We Have Learned About Cervical Ultrasound

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The National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network has completed 2 prospective, blinded observational studies of cervical ultrasound for the prediction of preterm birth and the identification of high-risk women who might benefit from interventions aimed at preventing spontaneous preterm birth. These reports and other clinical data support the concept that cervical competence is not a dichotomous variable, but more likely functions along a continuum that is reflected by the relationship between cervical length and reproductive outcomes. Because of its safety, availability, patient acceptance and reproducibility, the sonographic evaluation of the uterine cervix has become an important investigational tool that has advanced our understanding of the preterm birth syndrome and should allow a more focused approach to the most persistent and challenging problem in modern obstetrics.

The cervix has a dominant role in maintaining the intrauterine gestation until the spontaneous onset of term labor. For most of the pregnancy the cervical sphincter remains firmly closed, providing both mechanical support for the products of conception and protection against ascending pathogens. However, pathologic cervical ripening may occur at any time in a preterm gestation: the underlying causes are generally unknown.

In the United States in 1998, the incidence of preterm birth was 11.8%. The prevention of preterm birth, and its associated short- and long-term neonatal morbidities, is the most challenging problem in modern obstetrics. Prematurity is usually the result of spontaneous preterm birth: only a minority of patients are delivered for maternal or fetal indications. Chief components of contemporary models of the preterm birth syndrome include decidual activation and premature membrane rupture, preterm labor, and diminished cervical competence (or alternatively, premature cervical ripening). The concept that the cervix is either competent or not has been challenged by both clinical data and interpretative reviews. It has become increasingly apparent that cervical competence probably functions along a biologic continuum that is reflected in reproductive outcomes. Thus, research into the etiology and prevention of spontaneous preterm birth has focused on the cervix, and its underlying role in pathways to prematurity.

Traditionally, clinicians have evaluated the cervix by visual examination and digital palpation, the latter often summarized into a Bishop score. Although women with early cervical changes, as detected by palpation, are more likely to experience a preterm birth, low predictive value and considerable inter-observer variability have limited its clinical utility. Moreover, the examining hand can neither assess the entire cervical length nor detect early changes in the lower uterine segment and internal cervical (os). Recent investigations have shown that cervical effacement begins at the internal os. Funneling at the internal os may be effacement in progress. Recently, technical advances in vaginal ultrasonography and wide patient acceptance of the technique have circumvented many of the
limitations of both digital examinations and earlier transabdominal methods of cervical sonography.\textsuperscript{15}

**Evaluation of the Cervix With Vaginal Sonography**

For the examination, the patient should have an empty bladder and be placed in dorsal lithotomy position. A high-resolution (≥5 MHz) endovaginal probe, protected by a lubricated sterile transducer cover, is gently inserted along the vaginal canal. Essentially all endovaginal probes currently in use are based on a convex, switched array of active elements, which create a fan- or sector-shaped image. The sector should encompass at least a 120° field of view to create an image that facilitates simultaneous visualization of the required landmarks without excessive image blurring. The image “trapezoid” should stay in a vertical orientation to maintain a sagittal view of the cervix and lower segment.

Three landmarks are crucial for the measurement of cervical length: 1) External os, 2) Endocervical canal, and 3) Internal os. By sweeping the probe slightly from left to right, one or more of these landmarks can be visualized. Although there is significant biologic variation among patients (and also over time of gestation), the internal os can usually be recognized as a small notch or triangle at the interface between the amniotic cavity and the endocervical canal. With experience, various patterns of internal os anatomy can be appreciated. In some cases, a normal appearing internal os can never be visualized, because either funneling, a poorly developed lower uterine segment, or placenta previa should be suspected. These situations will be covered in more detail below.

Once the internal os has been recognized, its image should be maintained while the transducer is manipulated slightly in order to visualize the entire endocervical canal, ending at the external os. The external os is generally more difficult to visualize than the internal os because the vaginal mucosa is well applied to the ectocervix and has a similar echogenicity. The external os is often characterized by an echogenic area several millimeters inside of cervico-vaginal interface. With high quality sonographic equipment, more details of the external os can be recognized, and it commonly has the appearance of the small triangle or notch. The intervening cervical canal may have a varied appearance, depending on the echogenicity of the glands, mucous, and the canal itself. The canal is commonly more echolucent than the surrounding cervical and glandular tissue, but it may also appear as a faint echo-dense line.

