

## Validity of Sonographic Cervical Length Measurement and Cervical Funneling in Prediction of Spontaneous Onset of Labor at Term Pregnancy

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**Abstract: Objective:** The aim of the current study was to assess the accuracy of sonographic cervical length measurement and cervical funneling in prediction of spontaneous onset of labor in term primigravid women. **Methods:** The study included primigravid women pregnant at 37 weeks' gestation of a singleton pregnancy. All recruited eligible women were subjected to a transvaginal sonographic cervical assessment (for length and funneling) at 37 weeks' gestation. All recruited women had the transvaginal scan repeated weekly till completed 41 weeks' gestation. The endpoint was spontaneous onset of labor within 7 days of sonographic cervical assessment at different gestations. **Results:** A total of 208 primigravid women were recruited in the current study; of them 150 women completed the study and were included in the final analysis. The mean age of included women was  $24.3 \pm 3.6$  years (range: 20 – 32 years). Sonographic cervical length was a significant predictor of spontaneous labor within 7 days at all these gestations. There was a significant agreement between cervical funneling and spontaneous onset of labor within 7 days of recording funneling at different gestations. **Conclusion:** Sonographic cervical length measurement and cervical funneling seem to be significant predictors of spontaneous onset of labor at term pregnancy in nulliparous women.

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**Key Words:** sonographic cervical length – cervical funneling – prediction of labor.

### 1. Introduction

There is no single parameter that can reliably predict the time of onset of labor at term pregnancy. Estimating the time of high likelihood of onset of labor at term may be of some value in certain circumstances. Social preparation of the woman for delivery as well as availability of an attending obstetrician may be of concern in some distant areas<sup>[1]</sup>. There has been growing and good evidence regarding the association between sonographic cervical status (including cervical length measurement and cervical funneling) and preterm labor in a relatively large number of published studies<sup>[2-3]</sup>. Moreover, sonographic cervical length measurement was shown to be of a reliable accuracy in prediction of successful induction of labor<sup>[4-6]</sup> and successful trial of vaginal birth after Cesarean section (VBAC)<sup>[7]</sup>, when compared to the conventional or modified Bishop scores. A few relatively recent studies have shown a valid accuracy for sonographic cervical assessment in prediction of spontaneous onset of labor at term pregnancies<sup>[8-10]</sup>. The aim of the current study was to assess the validity of sonographic cervical length measurement and cervical funneling in prediction of spontaneous onset of labor at term pregnancy in a sample of Egyptian nulliparous women.

