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Is Sonographic Assessment of the Cervix Necessary and Helpful?

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Abstract

Transvaginal sonography of the cervix has emerged as a useful window onto preterm parturition. Cervical sonography allows measurements of cervical length which can aid clinicians in identifying women at risk for preterm birth. The use of transvaginal assessments of cervical length can assist in the triage of patients with possible preterm labor. Recent studies also support the use of cervical length measurements as a means of determining appropriate candidates for cerclage placement and progesterone supplementation to reduce the risk of premature birth, further highlighting the importance of this modality in modern obstetric management.

Keywords

Cervical; ultrasound; length; preterm; cerclage; progesterone

History

The cervix has a unique role in parturition, tasked with retention of a pregnancy until active labor, when it must then reverse functions, i.e. dilating to accommodate the delivery of a fetus. The cervix then returns to its original shape and must serially replicate its role in subsequent pregnancies. Failure of the cervix to retain the pregnancy has long been known as cervical incompetence, and more recently as cervical insufficiency. Given these remarkable requirements and the potential for neonatal morbidity and mortality associated with deficient function, it is not surprising that investigators have been fascinated with studying the cervix. Imaging modalities such as ultrasonography have produced numerous insights into cervical changes during pregnancy. Current practitioners are most familiar with measurement of a cervical length (CL) (Figure 1) with transvaginal sonography, but the early studies used a transabdominal (TA) approach. The width of the internal os and the cervical length between the internal os (sometimes described as having a triangular appearance) and the external os, were measured using TA sonography first in women with a classical diagnosis of cervical incompetence, defined as a history of three or more second trimester births with painless cervical dilation.

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Subsequent studies related ultrasonographic findings to obstetric outcomes, demonstrating a direct relation between the width of the internal os and the risk of preterm birth. The first delineation of the cervix as “short” versus “normal” used a threshold length of 3 cm¹. Along with other indices of cervical measurements, such as bulging of membranes into the endocervical canal and the thickness of the anterior wall of the lower uterine segment, the authors found that the presence of a “short” cervix was associated with a significantly increased risk for premature birth¹. As studies moved from descriptive to comparative, cervical lengths were stratified according to variables such as presence or absence of premature contractions or risk factors for preterm birth, allowing for improved conclusions regarding the utility of cervical sonography.

The breakthrough came with the use of transvaginal ultrasonography, which significantly improved visualization of the cervix². Sonek et. al. described their experience with transvaginal (TV) ultrasonography of the pregnant cervix including a protocol for measuring the cervix, which has been modified over time to become the current standard³. Measurement is performed over a period of approximately 5 minutes, and the shortest measurement that best displays the landmarks of internal os, external os, cervical canal, empty maternal bladder, and absence of undue pressure (the “shortest best” measurement) is recorded, not the average. The superiority of the TV approach was further illustrated when comparing ultrasound versus digital assessment of cervical length³. The authors found that the digital approach tended to underestimate the length of the cervix by a centimeter or more³. The inter-observer variation of TV CL measurements ranges between 5 to 10%³. The TV approach also improved the likelihood of obtaining adequate measurements. In a comparison of TV and TA sonography of the cervix, Andersen obtained adequate measurements of cervical length in 99.5% of women with TV sonography and only 86% with TA sonography⁴. Notably, abdominal measurements were 5.2 mm longer than measurements obtained vaginally, a significant difference. Because a full maternal bladder causes an unpredictable effect on TA measurements, the vaginal technique became the gold standard. The American College of Radiology and the American Institute of Ultrasound in Medicine both affirm the use of TV sonography as the optimal method visualization of the cervix.

