



Cervical length measurement in nulliparous women at term by ultrasound & its relationship to spontaneous onset of labour

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Background & objectives: Data on serial cervical length (CL) measurements in pregnancy at term to predict spontaneous labour onset are scarce and conflicting. This study was conducted to observe CL changes preceding spontaneous onset of labour, by serial transvaginal sonography (TVS) and transabdominal sonography (TAS), in nulliparous Indian women near term.

Methods: Only nulliparous women with a singleton foetus in cephalic presentation and who confirmed their gestational age were recruited. Sonographic CL measurements were taken at weekly intervals from 36 wk gestation onwards by a single ultrasonologist. Transabdominal and transvaginal measurements were undertaken using the suitable transducer probes with the women in the supine position.

Results: A total of 104 women with spontaneous onset of labour were evaluated. There was substantial variation in CL measurements, both by TVS and by TAS, from 36 to 40 wk gestation, although the two sets of measurements correlated closely. Mean CL changed significantly over the last three weeks before delivery. However, only one-third of the women showed CL change of >5 mm per week in the last three weeks. There was poor correlation between gestational age at delivery and the last measured CL, either by TVS or TAS. Length >3.1 mm, measured by TVS at 38 wk gestation, predicted post-dated pregnancy to a limited extent.

Interpretation & conclusions: Inter-individual variations in CL and in CL changes were large. Thus, it was not practical to predict spontaneous onset of labour by sonographic CL measurement near term. Post-dated pregnancy may be predicted with limited success. Further studies should explore other parameters, in addition to CL.

Key words Cervical length - nulliparous - onset of labour - term - transabdominal sonography - transvaginal sonography - ultrasound

Cervical length (CL) measurement in mid-pregnancy by the transvaginal sonography (TVS) has been extensively studied for prediction of preterm labour. However, data on term pregnancy are limited. Several methods have been tried to assess the remodelling and

ripeness of the cervix before labour induction and newer methods are being sought¹⁻³. The few existing studies in asymptomatic pregnant women have focussed mainly on the gestational timeframe very close to delivery, either before induction of labour or in post-dates pregnancies.

Two studies reported that the positive predictive value (PPV) of a single CL measurement in term pregnancy was as good as digital examination of the cervix in predicting spontaneous onset of labour within seven days^{4,5}. Ramanathan *et al*⁶ found that measurement of CL at 37 wk could define the likelihood of spontaneous delivery before 40 wk and 10 days. Meijer-Hoogeveen *et al*⁷ concluded that variations in CL and in CL changes were large, which hampered the value of single and repeated CL measurements for the prediction of spontaneous onset of labour at term. Souka *et al*⁸ indicated that it was feasible to utilize cervical measurements in the third trimester to calculate the probability of delivery at any gestational age by CL assessment. Thus, the issue of predicting spontaneous onset of labour by sonographic CL measurement at term remains unsettled.

Though intrusive, TVS has been widely used for CL measurement because, unlike transabdominal sonography (TAS), it is not affected by maternal obesity, oligohydramnios, bladder filling, attenuated echoes of the foetal head or artificially lengthened cervical dimensions caused by bladder compression⁹. Although TVS remains the reference standard for assessing the cervix¹⁰, TAS is non-intrusive and more acceptable and may also provide an effective means of assessing the cervix. The utility of transabdominal assessment of CL has been reported^{9,11}. Furthermore, TAS may be the only applicable technique in certain clinical scenarios in which vaginal examination needs to be restricted.

Measurement of CL in late pregnancy could help predict the spontaneous onset of labour and could assist clinicians in assessing favourability for the induction of labour. We hypothesized that the spontaneous onset of labour, including post-dated pregnancy, might be predicted by sonographic CL measurement. The objective of the present study was to observe CL changes preceding spontaneous onset of labour, by serial ultrasound examination (both TAS and TVS), in nulliparous Indian women near term and to decide whether the measurements could be used in prediction of the time of onset of spontaneous labour and whether post-dated pregnancy could also be predicted.

Material & Methods

The study was designed as an observational study with longitudinal follow up conducted in the department of Obstetrics and Gynaecology, R.G. Kar Medical College, Kolkata, India, after approval from

the Institutional Ethics Committee. All women gave written informed consent at the time of enrolment.

