American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Assessment of Gravid Cervix**

Variant 1: **Patient not at risk for preterm delivery: 16-24 weeks gestation; cervix <3 cm long or suggestion of funneling by transabdominal ultrasound examination.**

Radiologic Procedure	Rating	Comments	RRL*
US pregnant uterus transvaginal or transperineal (report minimum closed cervical length in mm or cm)	9	Assess for cervical change several times over a 10-minute period. Vs at beginning.	O
US pregnant uterus transvaginal or transperineal (report endocervical diameter and open length in mm or cm)	7	May add description of a U-shaped or V-shaped funnel if present.	O
US pregnant uterus transvaginal or transperineal (cervical stress test)	6	Performed only in settings with provisions for labor and delivery. Report shortest closed length.	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 2: **Patient at risk for preterm delivery (history of prior preterm birth or multiple gestations): 16-24 weeks gestation: cervix ≤3 cm long by transabdominal or transvaginal ultrasound examination.**

Radiologic Procedure	Rating	Comments	RRL*
US pregnant uterus transvaginal or transperineal (report minimum closed cervical length in mm or cm)	9	Assess for cervical change several times over a 10-minute period.	O
US pregnant uterus transvaginal or transperineal (report endocervical diameter and open length in mm or cm)	7	May add description of a U-shaped or V-shaped funnel if present.	O
US pregnant uterus transvaginal or transperineal (cervical stress test)	7	Performed only in settings with provisions for labor and delivery. Report shortest closed length.	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

ASSESSMENT OF GRAVID CERVIX

Expert Panel on Women's Imaging: Phyllis Glanc, MD[1]; Rochelle F. Andreotti, MD[2]; Susanna I. Lee MD, PhD[3]; Sandra O. DeJesus Allison, MD[4]; Genevieve L. Bennett, MD[5]; Douglas L. Brown, MD[6]; Theodore Dubinsky, MD[7]; Marcia C. Javitt, MD[8]; Donald G. Mitchell, MD[9]; Ann E. Podrasky, MD[10]; Thomas D. Shipp, MD[11]; Cary Lynn Siegel, MD[12]; Jade J. Wong-You-Cheong, MD[13]; Carolyn M. Zelop, MD.[14]

Summary of Literature Review

Introduction

The term *cervical incompetence* was first introduced in 1948 by Palmer and Lacomme [1]. This condition, which is characterized by painless midtrimester cervical dilatation, has a reported incidence of 1% and has been associated with as many as 20% of second-trimester miscarriages [2].

As a result of recent investigations that recognize features shared by women with cervical incompetence and those with premature labor, the concept of cervical incompetence as an "all or none" phenomenon has been challenged [3]. Cervical incompetence is believed to represent a continuum that relates to cervical length and pregnancy history [4,5].

Regardless of the precise definition of this condition, there is no debate that preterm birth (<37 weeks of gestation) continues as the leading cause of perinatal morbidity and mortality. Consequently, it remains a major obstetrical challenge. Although ultrasound (US) screening of cervical length can predict increased risk of preterm birth [4] there is no evidence that this information can be used to improve outcomes; thus there is no indication for routine screening by US. The single most reliable parameter for cervical assessment is a short cervix length. This observation should prompt consultation and consideration of other management options such as cerclage or activity restriction. This significant association between cervical length and preterm birth risk may not apply to women who have undergone cervical surgery that results in a shortened cervix prior to the onset of pregnancy.

Digital Examination

Initial assessment is usually clinical and is based on digital palpation of the cervix. This examination can detect changes in cervical texture such as softening (which occurs as a precursor to delivery), and distensibility of the external os. Because these findings occur relatively late in the process of cervical dilation, in some cases the changes are irreversible. Furthermore, some physicians question the accuracy of digital measurements, which consistently underestimate measurements made by transperineal US (TPUS) or transvaginal US (TVUS) [6-11]. Most likely, this inaccuracy is due to the anatomic configuration of the cervix because the portion of cervix that lies above the anterior fornix or above the bladder base is hidden from the examiner's fingers. The digital examination has other limitations: 1) it is a subjective assessment; 2) the internal cervical os, which reflects initial changes associated with premature cervical dilatation, is beyond the examiner's reach; and 3) there are potential side effects that include risk of infection and ruptured membranes [7]. The use of **routine** digital vaginal examination during pregnancy to reduce the prevalence of preterm birth is not supported by evidence from randomized controlled trials [12].