Prediction of Preterm Birth (PTB)

Anderson² and others reported studies relating cervical length to risk of preterm birth that led the NICHD MFM Research Network to include cervical sonography in the Preterm Prediction Study, an observational study of multiple markers of PTB risk⁵. More than 3000 women with singleton pregnancies were enrolled, chosen to reflect the parity and racial/ethnic characteristics of the 10 participating sites and the primary endpoint was birth before 35 weeks gestation. Cervical length was measured with TV ultrasound between 22-24 weeks gestation and again 4 weeks later with CL measurements being normally distributed at both exams⁵. The risk of preterm birth increased as the length of the cervix decreased. Compared to women whose cervical length was above the 75th percentile at 22-24 weeks (> 40 mm), the relative risk of premature birth before 35 weeks was 3.79 in women with a CL < 30 mm, and 6.19 for women with a CL < 26 mm⁵. A cervical length 25 mm at 24 weeks' had a sensitivity of 37.3% and a specificity of 92.2% for detection of premature birth < 35 weeks. A threshold of 30 mm had sensitivity and specificity of 54% and 76.3% respectively⁵. The risk was highest for women with the shortest cervical length below 15 mm, the 3rd percentile, but remarkably, fewer than 50% of these untreated women (the findings were masked) delivered before 35 weeks⁵. Other studies subsequently confirmed the inverse relationship between cervical length and the risk of premature birth⁶. Of 2505 women studied by Heath et al with transvaginal ultrasound at 23 weeks', only 43 (1.72%) had a cervical length 15 mm⁶. The likelihood ratios (LR) for premature birth 32 weeks in this

study were 51.5, 2.7 and 0.4 in women with CL measurements of 5 mm, 15 and 50 mm, respectively.

Studies relating cervical length to premature birth risk can be difficult to compare because of variations in the population enrolled, gestational age(s) at examination, number of examinations, and presentation of data and outcomes as continuous or categorical. Cervical length data collected in the NICHD Preterm Prediction Study has been analyzed in secondary analyses limited to women with⁷ and without⁸ a previous preterm birth. In women with a prior preterm birth, cervical length at 22-24 weeks gestation can distinguish women with high (> 35% if CL < 25 mm) and low (<10% if CL > 35 mm) risk of recurrent preterm birth⁷. A positive fetal fibronectin collected at the same time doubled the risk of preterm birth in these high risk women⁷. In low risk women, the sensitivity of a CL < 25 mm to detect women who would later deliver preterm was approximately 40 percent⁸. Another MFMU study of cervical length enrolled 183 women with a prior preterm delivery before 32 weeks. Cervical length measurements were obtained at two-week intervals beginning at 16-18 weeks. Cervical length was analyzed in 3 groups, as < 25 mm, 25-29 mm and 30 mm or higher, and related to gestational age at birth, categorized as < 26 weeks, 26-34 weeks and ≥ 35 weeks⁹. There are many other studies that have enrolled populations with and without *a priori* risk to perform cervical ultrasound studies using various thresholds, definitions, and imaging techniques, e.g., transperineal or transabdominal imaging⁶⁻⁹. Regardless, several findings have been consistently observed:

- Cervical effacement begins at the internal os, progressing cephalad to caudad. Effacement precedes dilation.
- The length of the closed portion of the cervical canal is related to the risk of preterm birth: the shorter the cervix, the greater the risk.
- A short cervix does not always – indeed, *does not usually* – mean that preterm birth will occur; most women with short cervix deliver after 35 weeks' gestation

What Causes a Short Cervix?

Initial interpretation of the relationship between short cervix and preterm birth was guided by the expectation that uterine contractions produce cervical change. Thus the finding of short cervix in the second trimester of pregnancy in women who did not have contractions was taken to be evidence of “a continuum of cervical competence” in which more length suggested greater competence – analogous to the sport of basketball, where greater height confers an advantage. This concept arose from a 1995 study in which cervical length measurements in women with a previous term birth were compared to measurements obtained from women with a history of premature births and from women with a classic history of cervical insufficiency¹⁰. Cervical length in the current pregnancy was linearly related to the gestational age at birth in the previous pregnancy: women who delivered before 26 weeks in a previous pregnancy had shorter cervical lengths than those delivering between 27-32 weeks, who had a shorter measurement than those who had delivered between 33-35 weeks¹⁰. The shortest cervical lengths were observed in women diagnosed with cervical insufficiency, and the longest were obtained from women who had previously delivered only at term. This pattern was consistent over a broad range of gestational age periods. These data suggested that cervical length was a surrogate for competence, and thus functioned as a continuum. In 1996, the first analyses from the NICHD Prediction Study emphasized the inverse relation between cervical length and risk of preterm birth⁵. Because the subjects were all asymptomatic outpatients, little credence was given to the possibility that short cervical length at 22-24 weeks' gestation could result from an active parturition process. Instead, the results were also interpreted as consistent with the “continuum of cervical competence”. This concept was later embraced by an American College of