Once these 3 landmarks are simultaneously visualized, the probe must be manipulated one last time before acquiring the cervical length. The probe should be withdrawn slowly (while maintaining a view of these landmarks) until the image blurs. At this point, the sonologist should increase the insertion pressure slightly, just until a satisfactory image returns. This technique minimizes pressure on the cervix and prevents mechanical distortion of the surrounding anatomy. The image should be frozen and electronic calipers should be used to measure the distance from the internal os to the external os. At times, the canal will have a curved or bent contour, and a line connecting the 2 os will not follow the endocervical canal. This biologic artifact can be avoided by measuring the endocervical canal in 2 linear segments, which connect at the point of maximum deflection along the canal. If the maximal deflection is ≥5 mm, we use the sum of the 2 linear segments to define the cervical length. It is advisable to repeat the measurement several times to find the shortest cervical length associated with the best quality image. Experience has shown that the first measurement is typically several millimeters longer than subsequent assessments.

If a normal appearing internal os cannot be visualized, the cervix should be assessed further to determine whether funneling is present. The appearance of funnels has been well characterized in the literature.\textsuperscript{16} We generally diagnose a funnel if the “notch,” which often defines the internal os, is greater than 5 mm from the end of the endocervical canal to its “shoulder” (seen more cephalad; Fig 1). Funnels may be subcategorized as primarily V-shaped or U-shaped, depending on their dominant appearance. When funneling is seen, the presumption is that the endocervical canal at the internal os has begun to dilate, but one can only estimate its (former) location. In this setting, we measure cervical length from the external os to the functional internal os, where the apex of the funnel meets the closed endocervical canal. In rare cases, a
funnel can replace essentially the entire endocervical canal (Fig 2) and the cervical length is zero. (This phenomenon can also be thought of as complete canal dilation.) Funnel measurements are inexact since the landmarks are not always distinct and may change during the examination. The point along the “shoulder” where the caliper should be placed is operator dependent, and at times, asymmetric “shoulders” are recognized (Fig 1). This diminishes the reproducibility of the measurement.

Another confounder of cervical length measurement is a poorly developed lower uterine segment (Fig 3). This phenomenon is probably due to either a delay in the normal maturing process of the lower segment, or, in some cases, the result of spontaneous muscular contractions. It can be visualized in approximately 15% of midtrimester gestations. Although it is a subjective diagnosis, we have published diagnostic criteria for this phenomenon (Table 1). In these cases, the internal os cannot be visualized, and thus a cervical length cannot be accurately measured. At times, a poorly developed lower uterine segment may spontaneously resolve during the scan, after which the cervical length can then be measured.

When performing vaginal sonography, we often use a provocative measure to assess for any dynamic changes. Moderate fundal pressure (insufficient to cause any patient discomfort) is applied while maintaining the image of the internal os to determine if a funnel develops or the cervical length shortens. If so, the cervical length should be remeasured. Cervical length shortening may also occur spontaneously, and

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**Figure 1.** Endovaginal sonograph (sagittal view) of a cervix with funneling at the internal os at 18 weeks of gestation. Cervical length is measured from the internal os to functional internal os (approximately 23 mm). Note asymmetric anterior and posterior “shoulders” cephalad to the internal os and lack of a well-defined “shoulder” landmark for caliper placement. Tick marks visible along the top of the image represent a 1-cm scale.

**Figure 2.** Endovaginal sonograph (sagittal view) of a cervix with complete canal dilation of approximately 8 mm at 20 weeks’ gestation in a twin pregnancy. Because the entire canal is dilated, the cervical length is defined as zero. Note the prolapsing chorioamnion at the external os.