Nonetheless, if a patient is clinically at risk for preterm delivery, or if the US examination detects a short cervical length, some obstetricians and gynecologists may perform a digital cervical examination. Once the patient is near term (>37 weeks), and early delivery is no longer an issue, this examination can be omitted, unless clinically indicated for other reasons. To optimize the results and patient management, it is important to correlate the findings of the US examination with the digital examination.

[1]Principal Author, Sunnybrook Health Sciences Centre, Bayview Campus, Toronto, Ontario, Canada. [2]Panel Chair, Vanderbilt University Medical Center, Nashville, Tennessee. [3]Panel Vice-chair, Massachusetts General Hospital, Boston, Massachusetts. [4]Georgetown University Hospital, Washington, District of Columbia. [5]New York University Medical Center, New York, New York. [6]Mayo Clinic, Rochester, Minnesota. [7]University of Washington School of Medicine, Seattle, Washington. [8]Walter Reed Army Medical Center, Washington, District of Columbia. [9]Thomas Jefferson University Hospital, Philadelphia, Pennsylvania. [10]Baptist Hospital of Miami/South Miami Center for Women and Infants, Miami, Florida. [11]Diagnostic Ultrasound Associates, Boston, Massachusetts, American College of Obstetrics and Gynecology. [12]Mallinckrodt Institute of Radiology, St. Louis, Missouri. [13]University of Maryland School of Medicine, Baltimore, Maryland. [14]Beth Israel Deaconess Medical Center, Harvard University School of Medicine, Boston, Massachusetts, American College of Obstetrics and Gynecology.

Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

Fetal Fibronectin

Fetal fibronectin is a test that can measure fibronectins level in secretions from the vagina and/or cervix. A review of five controlled studies that randomized 474 pregnant women did not find enough evidence to support or refute the use of the fetal fibronectin test for the management of women with symptoms of preterm labor [13]. This review did find an association between knowledge of fetal fibronectin levels and a lower incidence of preterm birth, suggesting that further research may be helpful.

Sonographic Examination

Unlike digital examination, sonographic measurement of cervical length generates an image that may be reviewed and standardized, thus overcoming subjectivity. It has limited ability to assess cervical softness or distensibility. Currently, there is insufficient evidence to recommend routine screening of asymptomatic or symptomatic pregnant women with TVUS cervical length. However, there is a nonsignificant association of the knowledge of the TVUS cervical length with a lower incidence of preterm birth in symptomatic women, suggesting that further research should be performed [14].

Normal-appearing cervix: Cervical length is normally distributed and should remain relatively constant until the third trimester when a decrease may be observed [15-17]. Most authorities consider 3.0 cm in length as the lower limit of normal. In one large prospective, multicenter study, 4.0 cm was reported as the 75th percentile, 3.5 cm as the 50th percentile, 3.0 cm as the 25th percentile, and 2.6 cm as the 10th percentile [4]. A transvaginal cervical-closed length measurement is the single best preterm birth predictor [18]. A cervical length >3 cm has a high negative predictive value for delivery in <34 weeks [8,19]. Alternatively a cervical length of <15 mm is moderately predictive (~70%) of preterm birth within 48 hours [18]. Funneling, defined as >3 mm, is also predictive of premature birth; however, the ability to define this feature is less consistent than the ability to measure cervical length, limiting its clinical utility [4,8,19].

