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Original Research Article

## Cervical sonomorphometric evaluation of normal and preterm labour by transvaginal and transabdominal sonography

Khusboo<sup>1</sup>, Dinesh Kumar<sup>2\*</sup>, Ashish Verma<sup>1</sup>, Suman Chaurasia<sup>3</sup>, Ramvilas Nag<sup>2</sup>

<sup>1</sup>Department of Radiology, Institute of Medical Sciences, BHU, Varanasi, Uttar Pradesh, India

<sup>2</sup>Department of Orthopaedics, Institute of Medical Sciences, BHU, Varanasi, Uttar Pradesh, India

<sup>3</sup>Department of Obstetrics and Gynaecology, ESIC and PGIMS Medical College, Chennai, India

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**\*Correspondence:**

Dr. Dinesh Kumar,

E-mail: oyedinesh@gmail.com

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### ABSTRACT

**Background:** Preterm delivery is major cause of perinatal morbidity and mortality. Measuring cervical length (CL) with ultrasonography has become increasingly acceptable as an early diagnostic procedure in patients at risk for PTL, with transvaginal ultrasonography (TV Us) being considered as the gold standard for the CL assessment.

**Methods:** A cohort of women with singleton pregnancies, and confirmed gestational age by first or early second trimester ultrasonography, last menstrual period & clinical assessment were selected to undergo transvaginal and transabdominal sonographic measurement of cervical length between 16 and 34 week gestation. Cervical length was first measured by transabdominal route (TAS) using a 3.5 MHz curved electronic array transducer with the patient in the supine position and with a full bladder, transvaginal sonography (TVS) was done by a 7.5 MHz probe attached to an ultrasound machine. The probe was covered with a latex condom and gel placed between the transducer and the cover and also on the surface. It was then gently inserted in the vagina to obtain a sagittal view of the cervix. Doppler measurement were taken by both transabdominal and transvaginal route.

**Results:** Gradual decrease in cervical length is seen with advancement of gestation weeks. TA Us cervical length values are noted higher than TV Us however significance is seen only at 24 weeks and cervical width are showing gradual increase with advancement of gestation weeks without significant difference between them. The study compared the mean spectral Doppler parameters RI, PI and S/D Ratio at different weeks & observed that TV Us values are more at each gestation weeks than TA Us showing significant difference 24 weeks onwards.

**Conclusions:** Although discrepancy in statistical significance, short cervical length, funneling and gland area are important to recognize for prediction of premature onset of labour, owing to the potential for perinatal morbidity and mortality and socioeconomic burden. Transvaginal sonography remains the dominant imaging modality for evaluation of the cervix. It is operator dependent modality so care should be taken to evaluate each morphologic character.

**Keywords:** Cervical length, Preterm delivery, Transvaginal ultrasonography, Transabdominal sonographic

### INTRODUCTION

Preterm delivery is defined as delivery between the 20th and 37th week of pregnancy that affects 7% to 11% of all pregnancies. Such deliveries continues to be the primary cause of perinatal mortality and morbidity worldwide.<sup>1,2</sup>

The first step to prevent preterm labour (PTL) is early identification of women at risk for PTL.

Monitoring cervical dimensions during pregnancy helps in the prediction of risk of PTL resulting in early diagnosis and institution of preventive therapy such as

encirclage, tocolysis and prophylactic steroids. Epidemiologic data and digital examination have not been proved to be helpful in identifying risk factors for PTL. Measuring cervical length (CL) with ultrasonography has become increasingly acceptable as an early diagnostic procedure in patients at risk for PTL, with transvaginal ultrasonography (TV Us) being considered as the gold standard for the CL assessment.<sup>3,4</sup> Despite this some investigators continue to propose that transabdominal sonography (TA Us) can be used to screen patients to detect those with a short cervix. This strategy had been used in the past in certain units to reduce the number of TV Us performed. There are few published studies on measurements obtained in Indian women at risk for PTL. Serial measurements are more appropriate for cervical dynamic assessments in pregnancy.

There is controversy around the routine ultrasound assessment of the cervix as a means of defining risk of PTL in low risk women. The aim of this study to assess cervical sonomorphometric changes with progression of gestation age by transabdominal and transvaginal sonography to establish normative reference value of various parameters and their deviation from normal course of evolution.

