CEOG Clinical and Experimental Obstetrics & Gynecology

Ultrasonographic wall thickness measurement of the upper and lower uterine segments in the prediction of the progress of preterm labour

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Summary

Objective: To assess the role of ultrasonographic measurement of the upper and lower uterine segments wall thickness in predicting the progress of preterm labour in patients presenting with preterm labour pains. *Study design:* Fifty pregnant women presenting at Obstetrics Department – Suez Canal University, Egypt with regular lower abdominal pains and diagnosed as having preterm labour were enrolled in the study. *Materials and Methods:* Measurements of the upper and lower uterine segments wall thickness by transabdominal ultrasonography in-between contractions and with full bladder were taken. The upper/lower uterine wall thickness ratio was calculated and correlated to the progress of the preterm labour and to the response to tocolytics. *Results:* The ultrasonographic upper/lower uterine wall thickness ratio was directly related to the progress of preterm delivery (PTD). The change in this ratio is correlated inversely with the response to tocolysis. Using the ROC curve, when the upper/lower uterine wall thickness ratio was ≤ 1.26 the sensitivity was 94.74 and the specificity was 100.00, and when the ratio was ≤ 1.52 the sensitivity was 100.00 and the specificity was 83.33. *Conclusions:* These data may serve as a baseline ultrasonographic reference values for further studies in prediction the progress of preterm labour in patients presenting with preterm labour pains.

Key words: Ultrasound; Upper uterine segment thickness; Lower uterine segment thickness; Prediction; Preterm Labour.

Introduction

The diagnosis of preterm labour is generally based upon clinical criteria of regular painful uterine contractions (four every 20 minutes or eight every 60 minutes) accompanied by cervical dilatation (≥ one cm) and/or effacement (≥ 80%) [1].

Traditional methods for predicting women destined to deliver preterm based on obstetrical history, demographic factors, and symptoms are neither sensitive nor specific [2-3]. A number of biologic markers in serum, amniotic fluid, and cervical secretions have been evaluated for their potential to predict preterm delivery (PTD). The most commonly used biochemical approach for differentiating women who are at high risk for impending PTD from those who are not at high risk is measurement of fetal fibronectin (fFN) in the cervicovaginal secretions. The test is performed alone or in conjunction with sonographic assessment of cervical length [4-5].

By the end of pregnancy the body of the uterus is divided into two segments which are anatomically distinct. The upper uterine segment is mainly concerned with contraction and is thick and muscular while the lower segment is prepared for distention and dilatation and is thinner. The lower segment has developed from the isthmus and is about eight to ten cm in length. When labour begins, the retracted longitudinal fibers in the upper segment pull on the lower segment causing it to stretch; this is aided by the force applied by the descending head or breech [6].

As the upper and lower uterine wall thickness were found to change in opposite directions throughout normal labour, the upper becomes thicker and lower becomes thinner, the authors thought of determining the ratio between the wall thickness of the upper and lower uterine segments, and to use this ratio as an indicator in predicting the progress of PTDs in patients represented by preterm labour pains.

Materials and Methods

The study was carried out as prospective cohort study aiming to assess the role of ultrasonographic measurement of upper and lower uterine segments wall thickness in predicting the progress of PTDs in patients presenting with preterm labour pains. This study was carried out in the Department of Obstetrics and Gynecology at Suez Canal University Teaching Hospital, Ismailia – Egypt and included 50 pregnant women with preterm labour pains admitted at Obstetrics and Gynecology Departments and enrolled in the study after fulfilling the study criteria and after obtaining the ethical approval from the faculty ethics committee.

The studied population included pregnant women presenting between 24 and 36 weeks gestation with early established preterm labour pains (regular uterine contractions with cervical dilatation one cm and less than three cm and/or cervical effacement of 80%). Other inclusion criteria involved single intrauterine pregnancy, intact membranes, primigravida or multigravida, and previous his-