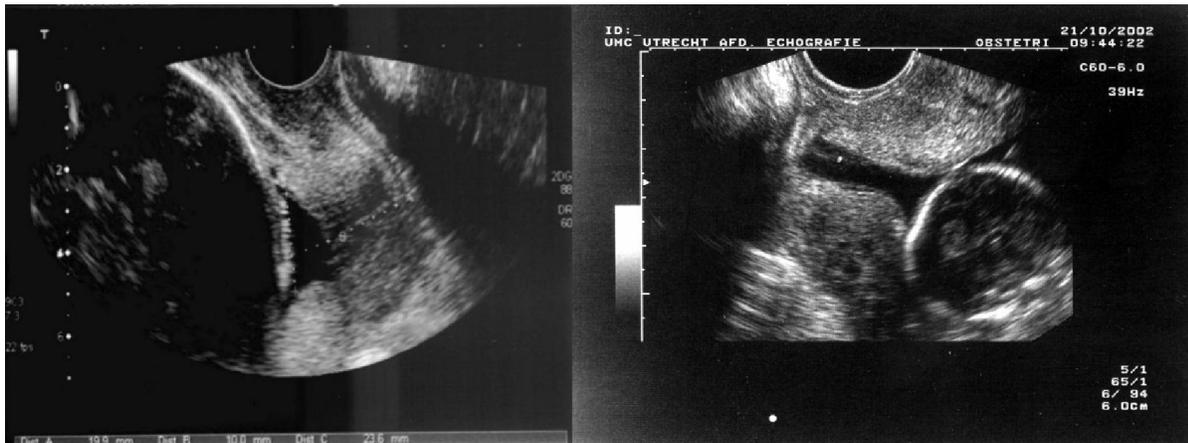
### 2. Methods

The current prospective study for accuracy of a diagnostic test was conducted at Ain Shams University Maternity Hospital during the period between August 2009 and March 2010. The study included primigravid women pregnant at 37 weeks' gestation of a singleton pregnancy, attending at the outpatient antenatal clinic of Ain Shams University Maternity Hospital. Women who had true labor pains, ruptured fetal membranes, non-vertex fetal presentation, previously-scarred uterus, fetal malformation or any maternal or fetal condition necessitating planned or Cesarean delivery were all not recruited in the study.

All recruited eligible women were subjected to a transvaginal sonographic cervical assessment at 37 weeks' gestation. Transvaginal sonography was performed using the 5-MHz transvaginal probe of SonoAce X4 Ultrasound Machine (Samsung Medison Co., Ltd<sup>®</sup>, Seoul, Korea). The sonographic examination was performed after emptying woman's bladder. The woman was asked to lie down in the lithotomy position. The probe is inserted into the vagina; the tip being 3 cm away from the cervical os to avoid distorting the shape or position of the cervical canal. Cervical length measurements were taken with the cervical canal being scanned in the midline sagittal plane. The length was measured as the distance between the internal os and the external os, with the whole length of the echogenic cervical canal mucosa being visualized, and the probe being pulled back to provide the best image with the lightest touch of the

probe. The internal os was identified as a dimple or a small triangle against the hypoechoic background of the amniotic fluid. Cervical length was measured three times; the average value of them was recorded. Cervical funneling was defined as a V-shaped or a U-shaped indentation of the internal os (Figure-1). *In the presence of cervical funneling, the length of an associated funnel wasn't included as part of the cervical canal length and the endocervical canal length measurement was taken from the apex of the funnel to the plane of the external os. Transvaginal sonographic scans were performed by one of three sonographers with at least 3-years expertise in obstetric cervical assessment. All recruited women had the transvaginal scan (for both*

cervical length measurement and assessment for funneling) repeated weekly till completed 41 weeks' gestation. The time of spontaneous onset of labor was noted. Women who developed any indication for planned or timely delivery (e.g. pregnancy-induced hypertension or pre-labor rupture of the membranes) were excluded from the final analysis. Women who pass beyond completed 41 weeks' gestation were all referred for induction of labor according to the protocol of Ain Shams University Maternity Hospital. The endpoint of the study was spontaneous onset of labor within 7 days of sonographic cervical assessment at different gestations.



**Figure-1 Cervical Funneling.** Transvaginal scan showing cervical funneling V-shaped (left) – U-shaped (right)

T-shaped cervical canal represents absence of funneling; Y-shaped represents first stage of funneling; and the V-shaped or U-shaped cervical canal represents a funneling completely extending over the cervical canal [12].

### Sample Size Justification

Data from a previous relevant study [8] showed that the rate of spontaneous onset of labor within 7 days from the first cervical assessment was 8.6%. The sensitivity of cervical funneling in prediction of spontaneous onset of labor within 7 days was 82%. The rate of planned or Cesarean delivery in such women was estimated to be 25%. The drop-out rate was assumed to be 10%. Calculation according to these values to reach the least statistically-acceptable figure produced a minimal sample size of 208 women.