Transabdominal evaluation: Although most obstetrical sonographic examinations are done transabdominally, this is the least reliable imaging method for evaluating the cervix. Using this approach, bladder overdistension as well as myometrial contractions can change the appearance of the lower uterine segment and cervix, creating a deceivingly normal appearance in women with cervical effacement, shortening, or frank dilatation. Furthermore, an underdistended bladder may preclude adequate cervical visualization for any one of a variety of reasons: acoustic shadowing from the pubic symphysis, refractive shadowing from the bladder-uterine interface, loss of the acoustic window provided by the urinary bladder and/or amniotic fluid, or an inability to manually displace the fetal head or other presenting part superiorly away from the lower uterine segment. Even when visible on a transabdominal scan, the cervical image may be suboptimal. Because the external os is often not clearly identified, a technically correct cervical length measurement may not be possible. Therefore, if a patient has a clinical history or sonographic findings suspicious for cervical pathology, consideration should be given to cervical scanning using either a transperineal or transvaginal approach.

Transperineal/transvaginal evaluation: These approaches are the most accurate for assessing the cervix, although bladder distension and myometrial contractions may still give a falsely normal cervical appearance. Since image resolution is better transvaginally, TPUS should be reserved for and offered to women at increased risk of preterm birth for whom vaginal assessment is unacceptably invasive or uncomfortable. TVUS is generally avoided in women in whom amniotic membrane rupture is suspected or documented in order to avoid the theoretical risk of infection; however, this is not an evidence-based decision [20,21]. In fact, several investigators have shown that a short cervical length is an independent risk factor for subsequent development of chorioamnionitis [22-24].

When the cervix is well visualized, TPUS can document cervical length as accurately as TVUS [25,26]. Cervical length is determined as the distance between the internal and external os. The internal os is normally at the level where the cervical canal meets the amniotic sac. The external os is generally well defined on TVUS but may be obscured by rectal gas on TPUS. This problem can be minimized by either scanning the patient in a lateral decubitus position or elevating the hips and buttocks on a thick pad or pillow, or by having the patient squeeze her buttocks together to dislodge rectal gas [16,27].

In patients at risk for cervical shortening or incompetence, some investigators suggest performing a cervical "stress test" by either applying transfundal pressure while scanning transvaginally or examining the patient during a Valsalva maneuver, coughing or while she is standing [15,17]. Transfundal pressure is considered the most effective stress technique in eliciting cervical changes during the active assessment of the cervix. It is defined as applying moderate pressure on the maternal abdomen in the direction of the uterine axis for 15 seconds. A

positive response is defined as any decrease in endocervical canal length accompanied by an increase in funnel width and length [28]. Because some patients will initially have a completely normal-appearing cervix, these important maneuvers may identify additional women at risk for preterm labor. If the cervix is already dilated or short, a cervical stress test should be avoided.

Abnormal-appearing cervix: Although the clinical presentation varies, from an imager's point of view cervical changes are essentially identical in patients in term labor or preterm labor, or who have cervical incompetence. In each of these clinical situations, cervical dilatation begins proximally, at the level of the internal os, and progresses distally. The documentation of closed cervical length remains the single most important parameter to measure. Shortening of the cervical length correlates with the clinical finding of effacement. Funneling may be considered a reflection of the process of producing cervical shortening. This parameter is less reproducible than cervical length and thus is of less value. It is typically defined as an open length at the level of internal cervical os of ≥3 mm, and by some observers as 5 mm [4,29]. A U-shaped configuration is often considered more concerning than a V-shaped configuration. Funneling in association with a long cervix does not appear to place women at increased risk of preterm delivery. Dilation of the internal cervical os may permit membranes, amniotic fluid, and even fetal parts or the umbilical cord to enter into the open cervix [4,30,31]. A falsely elongated cervical length may be obtained in the setting of pseudofunnel. A pseudofunnel occurs when the lower uterine segment contracts to form a funnel above the cervix. This is a transitory phenomenon with no clinical significance but may trick the examiner into including the contracted lower uterine segment as part of the cervical length. A pseudofunnel can be identified by noting that the "internal os" appears wider than the external os and by the change in the appearance of the cervix over time as the contraction resolves.