Revised manuscript accepted for publication November 25, 2013

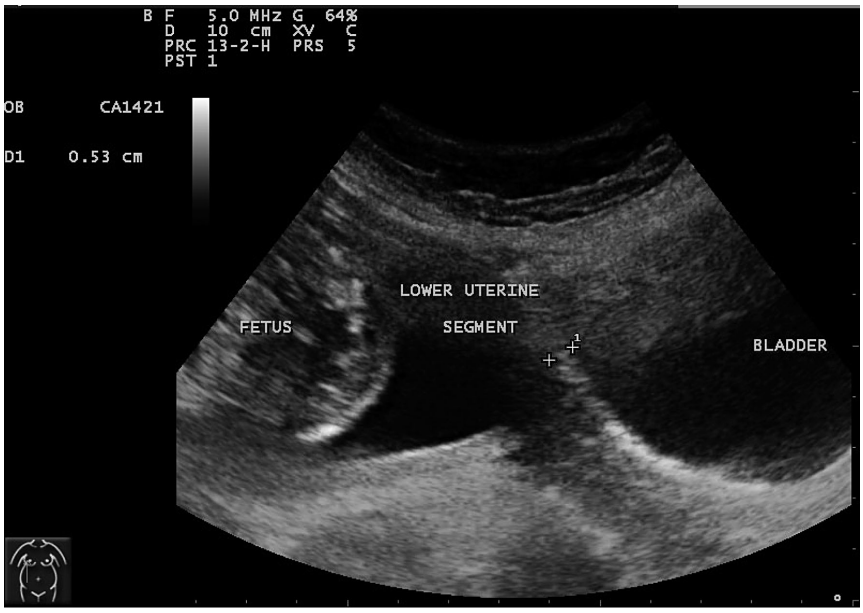

Figure 1. — Lower uterine segment thickness.

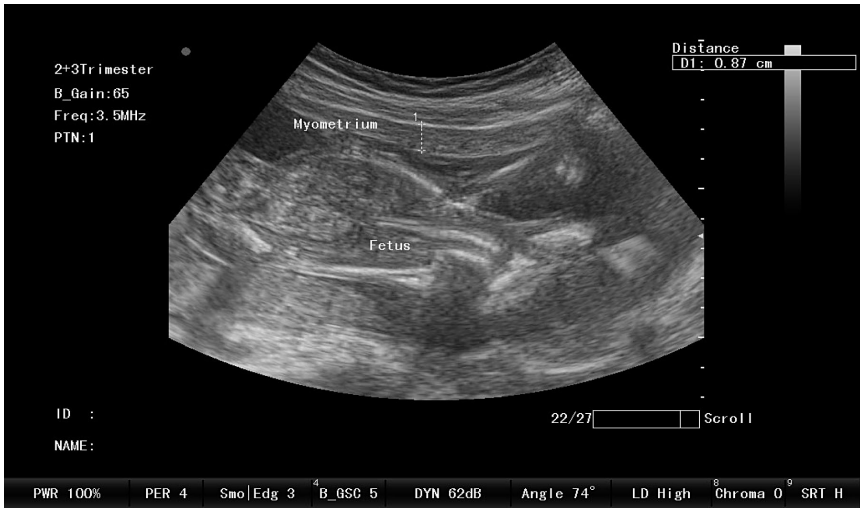

Figure 2. — Upper uterine segment thickness.

tory of preterm labour. Pregnant women with late established preterm labour pain (cervix ≥ three cm dilatation), twin pregnancy, preterm premature rupture of membranes, uterine anomalies, uterine fibroids, history of previous cesarean section, and low lying or anterior wall placental insertion were all excluded.

Detailed account of the different steps of the protocol was explained to the patient and informed consent for participation in the study was obtained. The data collected from the patients included their medical history, clinical and ultrasonographic examinations, investigations and treatments, and then all the patients were followed up till the time of delivery.

Transabdominal ultrasonographic examination was done using an ultrasonographic machine with a curvilinear probe with a 3.5-MHz frequency to measure the uterine wall thickness using the following technique: patients were placed in supine position and slightly tilted to the left. Then the uterus was centralized in the midline. The transabdominal sonographic examination was carried out with the bladder full to allow good visualization of the lower uterine segment. The lower uterine segment wall thickness was measured at two cm above the internal os (Figure 1). The upper uterine segment was measured at a point in the anterior uterine wall midway between the cervix at the level of the internal os and the fundus at the point of maximum convexity (Figure 2). Placental tissue is not included in the measurement. The myometrium is defined as a layer of homogenous echogenicity from the serosal surface to the decidua [9]. The image field was magnified before taking the measurement which was obtained between uterine contractions and by the same observer. At least three measurements were obtained from the uterine wall and the average value was calculated.

The patients' treatment included antibiotics, tocolytics, and corticosteroids. Antibiotics are given in the presence of infection such as urinary tract infection or a positive high vaginal swab. Calcium channel blocker (nifedipine) oral capsules ten mg orally every 15 minutes for one hour was the tocolytic regimen of choice. Corticosteroids for fetal lung maturity were given as betamethasone 12 mg I.M. injection two doses 24 hours apart.