### Statistical Methods

Statistical analysis was performed using Microsoft® Excel® version 2007 and Statistical Package for Social Sciences (SPSS®) for Windows® version 15.0. Data were presented as range, mean and standard deviation (for numeric variables) and

number (percentage) for categorical variables. Receiver operator characteristics (ROC) curves were constructed for estimating the association between cervical length measurement and spontaneous onset of labor before 7 days. Accuracy of both cervical length and cervical funneling in prediction of labor was presented in terms of sensitivity, specificity, positive and negative predictive values as well as likelihood ratios. Kappa ( $\kappa$ ) coefficient of agreement was used to estimate agreement between cervical funneling and spontaneous onset of labor. Significance level was set at 0.05.

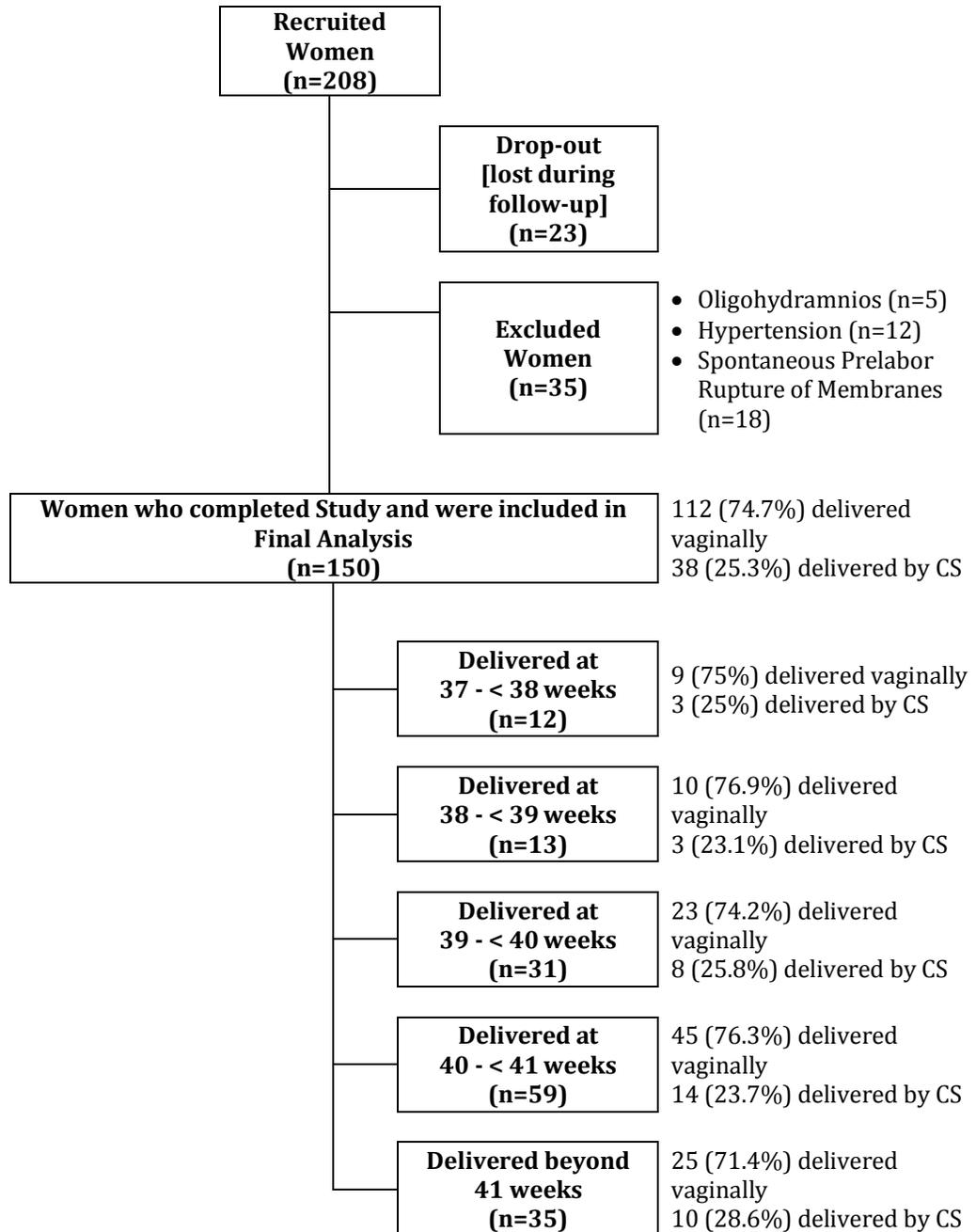
### 3. Results

A total of 208 primigravid women were recruited in the current study; of them 150 women completed the study and were included in the final analysis. Figure-2 shows a flow-diagram of the study course.

The mean age of included women was  $24.3 \pm 3.6$  years (range: 20 – 32 years). The mean weight was  $67.3 \pm 5.42$  Kg (range: 58 – 82 Kg). The mean body mass index (BMI) was  $23.2 \pm 2.61$  Kg/m<sup>2</sup> (range: 21.8 – 35.5 Kg/m<sup>2</sup>). The mean gestational age