Obstetricians and Gynecologists Practice Bulletin¹¹. The corollary that a short cervix could be corrected by a properly placed cerclage suture soon acquired believers, but subsequent clinical experience and research are not consistent with that conclusion¹²⁻¹⁵. Cerclage is not a uniformly effective treatment for short cervix, apparently beneficial for some women with a prior preterm birth, of no benefit for others, and linked to increased risk of preterm birth in women with twins¹²⁻¹⁵. Meanwhile, supplemental progesterone has been reported to reduce the risk of preterm birth in some women with short cervix¹⁶⁻¹⁷. The frequent failure of cerclage to provide a physical “cure”, accompanied by the greater success of a biochemical intervention, is strong evidence that short cervix does not after all represent the lower end of a biological continuum of competence. It instead suggests that the parturition process often begins with cervical softening and ripening early in the second trimester if not earlier. Further evidence to support “short cervix = parturition has begun” comes from a re-analysis of the cervical length data from the Prediction Study (Figure 2) showing that cervical shortening precedes spontaneous preterm birth at a similar rate for 4 or more weeks, regardless of the eventual clinical presentation as preterm labor or preterm PROM¹⁸.

The effect of progesterone supplementation to reduce the risk of preterm birth in women with short cervix is apparently related primarily to its effect on cervical softening offering further support for the conclusion that short cervix is evidence that parturition has begun. The specific changes in the appearance of the cervix as parturition progresses should be understood as clues to the cause(s) and progression of preterm parturition.

Cervical Shortening Described

The progression of changes in the cervix during the course of parturition has been visualized with the help of transvaginal sonography. Ziliani et al described the temporal sequence of cervical changes and described the change as T, Y, V and U¹⁹. As the cervix effaces, the relationship of the cervical canal to the lower uterine segment changes from a **T** to the notched **Y**¹⁹. With further effacement, the **Y** becomes a **V** and ultimately a **U** (Figure 3). This sequence is recalled by residents at the Ohio State University Medical Center by the mnemonic *Trust Your Vaginal Ultrasound*.

Funneling

Early studies recognized the development of the “triangular appearance” to the internal cervical os, a finding commonly referred to as funneling. (Figure 4). The width and the length of the funnel have been measured in several studies to evaluate their importance in predicting preterm birth. In an observational study of 183 women where TV sonography was performed, a cervical length of < 25 mm was significantly associated with PTB < 35 weeks while the presence of funneling was not a significant predictor of preterm birth¹⁵. Another study involving 590 ultrasounds replicated the finding that funneling does not significantly improve the prediction of premature birth when used in conjunction with CL measurements²⁰. Specifically, among those women with a CL < 25 mm, the gestational age at delivery was not statistically significant in those with (30.6 weeks) versus those without a funnel (31.9 weeks) ($p = 0.59$)²⁰. Therefore, the presence or absence of a funnel does not significantly improve the ability to predict PTB. That said, funneling is part of the “T-Y-V-U” progression of cervical effacement and is certainly a window into the parturition process.

Infection/inflammation correlation

The etiology of preterm parturition is both multifactorial and complex but intrauterine infection/inflammation is strongly associated with premature birth. The role of infection and inflammation in preterm parturition was assessed in one study where IL-8 concentrations from cervical secretions were compared with CL measurements in women presenting

between 24-36 weeks with preterm contractions²¹. Amniocentesis was performed on all women along with placental pathology to assess for the presence of histological chorioamnionitis. A short CL was significantly associated with both higher IL-8 concentrations and a positive amniotic fluid culture, linking infection and a short cervix. A prospective cohort study of all women between 22-35 weeks less than 3 cm dilated, assessed the relationship between CL and amniocentesis cultures²². The overall prevalence of PTB 35 weeks was 21.4% with positive cultures seen in 7% of the women. The most common organism identified in amniotic fluid cultures was *Ureaplasma urealyticum*. Women with a CL of < 15 mm had a significantly higher percentage of positive amniotic fluid cultures (26.3%) compared to those with a CL > 15 mm (3.8%). Of those with a CL ≥ 30 mm, only 1.9% had a positive amniotic fluid culture. Regression analysis revealed that the strongest predictor for a positive amniotic fluid culture was a short cervical length²². The authors also replicated the increased risk of premature delivery before 35 weeks in the setting of a short cervix²². It would appear then that a short cervical length is associated with a higher likelihood of intrauterine infection and inflammation but the causal relationship is less certain. A likely explanation is that a short cervix can potentially expose the membranes to the vaginal milieu leading to colonization and infection.