Eventually the entire endocervical canal becomes filled with fluid, and, if the membranes remain intact, they may be visible bulging into the vagina. Concurrent with dilatation, the cervix becomes effaced. Dilatation and effacement typically progress simultaneously, although, in a given patient, one or the other event may appear to predominate. Investigators have recommended quantifying these cervical changes using a variety of measuring techniques, but the simplest and most reproducible measurement in sensitivity and predictive value appears to be the residual closed length of the cervix [4]. This calculation, which takes into account both dilatation and effacement, can be obtained by measuring from the distal apex of endocervical funneling at the internal os to the external os. Analysis by Dilek et al [32] of low-risk pregnancies studied with TVUS indicates that using a cutoff value for cervical length of 33.15 mm yields an 80% sensitivity for predicting preterm delivery. This cutoff value resulted in a 12.7% false positive rate. Another multicenter observational study done for cervical length on TVUS from 16-24 weeks gestation categorized short cervical lengths as <25 mm, 25-29 mm, and ≥30 mm. In both the <25 mm group and the 25-29 mm group, the incidence of spontaneous midtrimester birth (<26 weeks) was higher than the incidence of later (26-34 weeks) preterm birth (<25 mm group: 37% vs 19%; 25-29 mm group: 16% vs 3%, respectively) as compared with women with a longer cervical length of ≥30 mm who had rates of 1% and 9%, respectively (P<.0001). Similarly, women whose cervix had shortened to ≤30 mm before 22 weeks were also more likely to experience a midtrimester than later preterm birth. On the other hand, women whose cervix has shortened to ≤30 mm after 24 weeks or maintained a length >30 mm had lower rates of midtrimester birth (P<.0001) [33]. The risk of preterm birth in twins at ≤25 mm cervix length was similar to that in singletons at ≤15 mm [34].

If a woman is clinically at risk for preterm delivery (such as prior preterm birth and multifetal gestation), or if a short cervix is detected by sonography, the precise length of the closed cervix should be measured and reported (this measurement is based on TPUS or TVUS scans). Endocervical canal dilation of 2-4 mm or funneling during second-trimester endovaginal sonography has been variably associated with an increased risk of recurrent preterm delivery independent of cervical length [35]. Studies have shown that restricting cervical cerclage to patients who demonstrate cervical changes on transvaginal surveillance appears to reduce the cerclage rate without compromising pregnancy outcome [36,37]. In addition, in cases with visible dilatation, the sonologist should report the maximal endocervical diameter. The percent of "effacement" based on sonographic images is less reliable, as the location of the internal os becomes more difficult to define.

False negative diagnoses can occur during transperineal or transvaginal scanning if a cervical stress test is omitted. Some of the most challenging patients to evaluate are those in whom the appearance of the cervix changes during the sonographic examination [38-40]. These transient but important observations underscore the need to observe the appearance of the cervix several times during a single obstetrical sonographic study, and suggest that a single image of the cervix may be insufficient for thorough cervical evaluation. A study of dynamic

cervical change on 10-minute real-time US showed that minimum cervical length was a better predictor of preterm delivery than was initial cervical length [41]. Gibson et al [42] demonstrated that on TVUS assessment of cervical length performed at 18, 24, 28, and 32 weeks gestation, shortening of cervical length ≥2.5 mm per week between 18 and 28 weeks' gestation also predicted preterm delivery. This is particularly the case in women at risk for preterm delivery, or those in whom a short cervix is detected by sonography. When a woman has transitory cervical changes, the minimal length of residual cervix should be reported, and the patient should be considered at risk. Clinical follow-up of these women reveals that 61%-74% have preterm labor or deliver prematurely [38,40].

Induction of labor occurs in up to 20% of pregnancies. Preinduction cervical lengths measured by US have shown a significant association with the induction-to-delivery interval and the risk for cesarean section [43-45].