at delivery was  $38.6 \pm 4.2$  weeks (range: 37 – 41 weeks). Of the included 150 women, 12 (8%) women delivered by completed 38 weeks, 25 (16.7%) delivered by 39 weeks, 56 (37.3%) delivered by 40

weeks, 115 (76.7%) delivered by 41 weeks, while 35 (23.3%) delivered beyond 41 weeks' gestation (Figure-3).



**Figure-2 Flow-Diagram of the Study Course**

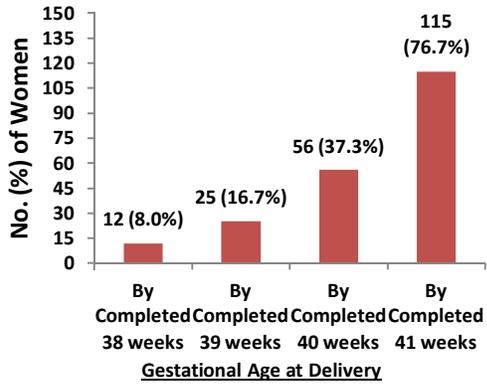


Figure-3 Bar-Chart showing Gestational Age at Delivery in Included Women

Receiver operator characteristics (ROC) curves were constructed for estimating the association between sonographic cervical length and delivery within 7 days at 37, 38, 39 and 40 weeks' gestations. Sonographic cervical length was significant predictor of spontaneous labor within 7 days at all these gestations, as denoted by the significantly large area under the curves (AUCs) (Figure-4). Table-1 shows the best cutoff values of sonographic cervical lengths measured at different gestations with their measures of accuracy.

There was a significant agreement between cervical funneling and spontaneous onset of labor within 7 days of recording funneling at different gestations (Table-2). Table-3 shows the accuracy of cervical funneling in prediction of labor at different gestations.