Debris

Debris, also called sludge, may be visualized overlying the internal os at the time of CL measurements which is thought to be a microbial biofilm (Figure 5). The relationship between debris and premature birth was investigated in a retrospective review of 281 women at risk for PTB who had a CL performed²³. Debris was present in 23.5% (66/281) of patients and a CL < 25 mm was noted in 50.5% (142/281)²³. After controlling for a short cervix and prior PTB, the presence of debris was significantly associated with a short diagnosis-to-delivery interval (HR 2.96 with 95% CI 1.6-5.3). Almost 70% of women with debris delivered before 32 weeks compared to 24.2% in those without debris. There were significantly higher rates of clinical and histological chorioamnionitis in women with debris. Debris appears to be a marker of microbial invasion as well as an independent risk factor for PTB in the setting of a short cervix but at this time management of a short CL should not be appreciably altered by the presence of debris.

Interventions

Transvaginal ultrasonography has most commonly been used to assess the risk for premature delivery in women with historical risk factors for preterm birth. Use as a screening test has been limited by the absence of an effective intervention for women who test positive. Investigators have looked at several treatment modalities for women identified to have a short cervix on ultrasound, including indomethacin, cerclage and progesterone supplementation^{12-17, 24}.

Cerclage placement with history of preterm birth

The use of transvaginal sonographic measurements of CL as a means to guide placement of an ultrasound-indicated cerclage for the prevention of recurrent PTB has been the subject of several studies. In an early non-randomized study of women with a CL ≥ 15 mm, the authors found that percentage of premature births (categorized as < 28, < 32, < 34 and < 37 weeks) was not significantly different between those with and without a cerclage²⁵. The analysis was not sufficiently powered to detect a difference in reduction in the percentage of premature births, though²⁵. To et al investigated the role of a Shirodkar cerclage in low and high risk women with a CL of ≥ 15 mm¹³. Out of 47,123 women who were screened, 253 met entry criteria with 127 women receiving cerclage and 126 women having expectant

management. Cerclage placement was not associated with a reduction in premature birth with a RR of 0.84 (95% CI 0.54, 1.31)²⁶. A number of studies have looked at prophylactic versus ultrasound-indicated cerclage placement. In a retrospective cohort study of 138 women at high risk for PTB, 57 had placement of an ultrasound-indicated cerclage when the CL was < 20 mm before 24 weeks gestation²⁶. The authors found that there was no difference in the median gestational age at delivery, the percentage of PTB or in the percentage of PTB < 25 weeks gestation between the prophylactic and the ultrasound-indicated group. A prospective cohort study of 380 women at increased risk of PTB investigated the predictive indicators of success in ultrasound-indicated cervical cerclage²⁷. The indications for placement of the cerclage were a CL < 15 mm, a CL < 25 mm with progressive shortening or funneling greater than 50%. The authors found that visible membranes and a CL < 15 mm were significantly associated with an earlier gestational age at delivery, a lower fetal survival rate and a shorter insertion-to-delivery interval. A matched case-control study by the same author compared elective cerclage placement to ultrasound-indicated cerclage among women at high risk for preterm birth²⁸. Among those in the ultrasound-indicated group, only 36% went on to have a cerclage (indications for placement of the cerclage were a CL < 15 mm, a CL < 25 mm with progressive shortening or funneling greater than 50%). There was no difference in the median gestational age at delivery or the proportion of births < 24 weeks gestation. This study highlights the safety of serial ultrasonographic measurements when deciding whether to place a cerclage for prevention of PTB.