**Figure 3.** Endovaginal sonograph (sagittal view) of a poorly developed lower uterine segment at 18 weeks of gestation. Note appreciable cervical length (>50 mm), areas of differing echogenicity, considerable distance between the bladder reflection and the amniotic cavity, and a presumptive internal os located notably cephalad to the inferior edge of the bladder reflection.
this phenomenon and the associated shortened cervical length measurement should also be recorded. We have determined that utilizing the cervical length associated with serial mid-trimester evaluations, and including either fundal pressure-induced or spontaneously occurring dynamic shortening, increases the predictive value of cervical length for spontaneous preterm birth. To observe these dynamic changes, we recommend that cervical scans last a minimum of 5 minutes.

Sonographer Certification and Proficiency

During 2 National Institute of Child Health and Human Development (NICHD) Network observational studies of cervical ultrasound, the sonographers and sonologists at the participating centers were given a video tape and study guide that showed the visualization of critical landmarks and the measurement of cervical length (and other ancillary characteristics). Subjective findings were also shown and explained. To become certified for these studies, and prior to patient enrollment, each sonographer submitted a video tape of 10 vaginal scans and their accompanying data sheets, which demonstrated proper technique, visualization, measurements, and subjective assessments. All of these tapes were reviewed by the respective primary investigator, who was blinded to obstetric outcomes. Based on the performance, additional taped examinations might be requested to confirm adherence to the sonographic protocol. Once enrollment began, the data coordinating centers randomly chose videotaped patient examinations from the participating centers to ensure protocol compliance and provide continuing feedback to the sonographers. These were periodically reviewed by the primary investigator, who was unaware of the obstetric outcomes and also by a member of the data coordinating center.

Additionally, we limited the number of certified sonographers. Because the volume of enrolled patients per center was not large, no more than 2 sonographers could be certified at a single site; if one of the certified sonographers left during the study, his/her replacement was certified in a similar fashion. Based on our collective experience with this process of sonographer certification and continuing quality assurance, we believe that formal supervised education and feedback is crucial to maintaining high standards of quality and reproducibility. These principles have been confirmed in other studies as well. Thus, centers that plan to use cervical ultrasound should develop their own protocols, because many sonographers in current practice did not receive formal educational experience in vaginal ultrasound and cervical assessment. Although some sonographers may have learned to evaluate the cervix by the transabdominal method, this technique has significant technical limitations, and the results are not reproducible.

During these quality assurance reviews, the most common pitfalls included the use of excessive probe pressure (which can be easily assessed by confirming approximately equal cervical widths on the anterior and posterior sides of the endocervical canal), inconsistent funnel measurements (understandable, given the biologic variation), and failure to recognize dynamic cervical shortening and a poorly developed lower uterine segment. However, from a practical standpoint, if a poorly developed lower uterine segment is not recognized and the cervical length is “measured,” a long value is consistently observed. This is unlikely to adversely influence patient management. Conversely, excess pressure or failure to recognize dynamic shortening could yield a falsely reassuring cervical length measurement.

Because these were blinded studies, the sonographers could only notify the managing physicians in cases of fetal death or placenta previa. Because the placenta often appears to be low-lying in the midtrimester, it might appear to encroach on the internal os, and thus we defined previa as placental implantation at least 1

<table>
<thead>
<tr>
<th>Table 1. Criteria for a Poorly Developed Lower Uterine Segment</th>
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<tbody>
<tr>
<td>Unusually long-appearing cervix (eg, length greater than 50-55 mm)</td>
</tr>
<tr>
<td>S-shaped endocervical canal</td>
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<tr>
<td>Two distinctly different areas of echogenicity within the “cervix”</td>
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<tr>
<td>Apparent internal os located appreciably cephalad to the inferior edge of the bladder reflection</td>
</tr>
<tr>
<td>Notably increased distance between the bladder reflection and the amniotic fluid</td>
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<tr>
<td>Asymmetric anterior and posterior lower uterine segment widths, cephalad to apparent internal os</td>
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cm on both sides of the internal os. Most cases of suspected placenta previa in the midtrimester resolve with advancing gestation. In selected cases, follow-up evaluations are necessary to rule out a previa, if the sonographic suspicion is high.