Consecutive consenting nulliparous women with a singleton foetus in the cephalic presentation were selected during May 2010 to April 2011 from the antenatal outpatient clinic of the department of Obstetrics and Gynaecology of a tertiary teaching hospital in Eastern India. For ensuring confirmed gestational age, only those women who had ultrasound in either the first or the second trimester (before 20 wk) were included. Exclusion criteria were admission for threatened preterm labour earlier in pregnancy, previous uterine surgery, uterine malformations or leiomyoma, foetal anomaly or death and foetal or maternal complication that could dictate labour induction or caesarean section before the onset of spontaneous labour.

Sonographic CL measurements were taken at weekly intervals from 36 wk gestation onwards. With the woman in a supine position and with a full bladder, the length of the cervix was measured by TAS (3.5 MHz sector transducer; AGILENT, Philips Medical Systems, Netherlands). Subsequently, CL was measured by TVS (7.5 MHz transvaginal transducer; AGILENT, Philips Medical Systems) with the bladder empty. The transvaginal ultrasound probe was withdrawn until a sagittal view of the cervix was obtained without distortion of the shape by pressure of the ultrasound probe. An adequate image for the measurement of CL was defined as the visualization of the internal os, external os and endocervical canal. The CL was measured, with electronic callipers, as the linear distance between the external os and the internal os along a closed endocervical canal. All measurements were carried out by a single ultrasonologist. After the procedure, the woman was advised to return the following week or to attend hospital for admission, if labour pain started.

Statistical analysis: Pearson's correlation coefficient (*r*) was calculated to quantify the associations between normally distributed numerical variables. Repeated measures analysis of variance (ANOVA) was used to assess significance of within-subject difference in CL measurements by TAS and TVS in the last three weeks before the spontaneous onset of labour. Categorization of women by extent of week-to-week change in CL by TVS in last three weeks was done defining 'minimal change' as a change of <5 mm per week. Receiver operating characteristic (ROC) curves

were drawn to decide the best CL (measured by TVS and TAS at 38 wk gestation) cut-off for the prediction of pregnancy extending beyond 40 completed wk of gestation *i.e.* post-dated pregnancy. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated for the cut-off with 95 per cent confidence intervals (CIs). Statistica version 6 (StatSoft Inc., 2001, Tulsa, Oklahoma) and MedCalc version 11.6 (MedCalc Software, 2011, Mariakerke, Belgium) softwares were used for analysis.

Results

A total of 111 nulliparous women were screened, of whom 104 were taken for final evaluation (Fig.1). Maternal age was 25.3 ± 3.12 (range 20-32) yr and the gestational age at delivery was 278.5 ± 5.19 (range 261-288) days. Of the 104 women with spontaneous onset of labour, 99 delivered vaginally and five women underwent emergency caesarean section, of whom one was for failure to progress in labour.

The descriptive summary of weekly CL measurements, by TVS and TAS, is shown in the Table. There was significant correlation between CL measurements by TAS and TVS. There was also correlation between the last TAS and the last TVS measurement ($r=0.72$). Comparison of changes in the mean CL across the last three weeks of gestation revealed that the week-wise difference between CLs, whether measured by TVS or TAS, was significant ($P<0.001$).

There was, however, no correlation between gestational age at delivery and the last measured

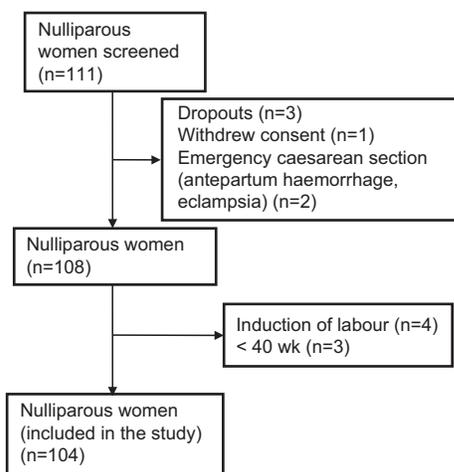


Fig. 1. Flowchart depicting flow of study participants.