## METHODS

The present study was carried out in the Department of Radiodiagnosis and Imaging, Sir Sunderlal Hospital, Institute of Medical Sciences, Banaras Hindu University, Varanasi. The patients were referred to us either from the Department of Obstetrics and Gynecology of IMS, BHU. This study protocol was approved by our institutional ethical committee. During the period from July 2014 to May 2015, 91 patients were selected for the present study.

A cohort of women with singleton pregnancies, and confirmed gestational age by first or early second trimester ultrasonography, last menstrual period and clinical assessment were selected to undergo transvaginal and transabdominal sonographic measurement of cervical length between 16 and 34 week gestation.

### *Exclusion criteria*

- History of first trimester bleeding
- Presence of uterine malformations and leiomyoma
- Presence of Pregnancy Induced Hypertension, Gestational diabetes and other medical disorders such as renal disease, essential hypertension which may influence gestational age at delivery
- Multiple pregnancy, low lying placenta and Oligo or polyhydramnios
- Placental abruption, placenta previa, invasive placenta or other placental anomaly.
- Congenital anomaly, chromosomal anomaly and intrauterine growth retardation

Written informed consent was obtained from all patients. All the patients were in second or third trimester of their pregnancy. The mean gestational age was  $26.2 \pm 2.6$  weeks. The subjects were asked to come for repeat examination at 16,20,24,30 and 36 weeks  $\pm 3$  days. The subjects were followed up for outcome of pregnancy in form of term labour (TL) or preterm labour (PTL) with the help of their attending obstetrician and contact numbers.

### *Imaging*

Pelvic sonography was performed on IU-22 (Philips medical systems, Bothel; WA, USA) equipment's using a 3.5 MHz curved electronic array transducer for transabdominal and 7.5 MHz probe for transvaginal route.

Cervical length was first measured by transabdominal route (TAS) using a 3.5 MHz curved electronic array transducer with the patient in the supine position and with a full bladder. If the bladder was not sufficiently full to provide an acoustic window, the examination was delayed until visualization of the cervix was achieved. The cervix was identified in the mid-sagittal plane and cervical length was measured by placing the calipers at each end of the endocervical canal. After that probe angled medially, and again color Doppler imaging was used to identify the uterine artery (UtA) at the apparent crossover with the external iliac artery. Measurements were taken approximately 1 cm distal to the crossover point. In all cases, once it had been ensured that the angle was less than  $30^\circ$ , the pulsed Doppler gate was placed over the whole width of the vessel. Angle correction was then applied and the signal updated until three similar consecutive waveforms had been obtained

Transvaginal sonography (TVS) was done by a 7.5 MHz probe attached to an ultrasound machine. The probe was covered with a latex condom and gel placed between the transducer and the cover and also on the surface. It was then gently inserted in the vagina to obtain a sagittal view of the cervix. The probe was moved laterally until the paracervical vascular plexus was seen. Color Doppler imaging was used to identify the UtA at the level of the cervicocorporeal junction. Measurements were taken at this point before branching of the UtA into the arcuate arteries.

An adequate image for the measurement of cervical length was defined as the visualization of the internal os, external os and endocervical canal. The image was then frozen and cervical length measured, with electronic calipers, as the linear distance between the external os and the internal os along a closed endocervical canal. In instances where the cervical canal was curved, its length was assessed as the sum of the lengths of two contiguous linear segments, placed along the endocervical canal, connecting the external os and the internal os. In case of funneling, measurements are taken from tip of funnel.

The cervical length was measured thrice in each subject and the shortest of the three measurements was recorded. The average time for examining one patient was 5 min. To maintain consistency and to reduce interobserver variation, all the measurements were carried out by a single ultrasonologist.

These measurements were repeated every four weeks till delivery. To reduce the interobserver variability and improve reproducibility of cervical measurements using transvaginal ultrasound the following criteria were adopted:

- The internal os is visualized as a flat dimple or an isosceles triangle
- The whole length of the cervix is visualized
- The external os appears symmetric
- The distance from the surface of the posterior lip to the cervical canal is equal to the distance from the surface of the anterior lip to the cervical canal
- Transducer pressure on the cervix is kept to minimum
- The widest viewing angle of available ultrasound field should be used.