Cervical Ultrasound and the Prediction of Spontaneous Preterm Birth

If cervical competence functions along a biologic continuum of reproductive performance, then assessment of cervical characteristics should provide useful information about at least one component of the preterm birth syndrome, and possibly clues about interactions with the other commonly recognized components in the model. Of the features of the cervix and lower uterine segment anatomy that can be visualized with vaginal sonography, the assessment of cervical length has been the most widely investigated. The sonographic measurement of cervical length has been well standardized and is reproducible. Moreover, it represents an objective linear measurement that lends itself well to assessment of its utility as a screening test and predictor of various pregnancy outcomes.

In a novel retrospective study of 461 women, past obstetric performance was correlated with cervical length assessment in the next pregnancy. The prior reproductive outcomes comprised a wide spectrum from clinically defined cervical incompetence to normal term births. The underlying hypothesis was that if cervical competence functioned as a dichotomous, “all or none,” biologic parameter, and if cervical length were a reasonable surrogate for competence, then women with cervical incompetence should have significantly shortened cervical length. Women, who were delivered prematurely for other causes should have uniformly longer cervical lengths, similar to those women who had experienced normal pregnancy outcomes. Instead, the investigators observed a continuum of cervical lengths (measured at several points in midgestation) directly proportional to the gestational age of the prior spontaneous preterm birth. This report provided fundamental insight into the relationship between cervical length and cervical competence as a continuous, rather than a dichotomous function of reproductive performance and confirmed the utility of cervical ultrasound as an important investigational tool.

Cervical ultrasound images have also been employed to predict obstetric performance, by assessing cervical length and other cervical and lower uterine segment characteristics prospectively at various points in gestation. If these characteristics could identify women at significantly increased risk for preterm birth (presumably from a clinically significant component of diminished cervical competence), then focused interventions could be evaluated in clinical trials.

In 1996, the NICHD Maternal-Fetal Medicine Units Network reported the results of a prospective, blinded study of nearly 3,000 unselected women with singleton gestations who were receiving their prenatal care at the 10 participating university centers. Vaginal ultrasonographic evaluations to assess cervical length and funneling at the internal os and concurrent digital examinations were scheduled at 24 and 28 weeks’ gestation. The investigators observed a strong inverse relationship between cervical length and the likelihood of spontaneous preterm birth <35 weeks’ gestation (Fig 4). Using a cutoff at the 10th percentile of cervical length (<26 mm) at the 24-week scan, there was an associated positive predictive value of only 18%, due, in large part, to the low frequency of preterm birth in the study population.

Figure 4. Estimated probability of spontaneous preterm delivery before 35 weeks of gestation from the logistic regression analysis (dashed line) and observed frequency of spontaneous preterm delivery (solid line) according to cervical length measured by endovaginal ultrasonography at 24 weeks in an unselected population. (Reprinted with permission.)
4.3%). The findings from the 28-week evaluation were even less predictive. Moreover, visualization of funneling did not improve the screening compared to the sole assessment of cervical length. Cervical length was more reliably evaluated than funneling, which was not consistently observed across the 10 centers. Although the information from the digital examinations (Bishop score) had some predictive value for eventual spontaneous preterm birth, its performance was inferior to cervical length.

These findings were significant because they supported the concept that cervical competence, and its surrogate, cervical length, function along a biologic continuum. They also confirmed the previously recognized comparative disutility of digital examinations and cast doubt on whether the recognition of funneling added appreciable information to the measurement of cervical length. This report also showed that, in a low-risk population, cervical ultrasound was not an efficient screening tool for spontaneous preterm birth.

As a result of the first investigation, we hypothesized that evaluations in high-risk women obtained earlier in pregnancy would improve the predictive value of cervical ultrasound, and that serial mid-trimester evaluation of length and other ultrasonographic characteristics would further improve the clinical utility of cervical ultrasound to identify women at high risk for spontaneous preterm birth. In 2001, the Network reported the results of a second investigation, designed to test these hypotheses and others not previously evaluated. We enrolled only women with a prior early (<32 weeks’) spontaneous preterm birth, because the gestational age of the prior birth has been consistently and inversely related to the risk of recurrence. Since it was not known when in gestation or how rapidly nonreassuring cervical findings could develop, we began the sonographic evaluations at 16 to 18 weeks’ gestation. Follow-up examinations were scheduled every 2 weeks until 23 to 24 weeks’ gestation. Women who had received a prophylactic cerclage in the current pregnancy because of a prior clinical history of cervical incompetence were excluded.