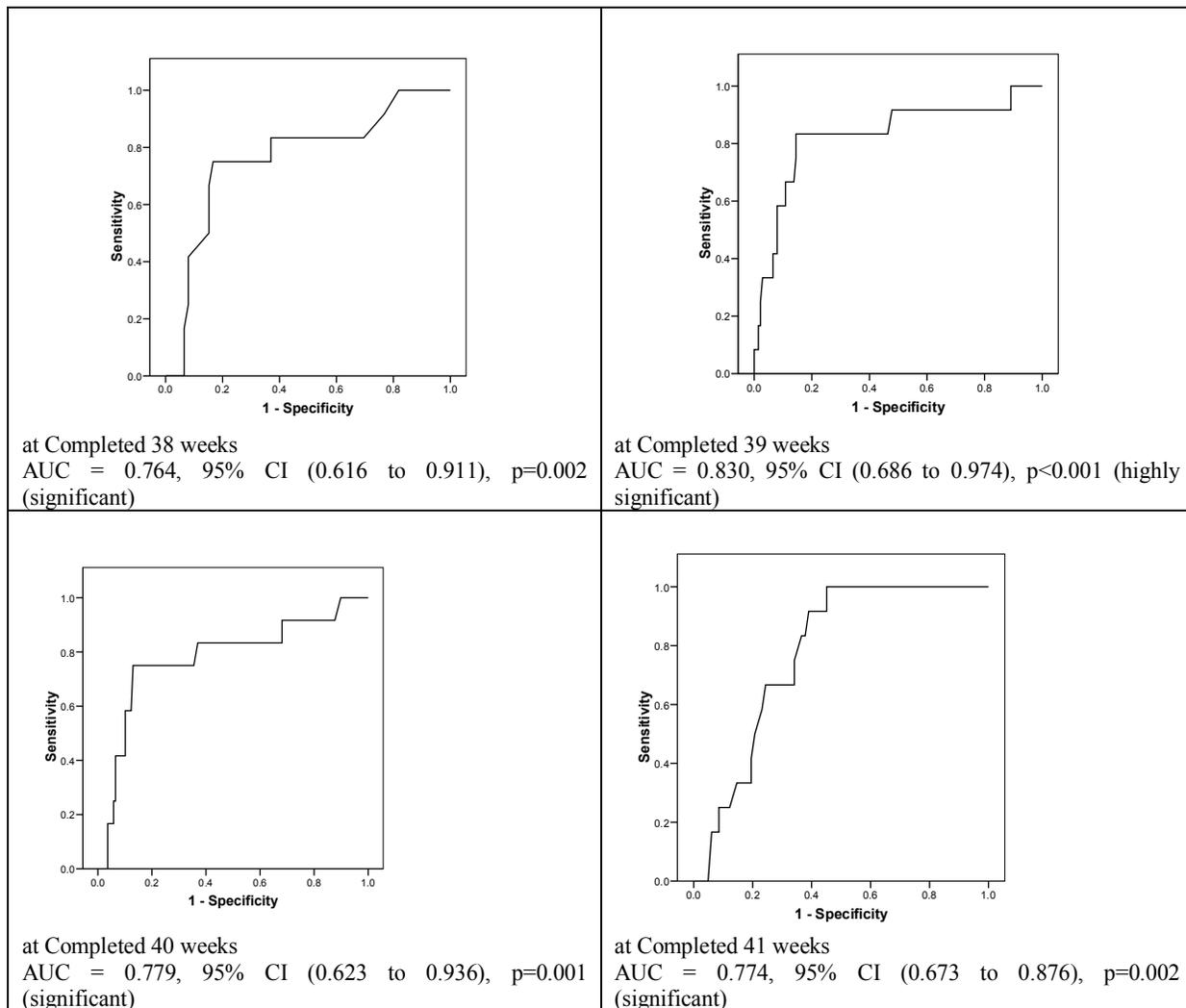


Figure-4 ROC Curves for Sonographic Cervical Length as Predictor of Spontaneous Labor within 7 Days AUC (95% CI) area under the curve and its 95% confidence interval

Table-1 Accuracy of Sonographic Cervical Length as Predictor of Spontaneous Labor within 7 Days

Prediction of Labor within 7 days	Cervical Length	Sensitivity	Specificity	PPV	NPV	LR+	LR-
At 38 weeks	≤ 29.3 mm	75%	83.3%	28.1%	97.5%	4.5	0.3
At 39 weeks	≤ 27.8 mm	83.3%	84.1%	31.3%	98.3%	5.2	0.2
At 40 weeks	≤ 25.3 mm	83.3%	80.4%	52.3%	98.2%	4.3	0.2
At 41 weeks	≤ 24.2 mm	64.4%	65.7%	66%	52.3%	1.9	0.5

PPV positive predictive value – NPV negative predictive value

LR+ positive likelihood ratio – LR- negative likelihood ratio

Table-3 Agreement between Sonographic Cervical Funneling and Spontaneous Labor within 7 Days