CL by either TVS ($r=0.16$) or TAS ($r=0.04$). There was also no correlation between ultrasound-delivery interval and CL, irrespective of the gestational week ($r=-0.15, -0.17, -0.09, 0.02, 0.14$ for measurements by TVS between wk 36 and 40; $r=-0.04, -0.16, -0.16, -0.19, -0.02$ for measurements by TAS in the corresponding weeks).

When individual changes in CL over the last three weeks before delivery were plotted, two different patterns were observed among the women (Fig. 2) – those in whom CL change was minimal (defined as decrease in CL <5 mm per week; $n=70, 67.31\%$) and those in whom CL decreased by ≥ 5 mm per week ($n=34, 32.69\%$). Thus, majority of the women did not have a change of ≥ 5 mm per week.

Fig. 3 shows the ROC curve constructed for CL measured by TVS at 38 wk gestation to decide cut-off for predicting occurrence of post-dated pregnancy. It

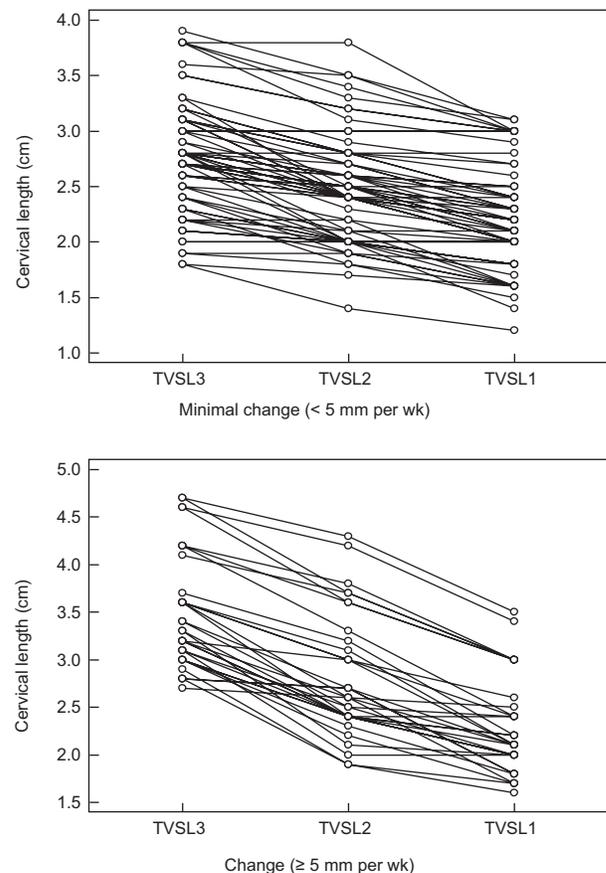


Fig. 2. Plots showing cervical length changes by transvaginal sonography over the last three weeks (TVSL3, TVSL2 and TVSL1 depicting the measurements in each week) – the study group can be categorized into women with minimal change (<5 mm per week; $n=70$) and women with change (≥ 5 mm per week; $n=34$).

Table. Descriptive summary of cervical length measurement (cm) by transvaginal and transabdominal sonography