In patients who have undergone a cervical cerclage procedure the cerclage height (distance from cerclage to external cervical os) should be obtained in addition to overall closed cervical length. A postcerclage cervical height of ≥18 mm may be associated with a reduction in preterm birth [46].

Magnetic resonance imaging (MRI): Emerging evidence suggests that MRI measurements of cervical length may be comparable to TVUS measurements. In the interim, until further research is available the findings should be confirmed by TVUS. Assessment of cervical length is not an indication for MRI [47].

Summary

- TPUS or TVUS provides unique information about the cervix that is otherwise not readily available.
- These examinations are easy to perform, have been shown to predict the risk for preterm delivery, and, in the appropriate clinical setting, should become an integral part of the obstetrical sonographic study.

Safety Considerations in Pregnant Patients

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation
- ACR-ACOG-AIUM Practice Guideline for the Performance of Obstetrical Ultrasound
- ACR Manual on Contrast Media
- ACR Guidance Document for Safe MR Practices

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".		

Supporting Documents

- ACR Appropriateness Criteria® Overview
- Procedure Information
- Evidence Table

References

1. Palmer R, Lacomme M. La béance de l'orifice interne, cause d'avortements à répétition? Une observation de déchirure cervico-isthmique réparée chirurgicalement, avec gestation à term consécutive. *Gynec et Obst.* 1948;47:905-906.
2. Ludmir J. Sonographic detection of cervical incompetence. *Clin Obstet Gynecol.* 1988;31(1):101-109.
3. Ayers JW, DeGrood RM, Compton AA, Barclay M, Ansbacher R. Sonographic evaluation of cervical length in pregnancy: diagnosis and management of preterm cervical effacement in patients at risk for premature delivery. *Obstet Gynecol.* 1988;71(6 Pt 1):939-944.
4. Iams JD, Goldenberg RL, Meis PJ, et al. The length of the cervix and the risk of spontaneous premature delivery. National Institute of Child Health and Human Development Maternal Fetal Medicine Unit Network. *N Engl J Med.* 1996;334(9):567-572.
5. Iams JD, Johnson FF, Sonek J, Sachs L, Gebauer C, Samuels P. Cervical competence as a continuum: a study of ultrasonographic cervical length and obstetric performance. *Am J Obstet Gynecol.* 1995;172(4 Pt 1):1097-1103; discussion 1104-1096.
6. Andersen HF, Nugent CE, Wanty SD, Hayashi RH. Prediction of risk for preterm delivery by ultrasonographic measurement of cervical length. *Am J Obstet Gynecol.* 1990;163(3):859-867.
7. Gomez R, Galasso M, Romero R, et al. Ultrasonographic examination of the uterine cervix is better than cervical digital examination as a predictor of the likelihood of premature delivery in patients with preterm labor and intact membranes. *Am J Obstet Gynecol.* 1994;171(4):956-964.
8. Iams JD, Paraskos J, Landon MB, Teteris JN, Johnson FF. Cervical sonography in preterm labor. *Obstet Gynecol.* 1994;84(1):40-46.
9. Jackson GM, Ludmir J, Bader TJ. The accuracy of digital examination and ultrasound in the evaluation of cervical length. *Obstet Gynecol.* 1992;79(2):214-218.
10. Lim BH, Mahmood TA, Smith NC, Beat I. A prospective comparative study of transvaginal ultrasonography and digital examination for cervical assessment in the third trimester of pregnancy. *J Clin Ultrasound.* 1992;20(9):599-603.
11. Mahony BS, Nyberg DA, Luthy DA, Hirsch JH, Hickok DE, Petty CN. Translabial ultrasound of the third-trimester uterine cervix. Correlation with digital examination. *J Ultrasound Med.* 1990;9(12):717-723.
12. Alexander S, Boulvain M, Ceysens G, Haelterman E, Zhang WH. Repeat digital cervical assessment in pregnancy for identifying women at risk of preterm labour. *Cochrane Database Syst Rev.* 2010(6):CD005940.