**Image analysis**

USG features evaluated for cervix were:

Cervical length (distance between internal and external os in mid sagittal view).

Cervical width (anteroposterior distance in mid portion perpendicular to axis of cervical length).

Funneling and its type V or U (opening of the internal cervical os and protrusion of the amniotic membranes of ≥ 5 mm into the internal os, as measured along the lateral border of the funnel).

Gland area (hypoechoic zone surrounding the cervical canal, which is assumed to correspond to the histological cervical gland area).

The flow velocity waveforms (FVWs) obtained from right uterine arteries was computed automatically. The program identified individual cardiac cycles and computed peak systolic velocity, end diastolic velocity, mean velocity and the indices resistive index (RI), pulsatility index (PI) and S/D ratio.

**Reference standard**

The clinical standard for a conclusive diagnosis of premature labour onset used were LMP, cervical dilatation, regular uterine contraction after careful exclusion of premature rupture of amniotic membranes, chorioamnionitis, placental abruption and trauma.

**Statistical analysis**

Mean values, sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy

of various cervical and Doppler parameters were calculated. Analyses were carried out using SPSS 16 System.

**RESULTS**

A total 91 pregnant patients presenting with gestation age between 16 to 36 years were examined by TA Us and TV Us (Table 1). Multiple parameters including cervical length, width, funnelling, gland area and spectral Doppler parameters RI, PI, S/D ratio of UtA was examined in each patient by TA Us and TV Us.

**Table 1: Age distribution.**

Age (yrs)	No.	%
11-20	6	6.6
21-30	79	86.8
31-40	6	6.6
Total	91	100

$\chi^2=0.083$ ;  $p=0.959$

**Table 2: Mean cervical length by TA Us and TV Us at different weeks.**

Variables	TA Us Mean±SD	TV Us Mean±SD	t-value	p-value
L_16	4.24±1.20	4.45±1.03	-0.645	0.522
L_20	4.19±0.82	3.98±0.69	1.133	0.262
L_24	4.08±0.85	3.80±0.73	1.995	0.048
L_30	3.90±0.95	3.57±0.69	1.628	0.108
L_36	3.40±0.49	3.01±0.71	1.881	0.069

**Table 3: Mean cervical width by TA Us and TV Us at different weeks.**

Variables	TA Us Mean±SD	TV Us Mean±SD	t-value	p-value
W_16	2.70±0.50	2.69±0.41	0.112	0.911
W_20	2.63±0.41	2.69±0.48	-0.567	0.573
W_24	2.67±0.49	2.74±0.46	-0.882	0.380
W_30	2.84±0.56	2.81±0.39	0.287	0.775
W_36	2.98±0.60	3.13±0.49	-0.821	0.418

The present observed that the comparison between of mean cervical length at different weeks by TA Us and TV Us. Both groups are showing gradual decrease with advancement of gestation weeks. TA Us cervical length values are noted higher than TV Us however significance is seen only at 24 weeks (Table 2) and cervical width are showing gradual increase with advancement of gestation weeks without significant difference between them (Table 3).

The study compared the mean spectral Doppler parameters RI, PI and S/D Ratio at different weeks and

observed that TV Us values are more at each gestation weeks than TA Us showing significant difference 24 weeks onwards (Table 4).

**Table 4: Mean RI, PI and S/D values at different gestation weeks by TA Us and TV Us.**

Variables	TA Us Mean±SD	TV Us Mean±SD	t- value	p- value
RI_16	0.59±0.12	0.63±0.11	-1.246	0.219
RI_20	0.58±0.09	0.61±0.08	-1.418	0.161
RI_24	0.52±0.10	0.59±0.10	-4.225	<0.001
RI_30	0.48±0.10	0.62±0.11	-5.642	<0.001
RI_36	0.48±0.10	0.57±0.11	-2.772	0.009
PI_16	1.07±0.39	1.18±0.37	-0.952	0.346
PI_20	1.01±0.39	1.08±0.27	-0.948	0.347
PI_24	0.82±0.24	1.02±0.33	-3.823	<0.001
PI_30	0.74±0.25	1.08±0.33	-4.767	<0.001
PI_36	0.74±0.23	1.15±0.69	-2.299	0.028
SD_16	2.68±0.86	2.84±0.80	-0.692	0.493
SD_20	2.43±0.46	2.57±0.52	-1.168	0.247
SD_24	2.14±0.51	2.60±0.76	-3.977	<0.001
SD_30	1.99±0.49	2.83±0.91	-4.762	<0.001
SD_36	1.99±0.39	2.41±0.79	-1.961	0.059