Period at cervical length measurement	Transvaginal sonography	Transabdominal sonography	Correlation coefficient (<i>r</i>)
Wk 36 (n=104)			
Range	1.8-6.5	3.0-8.1	0.87
Mean±SD	3.8±0.86	4.7±1.04	
Median (IQR)	3.8 (3.2-4.3)	4.8 (3.9-5.2)	
Wk 37 (n=104)			
Range	1.4-5.7	2.0-6.9	0.88
Mean±SD	3.3±0.81	4.1±0.91	
Median (IQR)	3.2 (2.7-3.8)	3.9 (3.5-4.7)	
Wk 38 (n=103)			
Range	1.2-5.2	2.0-5.9	0.78
Mean±SD	2.8±0.74	3.5±0.80	
Median (IQR)	2.8 (2.2-3.2)	3.5 (3.0-3.8)	
Wk 39 (n=93)			
Range	1.6-4.3	1.6-5.0	0.75
Mean±SD	2.5±0.56	3.1±0.68	
Median (IQR)	2.4 (2.0-2.8)	3.0 (2.8-3.2)	
Wk 40 (n=71)			
Range	1.4-3.5	1.8-4.1	0.80
Mean±SD	2.3±0.49	2.8±0.56	
Median (IQR)	2.2 (2.0-2.5)	2.7 (2.3-3.0)	
Last available measurement (n=104)			
Range	1.2-3.5	1.6-4.1	0.72
Mean±SD	2.2±0.48	2.7±0.56	
Median (IQR)	2.2 (2.0-2.5)	2.8 (2.3-3.0)	
Week three before delivery (n=104)			
Range	1.8-5.2	2.0-5.9	0.72
Mean±SD	3.0±0.66	3.7±0.77	
Median (IQR)	3.0 (2.7-3.3)	3.6 (3.2-4.0)	
Week two before delivery (n=104)			
Range	1.4-4.3	2.0-5.0	0.73
Mean±SD	2.6±0.56	3.2±0.66	
Median (IQR)	2.5 (2.2-2.8)	3.2 (2.9-3.5)	
Week one before delivery (n=104)			
Range	1.2-3.5	1.6-4.1	0.72
Mean±SD	2.2±0.48	2.8±0.56	
Median (IQR)	2.2 (2.0-2.5)	2.8 (2.3-3.0)	
<i>P</i> value for change over the last three weeks (repeated measures ANOVA)	<0.001	<0.001	
All Pearson's correlation coefficient (<i>r</i>) values in the last column are significant at <i>P</i> <0.05. The week-to-week changes were also significant (<i>P</i> <0.001) by Tukey's multiple comparison test. SD, standard deviation; IQR, interquartile range; ANOVA, analysis of variance			

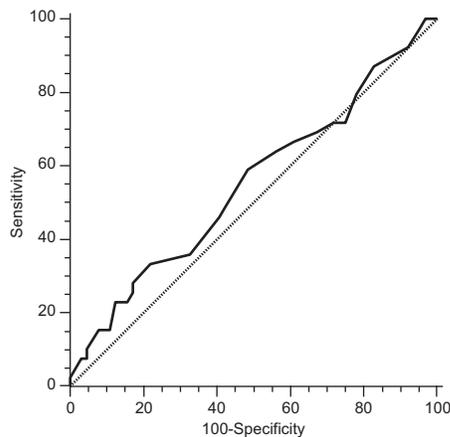


Fig. 3. Receiver operating characteristic (ROC) curve of cervical length measurement by transvaginal sonography at 38 wk to decide cut-off for prediction of post-dated pregnancy. There is no clear elbow but the cut-off identified corresponds to cervical length >3.1 cm.

suggested that if CL measured by TVS at 38 wk was >3.1 cm, then post-dated pregnancy was best predicted. However, the plot did not have a clear elbow (ROC space area 0.551; 95% CI 0.450-0.649), and for the point selected, sensitivity (33.3%; 95% CI 19.1-50.2%) and specificity (78.1%; 95% CI 66.0-87.5%) were not satisfactory. A similar situation was noted for the ROC curve for TAS (Fig. 4). The cut-off value for predicting post-dated pregnancy by TAS at 38 wk was 3.6 cm with sensitivity 43.6 per cent (95% CI 27.8-60.4%) and specificity 71.8 per cent (95% CI 59.2-82.4%) values suboptimal. The ROC space area, in this case, was almost similar at 0.570 (95% CI 0.468-0.667).

Discussion

The study showed large inter-individual variations in CL and also in CL changes before the spontaneous onset of labour at term. For predicting the spontaneous onset of labour, a single CL measurement at any point in pregnancy did not prove useful because of the large and unpredictable variability of CL. Previous studies have reported normal ranges for CL during pregnancy¹²⁻¹⁵.

The correlations between CL measurements by TAS and TVS for every gestational week were significant. The results were similar to the study by Saul *et al*¹⁶, who found that there was no difference between mean transabdominal and transvaginal CLs. The last CL measurement taken for each woman, whether measured by TVS or TAS, correlated only weakly with the time until spontaneous onset of labour. Further, CL was not correlated with gestational age at