The outcome recorded included time of delivery in weeks, mode of delivery, maternal and fetal complications of delivery,

Table 1. — *Demographic and laboratory data for the entire study population.*

	Responders (N = 38) Mean ± SD	Non-responders (N = 12) Mean ± SD	Student (t) test	*p* value
Age	23.79 ± 2.22	22.83 ± 1.70	1.4	0.16
GA	31.92 ± 2.63	31.33 ± 3.31	0.64	0.53
US GA	31.86 ± 2.81	30.67 ± 4.44	1.1	0.28
Hb%	9.86 ± 0.89	8.83 ± 0.45	2	0.05*
Pus cells	17.63 ± 15.44	25.83 ± 13.7	1.2	0.25
TLC	15.95 ± 4.77	20.9 ± 0.57	3.6	0.0008**

*Statistically significant
GA = gestational age; US GA = ultrasound gestational age
Hb% = hemoglobin concentration, TLC = total leucocytic count

and neonatal outcome. All data were collected for data management and statistical analysis using the SPSS software. Quantitative variables are shown as mean ± SD. Differences were considered significant when $p < 0.05$.

Results

The study population were divided into two groups: group 1 were those patients whose preterm labour pains stopped with tocolytics (38 patients) and group 2 were those patients who did not respond to tocolytics and went into deliver prematurely (12 patients).

For the whole study population; the maternal age ranged between 20 and 28 years with a mean of 23.56 ± 2.13. The parity ranged between para 0 (nullipara) and para 2. There was no significant difference in maternal age, parity or previous miscarriage between the two groups. The gestational age (by date and ultrasound) at presentation ranged between 25 to 34 weeks with an average of 31 weeks. No difference was noted between the two groups (Table 1).

Of note, the hemoglobin concentration and the total leucocytic count (TLC) were significantly different between the two groups (Table 1). Also all women included in the study had pus cells in urine that ranged between ten and 100 /HPF with a mean of 19.60 ± 21.51. No difference was noted between the groups.

Table 2 shows the descriptive statistics of uterine wall thickness of all patients included in the study. The maximum thickness noted in the upper uterine segment was 14.5 mm while it was 13 mm in the lower segment. In some cases the lower uterine segment was thicker than the upper giving rise to an upper/lower segment ratio of as low as 0.39. Seventy-two percent of patients (N = 36) had an upper/lower segment ratio of < 1.5 while 28% (N = 14) of patients had a ratio of ≥ 1.5.

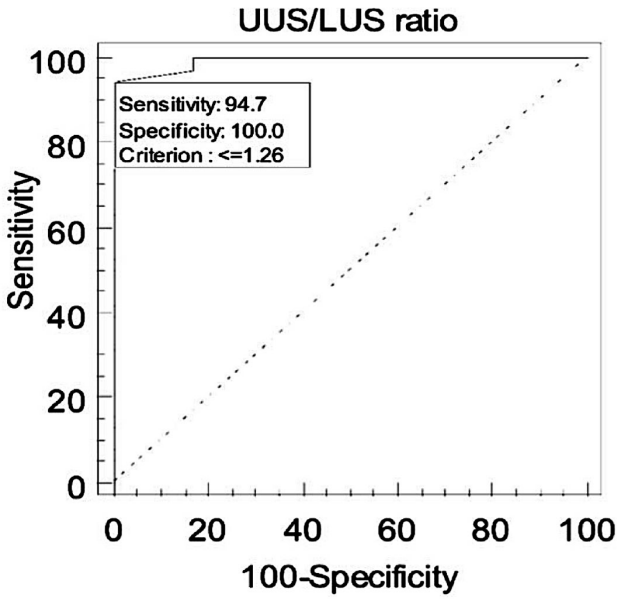

Figure 3. — The ROC curve shows sensitivity and specificity of the ultrasonographic measurement of the ratio between the upper and the lower uterine segments wall thickness.

In responders to tocolysis, the ultrasonographic measurement of the upper uterine segments wall thicknesses ranged between 3.5 and 14.5 mm with a mean of 6.27 ± 2 mm which was significantly thinner compared to the upper uterine wall thickness in non-responders, which ranged between 7.2 and 11.1 mm with a mean of 9.61 ±1.4 mm (Table 2). However, there was no significant difference between the lower uterine segment wall thicknesses between the study groups. In responders, the thickness ranged between two and 19 mm with a mean of 6.68 ± 3.39 mm, while in non-responders the thickness ranged between three and seven mm with a mean of 4.87 ±1.43 mm (Table 2).