## DISCUSSION

The human cervix has been shown to be a dynamic organ throughout the gestation, varying markedly in both size and length. As term approaches, the cervix begins to shorten, in association with effacement and dilatation. This may be favourable occurrence in successful human parturition, but if occurs early leads to preterm morbidity. Outcomes of several studies have indicated that ultrasound has an immense value in antenatal cervical surveillance.

Total 91 patients were examined by both TAS and TVS for evaluation of cervical factors and Doppler evaluation of uterine artery. Mean age of presentation was 26.2±2.6 years.

In present study reduction in mean cervical length is noted with advancement in gestation age in both patients with term and preterm birth by TA Us and TV Us respectively. Mean cervical lengths are seen less in patients with preterm delivery compared to those with term delivery in 24, 30, 36 weeks by TA Us and at all studied weeks by TV Us however significant difference in respect to gestation span is seen only at 20 weeks by TV Ultrasound.

In present study mean cervical length at 24 weeks and 30 weeks are 3.00 ±0.75 and 3.35±0.90 by TV Us. Iams et al<sup>5</sup> found that the length of the cervix at 24 and 28 wk were 35.2±8.3 and 33.7±8.5 mm, respectively. Mukherji et al<sup>6</sup> showed corresponding values of 38.0mm±2.1 and 38.1±2.5mm further supporting values of present study. The longer cervical lengths in the earlier study compared

to present study could be due to the different racial profile, and the exclusion of subjects with higher baseline risk of preterm delivery and with funneling, both of which are included for the present study.

On comparison of TA Us and TV Us, mean cervical length by TVUs are less in each follow up after 20 weeks. This can be explained by study of Dongen L et al, 1984 which showed bladder size also contributes to the variability of measurements obtained transabdominally: while a full bladder allows better visualization of the cervix. It can also affect the identification of the landmarks for measurements, and artificially increase the cervical length due to over distension. However significant difference by TA and TV approach is noted only at 24 weeks due to variation in sample size at different weeks.

In present study, it has been seen that TV Us measurements are affected by the degree of pressure applied with us transducer to the cervix which can slightly change the orientation and measurements. Maternal age, uterine contractions and cervical dynamic changes can also affect the measurement (Bertozi et al).<sup>7</sup> Meijer-Hoogveen et al reported that uterine contractility and bowel peristalsis can modify cervical length by up to 5mm.<sup>8</sup> Iams et al and Berghella et al concluded cervical length is inversely related to the risk of preterm birth in asymptomatic women.<sup>1,9</sup>

In present study increment in cervical widths are noted in both patients who undergone term delivery and those having preterm delivery (except at 30wk) on follow up. However no significant difference is noted between both groups by TA and TV Us. Increment can be explained by increased deposition of proteoglycans and collagen under effect of increase estrogen and progesterone and down regulation of matrix metalloproteinase with advancement of gestation age. Yun Sun Jo et al concluded cervical width was significantly larger in the 2nd trimester than in the 1st.<sup>10</sup> There is no difference according to parity and previous delivery mode in the 1st trimester however; the cervical width is larger in the multipara than the nullipara group in the 2nd trimester. The cervical width is larger in women who underwent labour than in the nullipara and the elective caesarean section groups due to the mechanical change of cervical stretching during labour. In present study no significant difference in mean cervical width value in between patients with term and preterm birth by TAUs and TVUs respectively and between TAUs and TVUs are noted.

Cervical funnelling is defined as protrusion of the amniotic membranes of >5 mm into the internal os, as measured along the lateral border of the funnel. In particular U-shaped funnel assessment required both the funnel depth and width to be measured, whereas V-shaped funnels required only measurement of depth.