Cervical Funneling in Prediction of Labor within 7 days	$\kappa$	<i>P</i>
At 38 weeks	0.792	<0.001 HS
At 39 weeks	0.728	<0.001 HS
At 40 weeks	0.684	0.001 S
At 41 weeks	0.613	0.021 S

$\kappa$  kappa coefficient of agreement

HS highly significant – S significant

Table-2 Accuracy of Sonographic Cervical Funneling as Predictor of Spontaneous Labor within 7 Days

Cervical Funneling in Prediction of Labor within 7 days	Sensitivity	Specificity	PPV	NPV	LR+	LR-
At 38 weeks	83.3%	92%	47.6%	98.4%	10.5	0.2
At 39 weeks	80%	93.6%	71.4%	95.9%	12.5	0.2
At 40 weeks	58.9%	94.7%	86.8%	79.5%	11.1	0.4
At 41 weeks	43.5%	88.6%	92.6%	32.3%	3.8	0.6

PPV positive predictive value – NPV negative predictive value

LR+ positive likelihood ratio – LR- negative likelihood ratio

#### 4. Discussion

The current study showed a significant association between each of sonographic cervical length measurement and cervical funneling, and spontaneous onset of labor within 7 days at different gestations (38 – 41 weeks' gestation). The relatively low PPVs for some variables in the current study were explained by the innate weakness of the PPV (being unreliably low when the prevalence of the event is not high). The sensitivity of sonographic cervical length peaked at 39 and 40 weeks' gestation, whereas the specificity peaked at 38 and 39 weeks' gestation. The sensitivity of cervical funneling was rather high at 38 and 39 weeks' gestation but dropped to relatively low levels at 40 and 41 weeks' gestation. The specificity of cervical funneling was rather high at all gestations, however.

A similar conclusion was reached by Bayramoglu *et al.*, who conducted a similar study on 93 Turkish pregnant women with similar characteristics (being nulliparous, at term, and of the same age group). They even proposed very close figures for the sonographic cervical length cutoff values [29.5 mm, 27.5 mm, 25.5 mm and 24.5 mm

for 38, 39, 40 and 41 weeks' gestations, respectively]. The predictive validity measures in this study were also comparable to those of the current study<sup>[8]</sup>. Rozenberg *et al.* compared the accuracy of Bishop score, sonographic cervical length and cervicovaginal fetal fibronectin in prediction of spontaneous onset of labor at term in 128 French women with singleton pregnancies at 39-40 weeks' gestation. They concluded that both Bishop score and sonographic cervical length were significant predictors of spontaneous labor within 7 days; cervicovaginal fetal fibronectin was not, however<sup>[9]</sup>. These findings were in agreement with the results of the relatively large study conducted by Ramanathan *et al.* on 1571 British women, who found a significant association between shorter cervical length measured by transvaginal scan at 37 weeks' gestation and delivery prior to 40 weeks' gestation. A sonographic cervical length ≤ 20 mm at 37 weeks with associated with a nullified likelihood of delivery beyond 40 weeks' gestation<sup>[10]</sup>. In a fourth study conducted on 149 Korean nulliparous women, long cervical length measured by transvaginal ultrasound scan at 37 weeks' gestation (but not at 20-24 weeks'

