] found that LUS thickness correlated inversely with the risk of rupture and concluded that thickness more than 3.5 mm is protective against rupture. Although the sensitivity and positive predictive value of a thin segment for a defective scar were low, the negative predictive value of a thick LUS was high. Other reports using 3 mm as cutoff validated similarly [16, 17]. Bajwel et al. [6] using receiver operator curve analyses opined that full LUS thickness of ≥2.3 mm was associated with higher risk of complete uterine rupture. On the other hand, measuring only the myometrial layer instead of full LUS thickness, Asakura et al. [12] concluded that if the myometrial layer was 1.6 mm or more, the trial of labor could proceed with confidence. These findings are supported by those of Cheung [13] and Gotoli et al. [14], who suggest a myometrial layer ≥1.5 and 2 mm, respectively, for potentially safe vaginal birth after cesarean.

We assessed the LUS at or after 38 weeks of pregnancy and engaged status of fetal head did not appear to influence the measurements. The adopted policy of making one to empty the bladder and drink measured quantity of water an hour before scheduled ultrasound seems to overcome differences attributable to degree of bladder filling.

The variation between two observations by sonographic measurement of LUS is believed to be due to contractile state of the uterus, displacement of amniotic fluid, fetal movement, compression of LUS by fetus, and degree of bladder filling [8]. Inter-operator variability is taken care of by only one sonologist performing the measurements. The operator pressure through transducer can add to some difference in the measurements.

Thickness of the LUS measured directly at cesarean by calipers when not in labor in comparison with antenatal ultrasound measurements, was lesser in groups with previous cesarean and unscarred uteri. This difference in direct and ultrasound LUS thickness could be due to the inclusion of posterior wall of the bladder during sonographic measurements. Some stretch of the lower uterine lip may have
...reduced the thickness to some extent while measuring it by calipers. LUS measurement with caliper was recorded before fetal head delivery than after delivery as LUS would become thicker after delivery with release of stretch factor of fetal amniotic fluid and oxytocin. Sonographic LUS thickness of 0.2 mm in two of the cases cannot be explained on the basis of contribution by bladder wall and stretch factor.

Taking cut off for LUS thickness of 3 mm in the present study showed a high negative predictive value suggesting that a LUS thickness 3 mm is usually easy to detect and aggravate a finding may encourage obstetricians to consider vaginal birth in women with previous caesarean delivery. But in two of seven cases the actual LUS was not measurable despite sonographic measurement of 3 mm, and there were two records of scar dehiscence in those with 3 and 4 mm of LUS thickness. These findings should make one to rethink about the importance to be given to antepartum LUS thickness in women with previous caesarean births. Since there are anecdotal case reports highlighting occurrence of scar dehiscence despite normal sonographic evaluation of LUS thickness, there is a need to have randomized studies to know the role of LUS thickness in predicting uterine scar integrity. It is perhaps necessary to shift the objective from trying to predict uterine scar disruption in women with previous caesarean births and concentrate on foreseeing adverse effects of a trial of labor on maternal or neonatal outcome.

Conflict of Interest Statement None.

References