The NICHD Vaginal Ultrasound Cerclage Trial (VUCT) was the first and only randomized controlled trial of ultrasound-indicated cervical cerclage in women at high risk for PTB¹⁵. The VUCT randomized 301 women with a prior PTB < 34 weeks and a CL < 25 mm to expectant management or cerclage placement¹⁵. The primary outcome of delivery before 35 weeks gestation occurred in 32% of those with a cerclage versus 42% of those without (OR of 0.67 with 95% CI of 0.42 to 1.07). The regression model, though, found a significant interaction between cerclage and cervical length. Because of this finding, the authors performed a separate analysis of women with a cervical length < 15 mm. Of those women with a CL < 15 mm, cerclage placement was associated with a significant reduction in the odds of PTB with an OR of 0.23 (95% CI of 0.08 to 0.66). This article strengthens the utility of TV sonography in the management of women with prior PTB and can guide the clinician in determining whether to place an ultrasound-indicated cerclage. On the basis of the NICHD VUCT, we would recommend placement of cerclage in all women with a prior PTB who have a CL < 15 mm and would strongly consider it in women with a CL < 20 mm.

Cervical Sonography to Evaluate Women with Possible Preterm Labor

Cervical ultrasound can aid in the assessment of women presenting with complaints of premature contractions. A prospective study of 72 women presenting to a Labor and Delivery unit with the complaint of contractions evaluated the utility of TV sonography in assisting triaging of patients²⁹. The authors found that both the presence of a funnel (which they referred to as “wedging”) and a short cervix were independent predictors of PTB < 37 weeks. As “wedging” had a sensitivity of 100% for detection of PTB, the authors concluded that TV sonography was useful in the evaluation of preterm labor. Several other studies have investigated TV sonography in the evaluation of women presenting to triage with premature contractions and have found that a CL > 30 mm generally excludes the likelihood of premature birth and such women may be discharged home. One prospective study involved performance of a digital exam and a CL measurement in women between 20 to 35 weeks gestation with contractions³⁰. After controlling for confounding variables, the authors found that CL was the only significant predictor of PTB less than 37 weeks while digital examination was not. A prospective study followed women who had both CL measurements

and a digital estimate of the CL³¹. Comparing women who delivered < 35 weeks gestation to those who did not, there was a significant difference between the groups in cervical length measured sonographically but not when assessed digitally. Women presenting between 24-36 weeks gestation with contractions and who were < 3 cm dilated with intact membranes had a CL measurement performed at the time of initial evaluation³². The authors found that a CL < 15 mm was significantly associated with an increased risk of delivery within 7 days. A follow-up study, controlling for gestational age, parity and use of tocolytics, found that a decrease in CL (measured continuously) was the only significant predictor of PTB within 7 days, 48 hours or before 35 weeks³³. Women evaluated for premature labor using both fFN and CL had a triage evaluation time that was roughly 1 hour less than the group where neither modality was used when the CL was ≥ 30 mm ($p = 0.004$). The use of TV sonography can appreciably aid the practitioner in the diagnosis of preterm parturition.

Progesterone Supplementation

Women with no prior history of premature birth may have an incidental finding of a short CL on TV sonography and it can be unclear how to best manage these patients. Several studies have looked at the role of progesterone supplementation in the setting of a short cervix. Women, predominantly nulliparous, with a CL ≤ 15 mm between 20-25 weeks were randomized to 200 mg of daily vaginal progesterone versus placebo¹⁶. The authors found that progesterone was associated with a 44% reduction in the risk of PTB < 34 weeks which was statistically significant. A small secondary analysis from a randomized controlled trial investigated the role of 90 mg of vaginal progesterone in women with a prior PTB and a CL < 28 mm between 16 and 23 weeks gestation³⁴. The study found a significant reduction in the percentage of premature births before 32 weeks gestation which was the primary study outcome. Hassan et al. randomized 465 women, the majority with no prior PTB, who had a cervical length of 10 to 20 mm between 19 and 24 weeks gestation to either 90 mg of daily vaginal progesterone or placebo¹⁷. Even after controlling for risk factors associated with PTB, progesterone lowered the risk of PTB before 33 weeks by 48% (95% CI of 0.31 to 0.91). When investigating the subset of women who had no prior PTB, progesterone use was also associated with a lower risk of PTB (7.6 % for progesterone versus 15.3% for placebo, RR 0.50, 95% CI 0.27 to 0.90). Based on these findings, progesterone administration should be offered to asymptomatic women who are found to have a short CL on TV sonography.