gestation) was significantly associated with higher risk of prolonged pregnancy [AUC = 0.702, 95% CI (0.582 to 0.712),  $p=0.002$ ]. A sonographic cervical length  $\geq 30$  mm, in this study, was associated with prolonged pregnancy with a sensitivity of 78% and a specificity of 62%. They found a significant positive correlation between sonographic cervical length and gestational age at delivery [ $r=0.387$ ,  $p<0.001$ ] <sup>[1]</sup>. A quite different conclusion was reached in the study conducted by Vimercati *et al.* on 120 Italian nulliparous women. They found a significant association between cervical length and the risk of prolonged pregnancy, but at 39 weeks' gestation and onwards. Sonographic cervical lengths measured at 37-38 weeks' gestation were not significant predictors in this study, however <sup>[11]</sup>. Meijer-Hoogveen *et al.* conducted a study on 162 Belgian nulliparous women for assessing the accuracy of sonographic cervical length (measured both in supine and upright positions) in prediction of labor at term. They found a significant association between cervical length at 37-38 weeks' gestation and delivery prior to 40 weeks' gestation, but with low sensitivity and NPV (supine position: 46% and 40%, respectively; upright position: 53% and 40%, respectively). Two added observations were reported in this study. One is the comparison between cervical length measured in the supine and upright positions. The study showed a significant and strong positive correlation between the two measurements [ $r=0.9$ ,  $p<0.001$ ]; yet there was a significant difference between them; with the supine measurements being longer than upright ones [mean difference = 1.9 mm, 95% CI (0.8 to 3.2)]. The second observation was the inter-observer variation in sonographic cervical length measurements, which was found to be quite large <sup>[12]</sup>. This large inter-observer variation may explain the variation in accuracy variables in different published studies. Several published studies have shown a significant association between cervical funneling and preterm labor <sup>[13-15]</sup>. Few studies regarding its accuracy in prediction of spontaneous labor at term were published, however. Bayramoglu *et al.* found a significant agreement between cervical funneling and spontaneous onset of labor within a 7-day period at 37-40 weeks' gestations <sup>[8]</sup>. Likewise, Arabin *et al.* found a significant association between cervical funneling and early spontaneous onset of labor <sup>[16]</sup>. Briger *et al.* published conflicting results regarding predictive value of cervical funneling in spontaneous onset of labor. They conducted a prospective study on 55 Chinese nulliparous women and found no significant association between cervical funneling at 36-37 weeks and early onset of labor <sup>[17]</sup>.

Clinical implications of the results of the current and relevant studies may be categorized into

three aspects. Firstly, identifying women with long sonographic cervical length may predict a high likelihood of prolonged pregnancy. Simple measures like sweeping of the membranes or even outpatient cervical ripening with prostaglandins may help decrease this likelihood in such women. Secondly, identifying women planned for elective CS who are unlikely to get into spontaneous onset of labor may help shifting the timing of elective CS to 38-39 weeks' gestation without concerns regarding the risk of unplanned or emergency CS. Thirdly, accurate prediction of onset of labor may help women arrange their social preparations for delivery, particularly those related to accessibility to specialized maternity centers. This latter benefit may be of major concern for women residing at distant rural areas in particular.

In conclusion, sonographic cervical assessment (for length and funneling) seems to be a significant predictor of spontaneous onset of labor at term pregnancy in nulliparous women.

#### References

1. Suh YH, Park KH, Hong JS, Noh JH. Prediction of prolonged pregnancy in nulliparous women by transvaginal ultrasonographic measurement of Cervical length at 20-24 weeks and 37 weeks. *J Korean Med Sci* 2007; 22: 89-93.
2. Kayem G, Maillard F, Popowski T, Haddad B, Sentilhes L. Uterine cervical length measurement by endovaginal ultrasonography: Technique and main utilizations. *J Gynecol Obstet Biol Reprod (Paris)*. 2010; 39 (4): 267-275.
3. Sotiriadis A, Papatheodorou S, Kavvadias A, Makrydimas G. Transvaginal cervical length measurement for prediction of preterm birth in women with threatened preterm labor: a meta-analysis. *Ultrasound Obstet Gynecol* 2010; 35 (1): 54-64.
4. Keeganasseril A, Suri V, Bagga R, Aggarwal N. Pre-induction sonographic assessment of the cervix in the prediction of successful induction of labour in nulliparous women. *Aust N Z J Obstet Gynaecol* 2007; 47 (5): 389-393.
5. Park KH. Transvaginal ultrasonographic cervical measurement in predicting failed labor induction and cesarean delivery for failure to progress in nulliparous women. *J Korean Med Sci* 2007; 22 (4): 722-727.
6. Hatfield AS, Sanchez-Ramos L, Kaunitz AM. Sonographic cervical assessment to predict the success of labor induction: a systematic review with metaanalysis. *Am J Obstet Gynecol*. 2007; 197 (2): 186-192.
7. Jo YS, Lee GS, Kim N, Jang DG, Kim SJ, Lee Y. Clinical Efficacy of Cervical Length and