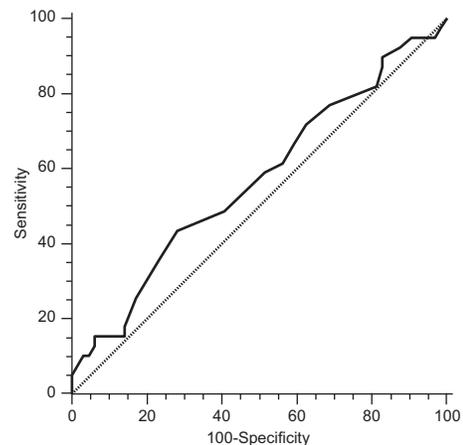


Fig. 4. Receiver operating characteristic (ROC) curve of cervical length measurement by transabdominal sonography at 38 wk to decide cut-off for prediction of post-dated pregnancy. There is no clear elbow but the cut-off identified corresponds to cervical length >3.6 cm.

delivery in the period investigated in this study *i.e.* ≥ 36 wk. There was also no relation between gestational age at delivery and the ultrasound examination-delivery interval.

Meijer-Hoogveen *et al*⁷ have concluded that between 37 and 38 wk gestation, spontaneous onset of labour before 41 wk can be predicted by a CL measurement but with low sensitivity and poor NPV. In addition, the last CL measurement taken for each woman was only weakly correlated with the time until spontaneous onset of labour, and even in the last 48 h before delivery, a quarter of their population still had CL >30 mm. Further, CL was not correlated with gestational age in the period investigated in that study *i.e.* ≥ 36 wk⁷. Zorzoli *et al*¹⁷ found that gestational age at delivery did not correlate with cervical dimensions at any stage of pregnancy. Another study concluded that the Bishop score and ultrasonographic measurement of CL were valuable for predicting the onset of spontaneous labour within seven days only when these assessments were performed close to term⁴. Vimercati *et al*¹⁸ found significantly shorter CL at 39 and 40 wk of gestation in a group who had spontaneous onset of labour before 41 completed wk of gestation, compared to those who did not, but could not find any cut-off value for CL that was predictive. Souka *et al*⁸ found that a significant proportion of pregnancies destined to deliver at term had short cervical measurements.

In this study, majority of women did not show a change ≥ 5 mm per week. Meijer-Hoogveen

*et al*⁷ found that women with spontaneous onset of labour could be divided into three groups: those with unchanged CL before delivery; those with a fall in CL in the last two weeks before delivery and those with a gradual change in CL starting before the last two weeks before delivery. They also demonstrated large inter-individual variations in CL changes before the spontaneous onset of labour at term, and found a decrease in CL preceding labour in only half of their sample, which was either gradual over several weeks or within the last two weeks before delivery, while in the others, CL remained unchanged until shortly before delivery. In our study, a notable decrease in CL preceding labour was observed in only a third of our sample, which was over the last three weeks before delivery. In others, CL remained largely unchanged until shortly before delivery.

It was ascertained that CL >31 mm by TVS at 38 wk gestation could predict post-dated pregnancy to some degree although the diagnostic indices were not optimum. Meijer-Hoogeveen *et al*⁷ found that a single CL measurement <30 mm, between 37 and 38 wk of gestation, predicted spontaneous onset of labour before 41 wk gestation with a sensitivity of 46 per cent, specificity of 78 per cent, PPV of 82 per cent and NPV of 40 per cent in the supine position and sensitivity of 53 per cent, specificity of 72 per cent, PPV of 81 per cent and NPV of 40 per cent in the upright position.

This study had two major limitations. First, it was not continued beyond 40 completed gestational wk, and hence, it was not clear what happened to the cervical changes in post-dated pregnancy. Second, only one cervical parameter, namely the CL was studied, for the prediction of spontaneous onset of labour which might not be sufficiently discriminatory; other parameters such as cervical width, funnelling of the internal os and sludging could have been considered as a composite index for possible prediction of impending labour.

In conclusion, the changes occurring in the cervix over the last few weeks of pregnancy were heterogeneous and did not show any consistent pattern. This large variability limits the utility of CL measurement for prediction of spontaneous onset of labour near term by either a single or repeated assessments. CL >31 mm measured by TVS or >36 mm by TAS at 38 wk gestation can predict post-dated pregnancy to a limited extent. Ultrasound

measurements of CL alone in nulliparous women at term were not practical in the prediction of spontaneous onset of labour. Future studies should address other cervical parameters in addition to the length of cervix.

Conflicts of Interest: None.

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