In our study out of 91 patients, total 6 (6.6percent) presented with V shape funnelling in which 2 were associated with cervical length  $\leq 3$  cm (33% association) and 2 were delivered at preterm gestation with insignificant association with preterm labour (p value-0.4).

When compare to TA Us and TV Us for detection of funnelling, 4 out of 6 preterm were detected with funnelling by TA Us (76% detection rate). It has been shown that the presence of a funnel is a significant risk factor for adverse perinatal outcome and that it is best measured as a categorical variable (present or absent). Other investigators have suggested that the finding of a funnel at the internal os is a poor independent predictor of PTB once the effect of short cervix is considered (Berghella et al).<sup>11</sup> The shape of the funnel (U or V), percent funnelling, and the depth and width of the funnel have all been described as methods of assessing cervical funnelling. In high-risk women, the progression to a U-shaped funnel has been associated with an increased risk of preterm delivery (Owen et al).<sup>12</sup> Thus the relationship between cervical funnelling and PTB remains unclear. U-shaped funnels may have a different pathophysiologic mechanism than V-shaped funnels as they appear to be associated with significantly earlier birth when compared to no funnel or V-shaped funnels. The development of a U-funnel may be in the evolution pathway of acute cervical insufficiency, which might explain the disproportionate benefit from cerclage intervention when compared to women with no funnel or a V-funnel.

### **Doppler evaluation**

The flow velocity waveforms (FVWs) obtained from right uterine arteries was computed automatically. The program identified individual cardiac cycles and computed peak systolic velocity, end diastolic velocity, mean velocity and the indices RI, PI and S/D

The main branch of each uterine artery enters the uterus just above the cervix and ascends along the lateral part of its wall which further gives arcuate and radial arteries. In the non-pregnant -state, the uterine artery is a high resistance vessel. In normal pregnancy, trophoblasts invade the spiral arteries, stripping their musculoelastic coat and converting them into low resistance vessels. UtA Doppler examination provides important information on the conversion process of spiral arteries into uteroplacental arteries.

The PI and resistance index, alone or in combination with the presence of an early diastolic notch, have been the most commonly used indices. The PI describes the shape of the velocity waveform much better, as it includes the area below the curve in the formula. Likewise and for this reason, the PI index indirectly informs about the presence or absence of a protodiastolic notch.

In present study gradual reduction in values of RI and PI are noted from 16 to 36 weeks, for both term and preterm gestation span by TA Us and TV Us. This can be explained by the theory trophoblastic invasion proceeds during the late second and third trimesters. Second, important maternal hemodynamic changes, such an increased cardiac output and reduced blood viscosity and peripheral resistance, also take place with advancement of gestation. Finally, there is a rise in the diameter of the UtA throughout gestation due to the increasing levels of estrogens, which have a vasodilatory effect.

Rise in mean RI and PI values are noted in preterm with preterm birth at 36 weeks. Mean values are slightly more in patients with preterm birth. This may be due to deviation from normal physiologic changes. However no significant association is seen between Doppler indices and preterm birth. Significant reduction in PI values are noted in patients with term gestation and total no. of patients at 20and 24 weeks by TV Us and at 20 weeks by TA Us compared to baseline value at 16 weeks. However In patients with preterm birth no significant reduction is seen when compared to baseline value at 16 weeks.

Gomez et al<sup>13</sup> confirmed previous reports of Altman et al suggesting that mean UtA-PI shows a significant and progressive decline with gestation. They also showed that, together with the progressive fall in the mean UtA-PI with increasing GA. This study further demonstrates that late stages of pregnancy are characterized by very low impedance indices in the UtA Doppler examination. Aside from the factors discussed above, this may have been influenced by the fact that women with the highest PI values are more likely to deliver early. Findings of present study correlate strongly with these studies.

### **CONCLUSION**

Although discrepancy in statistical significance, short cervical length, funneling and gland area are important to recognize for prediction of premature onset of labour, owing to the potential for perinatal morbidity and mortality and socioeconomic burden. Transvaginal sonography remains the dominant imaging modality for evaluation of the cervix. It is operator dependent modality so care should be taken to evaluate each morphologic character. Repeat examination should be done in women with high risks. Transabdominal approach should not be used for cervical assessment. For uterine artery evaluation transabdominal approach should be used in 2nd and 3rd trimester.

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