13. Berghella V, Hayes E, Visintine J, Baxter JK. Fetal fibronectin testing for reducing the risk of preterm birth. *Cochrane Database Syst Rev.* 2008(4):CD006843.
14. Berghella V, Baxter JK, Hendrix NW. Cervical assessment by ultrasound for preventing preterm delivery. *Cochrane Database Syst Rev.* 2009(3):CD007235.
15. Guzman ER, Rosenberg JC, Houlihan C, Ivan J, Waldron R, Knuppel R. A new method using vaginal ultrasound and transfundal pressure to evaluate the asymptomatic incompetent cervix. *Obstet Gynecol.* 1994;83(2):248-252.
16. Hertzberg BS, Kliewer MA, Baumeister LA, McNally PB, Fazekas CK. Optimizing transperineal sonographic imaging of the cervix: the hip elevation technique. *J Ultrasound Med.* 1994;13(12):933-936; quiz 1009-1010.
17. Wong G, Levine D, Ludmir J. Maternal postural challenge as a functional test for cervical incompetence. *J Ultrasound Med.* 1997;16(3):169-175.
18. 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.
19. Crane JM, Van den Hof M, Armson BA, Liston R. Transvaginal ultrasound in the prediction of preterm delivery: singleton and twin gestations. *Obstet Gynecol.* 1997;90(3):357-363.
20. Carlan SJ, Richmond LB, O'Brien WF. Randomized trial of endovaginal ultrasound in preterm premature rupture of membranes. *Obstet Gynecol.* 1997;89(3):458-461.
21. Hong JS, Park KH, Noh JH, Suh YH. Cervical length and the risk of microbial invasion of the amniotic cavity in women with preterm premature rupture of membranes. *J Korean Med Sci.* 2007;22(4):713-717.
22. Gomez R, Romero R, Nien JK, et al. A short cervix in women with preterm labor and intact membranes: a risk factor for microbial invasion of the amniotic cavity. *Am J Obstet Gynecol.* 2005;192(3):678-689.
23. Hassan S, Romero R, Hendler I, et al. A sonographic short cervix as the only clinical manifestation of intra-amniotic infection. *J Perinat Med.* 2006;34(1):13-19.
24. Iams JD. The preterm prediction study: Cervical length and perinatal infection. *American Journal of Obstetrics and Gynecology.* 1997;176(1, Part 2):S6-S6.
25. Yazici G, Yildiz A, Tiras MB, Arslan M, Kanik A, Oz U. Comparison of transperineal and transvaginal sonography in predicting preterm delivery. *J Clin Ultrasound.* 2004;32(5):225-230.
26. Kurtzman JT, Goldsmith LJ, Gall SA, Spinnato JA. Transvaginal versus transperineal ultrasonography: a blinded comparison in the assessment of cervical length at midgestation. *Am J Obstet Gynecol.* 1998;179(4):852-857.
27. Hertzberg BS, Bowie JD, Weber TM, Carroll BA, Kliewer MA, Jordan SG. Sonography of the cervix during the third trimester of pregnancy: value of the transperineal approach. *AJR Am J Roentgenol.* 1991;157(1):73-76.
28. Guzman ER, Pisatowski DM, Vintzileos AM, Benito CW, Hanley ML, Ananth CV. A comparison of ultrasonographically detected cervical changes in response to transfundal pressure, coughing, and standing in predicting cervical incompetence. *Am J Obstet Gynecol.* 1997;177(3):660-665.
29. To MS, Skentou C, Liao AW, Cacho A, Nicolaides KH. Cervical length and funneling at 23 weeks of gestation in the prediction of spontaneous early preterm delivery. *Ultrasound Obstet Gynecol.* 2001;18(3):200-203.
30. Timor-Tritsch IE, Boozarjomehri F, Masakowski Y, Monteagudo A, Chao CR. Can a "snapshot" sagittal view of the cervix by transvaginal ultrasonography predict active preterm labor? *Am J Obstet Gynecol.* 1996;174(3):990-995.
31. Zilianti M, Azuaga A, Calderon F, Pages G, Mendoza G. Monitoring the effacement of the uterine cervix by transperineal sonography: a new perspective. *J Ultrasound Med.* 1995;14(10):719-724.
32. Dilek TU, Gurbuz A, Yazici G, et al. Comparison of cervical volume and cervical length to predict preterm delivery by transvaginal ultrasound. *Am J Perinatol.* 2006;23(3):167-172.
33. Owen J, Yost N, Berghella V, et al. Can shortened midtrimester cervical length predict very early spontaneous preterm birth? *Am J Obstet Gynecol.* 2004;191(1):298-303.
34. Goldenberg RL, Iams JD, Miodovnik M, et al. The preterm prediction study: risk factors in twin gestations. National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network. *Am J Obstet Gynecol.* 1996;175(4 Pt 1):1047-1053.
35. Yost NP, Owen J, Berghella V, et al. Second-trimester cervical sonography: features other than cervical length to predict spontaneous preterm birth. *Obstet Gynecol.* 2004;103(3):457-462.