- Volume for Prediction of Labor Onset in VBAC Candidates. *Int J Med Sci.* 2012; 9 (9): 738-742.
8. Bayramoglu O, Arslan M, Yazici FG, Erdem A, Erdem M, Bayramoglu K, Camdeviren H. Prediction of spontaneous onset of labor at term: the role of cervical length measurement and funneling of internal cervical is detected by transvaginal ultrasonography. *Am J Perinatol* 2005; 22(1): 35-39.
  9. Rozenberg P, Goffinet F, Hessabi M. Comparison of the Bishop score, ultrasonographically measured cervical length, and fetal fibronectin assay in predicting time until delivery and type of delivery at term. *Am J Obstet Gynecol.* 2000; 182 (1 Pt 1):108-113.
  10. **Ramanathan G, Yu C, Osei E, Nicolaides KH.** Ultrasound examination at 37 weeks' gestation in the prediction of pregnancy outcome: the value of cervical assessment. *Ultrasound Obstet Gynecol* 2003; 22 (6): 598-603.
  11. **Vimercati A, Greco P, Lopalco P, Loizzi V, Scioscia M, Mei L, Rossi AC, Selvaggi L.** The value of ultrasonographic examination of the uterine cervix in predicting post-term pregnancy. *J Perinat Med.* 2001;29(4):317-21.
  12. Meijer-Hoogeveen M, Van Holsbeke C, Van der Tweel I, Stoutenbeek P, Visser GHA. Sonographic longitudinal cervical length measurements in nulliparous women at term: prediction of spontaneous onset of labor. *Ultrasound Obstet Gynecol* 2008; 32: 652–656.
  13. Mancuso MS, Szychowski JM, Owen J, Hankins G, Iams JD, Sheffield JS, Perez-Delboy A, Berghella V, Wing DA, Guzman ER; Vaginal Ultrasound Trial Consortium. Cervical funneling: effect on gestational length and ultrasound-indicated cerclage in high-risk women. *Am J Obstet Gynecol* 2010; 203 (3): 259.e1-5.
  14. Tsikouras P, Galazios G, Zalvanos A, Bouzaki A, Athanasiadis A. Transvaginal sonographic assessment of the cervix and preterm labor. *Clin Exp Obstet Gynecol* 2007; 34 (3): 159-162.
  15. Berghella V, Owen J, MacPherson C, Yost N, Swain M, Dildy GA 3rd, Miodovnik M, Langer O, Sibai B; National Institute of Child Health and Human Development (NICHD) Maternal-Fetal Medicine Units Network (MFMU). Natural history of cervical funneling in women at high risk for spontaneous preterm birth. *Obstet Gynecol* 2007; 109 (4): 863-869.
  16. Arabin B, Roos C, Kollen B, Van Eyck J. Comparison of transvaginal sonography in recumbent and standing maternal positions to predict spontaneous preterm birth in singleton and twin pregnancies. *Ultrasound Obstet Gynecol* 2006; 27: 377–386.
  17. **Brieger GM, Ning XH, Dawkins RR, Ying KQ, Weng C, Chang AM, Haines CJ.** Transvaginal sonographic assessment of cervical dynamics during the third trimester of normal pregnancy. *Acta Obstet Gynecol Scand* 1997; 76 (2): 118-122.

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