In responders, the upper/lower uterine segments ratio ranged between 0.39 and 1.52 with a mean of 1.01 ± 0.23,

Table 2. — *The ultrasonographic measurement of the upper and lower uterine segment thickness and the ratio between them in the study population.*

	All patients (N = 50) Mean ± SD	All patients (N = 50) Range (min. - max.)	Responders (N = 38) Mean ± SD	Non-responders (N = 12) Mean ± SD	*p* value
UUS thickness (mm)	6.07 ± 2.35	3.5- 14.5	6.27 ± 2.00	9.61 ± 1.40	< 0.0001*
LUS thickness (mm)	6.25 ± 3.12	2 - 13	6.68 ± 3.39	4.87 ± 1.43	0.078
UUS/LUS ratio	1.26 ± 0.53	0.39 – 2.6	1.01 ± 0.23	2.06 ± 0.40	< 0.0001*

UUS = upper uterine segment thickness; LUS = lower uterine segment thickness; UUS/LUS = upper uterine segment / lower uterine segment ratio;
*Statistically significant between responders and non-responders to tocolytics.

Table 3. — *Criterion values and coordinates of the ROC curve.*

Criterion	Sensitivity	Specificity	+LR	-LR	+PV	-PV
≤1.26	94.74	100.00		0.053	100.0	85.7
≤1.5	97.37	83.33	5.84	0.032	94.9	90.9
≤1.52	100.00	83.33	6.00	0.00	95.0	100.0

+LR: positive likelihood ratio; -LR: negative likelihood ratio;
+PV: positive predictive value; -PV: negative predictive value.

Table 4. — *Descriptive statistics for neonatal outcome.*

	Responders (N = 38) Mean ± SD	Non-responders (N = 12) Mean ± SD	Student (t) test	*p* value
Gestational age at delivery (weeks)	37.13 ± 1.19	30.67 ± 4.44	9.5	< 0.000*
Neonatal weight (kg)	3.12 ± 0.38	1.56 ± 0.46	15.4	< 0.0001*
One minute Apgar score	9.03 ± 0.94	6.42 ± 1.08	8.1	< 0.0001*

*Statistically significant

while in non-responders this ratio ranged between 1.5 and 2.6 with a mean of 2.06 ± 0.4 and this difference was statistically significant (Table 2).

Figure 3 shows the ROC curve sensitivity and specificity of the ultrasonographic measurement of the ratio between the upper and the lower uterine segments wall thickness.

Table 4 shows the descriptive statistics of neonatal outcome of the study with a mean gestational age at delivery of 37.13 months in responder that was statistically significant compared to that of non-responders (30.67 weeks). Six neonates (15.8%) in the responders group required neonatal ICU admission compared to all neonates (100%) in the non-responder group.

Neonatal weight ranged between 2,200 and 4,200 grams with a mean of 3.12 ± 0.382 in responders and ranged between 900 and 2,250 grams with a mean of 1.56 ± 0.46 in non-responders, with a significant *p*-value. One minute Apgar score ranged between 7 and 10 with a mean of 9.03 ± 0.94 in responders and ranged between 5 and 8 with a mean of 6.42 ± 1.08 in non-responders with significant *p*-value (Table 4).

Discussion

Aside from the digital vaginal examination and cervical assessment by ultrasonography, obstetricians have limited ability to predict the progress of a pregnant woman who is having contractions prematurely. Predicting the progress of such women is of utmost importance as obstetric and neonatal interventions and procedures would differ if the possibility of labour continuing is very high.

There are some predictive biochemical markers that can be used to predict the progress the preterm labour in symptomatic pregnant women such as fetal fibronectin, phosphorylated insulin-like growth factor binding protein, and estriol. Other few potential future biomarkers are still under trial-like cytokines, matrix metalloproteinases, relaxin, stress-related biomarkers, endocannabinoids, and pregnancy associated plasma protein A.

As measuring of the myometrial thickness by transabdominal ultrasound is a non-invasive method, the present authors proposed measuring the upper and the lower uterine segments in patients presenting with preterm labour pains and use the absolute value and/or the ratio between the upper and lower uterine segments as predictors of the progress of labour in women who present with preterm labour pains.

To the best of the authors' knowledge, there is paucity of previous studies in the literature studying the uterine wall thickness during preterm labour. Only few studies used ultrasonography to measure uterine wall thickness, and the investigators concentrated on the lower uterine segment before and during labour in a full term pregnancy. It has been used in different studies to correlate the lower uterine segment thickness to the success of trial of vaginal delivery after cesarean section and the risk of uterine rupture in these cases [7, 8].