36. Groom KM, Bennett PR, Golara M, Thalon A, Shennan AH. Elective cervical cerclage versus serial ultrasound surveillance of cervical length in a population at high risk for preterm delivery. *Eur J Obstet Gynecol Reprod Biol.* 2004;112(2):158-161.
37. To MS, Palaniappan V, Skentou C, Gibb D, Nicolaides KH. Elective cerclage vs. ultrasound-indicated cerclage in high-risk pregnancies. *Ultrasound Obstet Gynecol.* 2002;19(5):475-477.
38. Hertzberg BS, Kliewer MA, Farrell TA, DeLong DM. Spontaneously changing gravid cervix: clinical implications and prognostic features. *Radiology.* 1995;196(3):721-724.
39. Parulekar SG, Kiwi R. Dynamic incompetent cervix uteri. Sonographic observations. *J Ultrasound Med.* 1988;7(9):481-485.
40. Riley L, Frigoletto FD, Jr., Benacerraf BR. The implications of sonographically identified cervical changes in patients not necessarily at risk for preterm birth. *J Ultrasound Med.* 1992;11(3):75-79.
41. Jenkins SM, Kurtzman JT, Osann K. Dynamic cervical change: is real-time sonographic cervical shortening predictive of preterm delivery in patients with symptoms of preterm labor? *Ultrasound Obstet Gynecol.* 2006;27(4):373-376.
42. Gibson JL, Macara LM, Owen P, Young D, Macauley J, Mackenzie F. Prediction of preterm delivery in twin pregnancy: a prospective, observational study of cervical length and fetal fibronectin testing. *Ultrasound Obstet Gynecol.* 2004;23(6):561-566.
43. Bartha JL, Romero-Carmona R, Martinez-Del-Fresno P, Comino-Delgado R. Bishop score and transvaginal ultrasound for preinduction cervical assessment: a randomized clinical trial. *Ultrasound Obstet Gynecol.* 2005;25(2):155-159.
44. Crane JM. Factors predicting labor induction success: a critical analysis. *Clin Obstet Gynecol.* 2006;49(3):573-584.
45. Park KH, Kim SN, Lee SY, Jeong EH, Jung HJ, Oh KJ. Comparison between sonographic cervical length and Bishop score in preinduction cervical assessment: a randomized trial. *Ultrasound Obstet Gynecol.* 2011;38(2):198-204.
46. Scheib S, Visintine JF, Miroshnichenko G, Harvey C, Rychlak K, Berghella V. Is cerclage height associated with the incidence of preterm birth in women with an ultrasound-indicated cerclage? *Am J Obstet Gynecol.* 2009;200(5):e12-15.
47. Brandao RS, Pires CR, de Souza E, et al. Magnetic resonance imaging vs. transvaginal ultrasound for cervical length assessment in the second half of pregnancy. *Ultrasound Med Biol.* 2010;36(4):571-575.