Multiple Gestations

The use of TV sonography is incorporated into the management of multiple gestations despite the fact that interventions such as cerclage and progesterone are ineffective in multiple pregnancies. The Preterm Prediction Study measured a CL transvaginally at 24 weeks gestation in 147 women with twin pregnancies and found that a short cervix (< 25 mm) at 24 weeks was significantly associated with an increased risk of PTB³⁵. The sensitivity and specificity for PTB < 35 weeks gestation was noted to be 29.8% and 89% respectively. In a prospective observational study of 87 women with a twin pregnancy who presented to triage with premature contractions between 24 to 36 weeks gestation, the authors found that when the CL was greater than 25 mm there were no cases of delivery within 7 days³⁶. Despite some of the limitations of TV sonography in twin pregnancies, we believe that CL can play a role in guiding clinicians caring for twin pregnancies. Specifically, a long cervical length (greater than 25 mm) may safely reassure the clinician and can allow a patient to avoid being placed on bedrest.

Universal Cervical Length Screening

Whether to universally screen all pregnancies with TV sonography has been the subject of two recent publications. Cahill et. al. used a decision analysis to assess how cost effective universal screening of patients with TV sonography is compared to a risk-based screening approach³⁷. Even over a wide variation of cost and outcome assumptions, universal screening was found to more cost effective than a risk-based approach. A similar cost-effectiveness analysis model compared “no screening” to “universal screening” of all singleton pregnancies with a single TV scan between 18-24 weeks gestation³⁸. The model found a significant cost-savings for the universal screening approach, also under a large variation of assumptions. Pending further research regarding the safety of universal screening, though, our recommendation would be for a liberal selective screening over universal screening.

Cautionary Notes & Summary

In trained hands, cervical sonography can be an extremely useful tool, but it is not without its limitations. In a review of 60 ultrasound examinations of women who were at risk for PTB, the authors highlighted several of the problems encountered during CL measurement³⁹. An artificial lengthening of the cervix due to excessive pressure on the transducer was the most commonly encountered problem, occurring in 12% of cases. An undeveloped lower uterine segment, primarily due to early gestational age at the time of measurement, occurred in 8% of cases. To ensure that TV sonography is optimally utilized, the Fetal Medicine Foundation (FMF) has incorporated a number of these pitfalls in their certificate of competence. Practitioners can complete the FMF certification after performance of a short internet course and submission of two images of a normal and short cervix. Although TA sonography and digital examination are alternatives to TV sonography, they are less reliable in the prediction of PTB and prone to inaccuracies in assessment of cervical length⁴. Specifically, digital examination of the cervix to compute a Bishop's score has been studied in conjunction with CL measurements and the sensitivity and specificity are generally lower than that of transvaginal measurements in prediction of PTB⁴⁰. Another study compared the interobserver reliability of digital and transvaginal estimates of CL with the former yielding 35% agreement and the latter 74% agreement⁴¹. Therefore, when available, transvaginal sonography is the preferred tool for assessment of cervical length.

The use of TV sonography has gained in popularity and many clinicians are experienced in the performance of it. Given the utility of progesterone and cerclage in the reduction of PTB in the setting of a short cervix, performance and/or knowledge of TV sonography is vital for all providers of obstetric care. Returning to the question of whether sonography of the cervix is necessary or useful, the abundance of literature supports its role in elucidating the mechanism of parturition and as a supplemental tool in the role of prevention of premature birth. Progressive cervical shortening, assessed via sonography, reveals the process of parturition as one of slow evolution. It is likely that future studies will continue to refine the definition of parturition and premature birth.

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Figure 1. Transvaginal ultrasound of cervical length

Figure 2. Rate of cervical change by phenotype of preterm birth

Figure 3. Progressive cervical effacement seen sonographically

Figure 4. Diagram of cervical funneling

Figure 5. Debris seen in the lower uterine segment, at the internal os