Tanik *et al.* compared the ultrasonographic measurement of the lower uterine segment wall thickness with intraoperative findings in 50 pregnant women with previous history of caesarean sections, and they found sensitivity 100%, specificity 82%, positive predictive value 87%, and negative predictive value 100% confirming the reliability and safety of ultrasound in evaluating the uterine wall thickness [7]. Also, Rosenberg *et al.* found that the risk of uterine rupture or dehiscence is directly related to the degree of lower uterine segment thinning measured at or around 37 weeks of gestation, and in particular this risk increases significantly when the thickness is 3.5 mm or less. [8]

In 2005, Buhimschi *et al.*, showed that the sonographic evaluation of myometrial thickness may represent an alternative clinical tool for the prediction of a short latency interval in women with prelabour premature rupture of membranes (PPROM) in 45 pregnant women with singleton pregnancy. They concluded that significant thickening of the anterior and fundal walls of the uterus follows PPROM and that a thick myometrium in non-labouring patients with PPROM is associated with longer latency interval [9].

In the present study, the authors have excluded any factor that may affect the uterine wall thickness such as history of previous cesarean section or PPROM. Also, anterior wall and/or low lying placentae were excluded as Degani and Leibvitz found that the myometrial thickness was significantly increased behind the placental insertion site, as compared to other portions of the uterine wall, and attributed this to increased vascular tissue elements in the myometrium at placentation area [10].

The present authors have chosen the point midway between the cervix and the fundus to represent the thickness of the upper uterine wall while the lower uterine wall thickness was measured two cm above the internal os with a full bladder to clearly identify the myometrium-bladder interface.

Both measurements were taken while the ultrasound probe was oriented in the midline sagittal plane. The authors have found that these points are easily reproducible.

Durnwald and Mercer, in their study of the myometrial thickness in pregnancy, used the same points as representing both uterine wall thicknesses, and they also found no significant difference in myometrial thickness between the second and third trimesters. At both trimesters, the myometrial thicknesses were less compared to the first trimester [11].

Determining the ratio between the wall thickness of the upper and lower uterine segments and using this ratio in predicting the progress of PTDs is novel. Durnwald and Mercer found that myometrial thickness of the different parts of the uterus was greater in multipara compared to primiparous women. Also, women with a high body mass index (BMI) are more likely to have an anterior wall measurement greater than those with women with a BMI < 30 kg/m² [11]. For this reason, an upper/lower uterine segment ratio would be more accurate in representing the changes of the uterine walls compared to the absolute values as these can be influenced by parity and BMI.

The study population was divided into two groups based on their responses to tocolytic therapy: group 1 (responders) and group 2 (non-responders). It was found that the response to tocolysis correlated inversely with changes in the ratio between the ultrasonographic measurement of the upper and the lower uterine segments wall thickness. Using a cutoff ratio, the authors found that when the ratio was ≤ 1.26, the sensitivity was 94.74, and the specificity was 100.00, and when the ratio was ≤ 1.52, the sensitivity was 100.00 and the specificity was 83.33. This means that the higher the ratio, the more likely that the woman will continue to labour and the less likely that the uterine contractions would respond to tocolytics. Changes of the ratio can be explained by the fact that during the course of labour – term or preterm - the lower uterine segment undergoes progressive thinning which together with thickening of the upper segment would result in high upper/lower uterine segment ratio.

The authors encountered a couple of technical difficulties while carrying out the study. The first one was getting the exact midpoint of the anterior uterine wall to measure the myometrial thickness at that point. It is difficult to visualize the whole anterior uterine wall from the internal os to the fundus of the uterus in one screen view. They tried measuring the anterior uterine wall in two steps i.e. from the internal os to one point in the anterior wall and from that point to the fundus and then dividing that by 2 to get the midpoint. Of note, the myometrial thickness in the anterior wall did not differ significantly – if at all different – when measured few centimeters above or below the midpoint. Hence, the authors think it is not necessary to stick to the exact anterior uterine wall midpoint in measuring the myometrial thickness but this needs to be confirmed in a separate study.

The second technical problem was measurement in overweight/obese women where the anterior uterine wall/anterior abdominal wall interface occasionally was not very clear. Getting a better view and more accurate measurement was achieved by taking more time in scanning together with changing the ultrasound gain.

The study has few limitations. The small number of study population is one limitation. Careful selection of the patients and the unwillingness of some patients to participate in the study were factors behind the small sample size. Excluding a sizable portion of patients such as those with anterior placentae, twins, previous lower segment scar etc. makes the application of the results limited to a certain group of patients. Nevertheless, the findings may be helpful to such group and further studies may look at different sets of patients.

In conclusion, ultrasound measurements of the upper and lower uterine segments thickness may add to the clinical examination of a woman presenting with preterm labour pains in an attempt to predict the potential progress of such labour and/or the response to tocolytics if deemed necessary. The study serves as a baseline clinical trial that certainly needs more of the same before implementing the technique into routine practice.

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