A total of 590 vaginal sonograms were performed by certified sonographers and sonologists on 183 high-risk women. At each evaluation, we recorded cervical length and internal os funneling; fundal pressure was then applied to determine if provoked cervical shortening occurred. However, if a poorly developed lower uterine segment was recognized, the cervical length was not measured. Any spontaneous dynamic cervical length shortening that occurred during the examination was noted, including resorption of a poorly developed lower uterine segment. Other cervical and lower uterine segment features identified or measured included: 1) posterior cervical width, 2) lower uterine segment thickness, 3) cervical orientation (vertical/horizontal), 4) minor degrees of canal dilation (<5 mm) with or without, 5) membrane prolapse, and 6) the angle formed by the intersection of the endocervical canal and the posterior lower uterine segment. The primary study endpoint was spontaneous preterm birth <35 weeks’ gestation, and the observed population incidence was 26%.

When the shortest ever observed cervical length, both from the serial evaluations and the result of dynamic shortening, was evaluated for the prediction of preterm birth, women whose cervical lengths were <25 mm had a relative risk of spontaneous preterm birth <35 weeks’ of 4.5 (95% confidence interval 2.7-7.6). From a logistic regression model, we determined that for each 5-mm increase in cervical length, the odds of spontaneous preterm birth fell by 43%. The <25-mm threshold was associated with a sensitivity of 69%, a specificity of 80% and a positive predictive value of 55%.

We also studied funneling and dynamic changes as potentially independent risk factors for spontaneous preterm birth. Clearly, women with either or both of these findings were at higher risk for spontaneous preterm birth, but neither was consistently associated with shorter cervical length. Reviews of the videotaped examinations indicated that, although funnel recognition was reliably recorded, funnel depth measurement was unacceptably operator dependent, owing to the lack of reliable landmarks and to significant biologic variation among funnels. After controlling for cervical length, neither funneling nor dynamic shortening was a statistically significant predictor.

We concluded from these observations that the process by which the cervix shortens may not be as important as the fact that it does shorten.

Because serial sonographic evaluations were performed (median 3 evaluations per patient),
we could determine the rate of cervical shortening and its relation to spontaneous preterm birth. Independent of the baseline cervical length, higher rates of cervical shortening (mm/week) were significantly associated with higher odds of spontaneous preterm birth. Inclusion of cervical length shortening from dynamic changes and data from serial evaluations significantly improved the utility of cervical ultrasound as a screening test for spontaneous preterm birth in a receiver operator characteristic curve analysis (Fig 5). From this curve, a cervical length cutoff of < 25 mm was the best compromise between sensitivity and specificity (1-false-positive rate), and maintained a clinically significant positive predictive value of 55%.

Cervical and lower uterine segment characteristics other than cervical length, funneling and dynamic changes were also reported from this study.21 We chose to study these characteristics both because they were novel and because they were plausibly related to the syndrome of spontaneous preterm birth. For example, posterior cervical width was considered a surrogate for overall cervical size. Whereas smaller cervices may have been a risk factor for cervical hypoplasia, we observed similar mean dimensions in women who were delivered prior to, as opposed to, beyond 35 weeks of gestation. Similarly, we measured the lower uterine thickness adjacent to the bladder reflection as a marker of lower segment thinning. This measurement did not distinguish women who would deliver before 35 weeks’ gestation. The cervical canal contour (straight v curved), dominant cervical position (horizontal/vertical), and prominent vascularity of the lower uterine segment also did not identify women who delivered before 35 weeks'. However, chorioamnionic membrane visualization at the internal os, implying mechanical or inflammatory disruption of the local membrane-decidual interface, was a significant risk factor for spontaneous preterm birth. Also significant were minimal degrees (1-4 mm) of endocervical canal dilation. Both chorioamnion visualization and canal dilation remained significant predictors after controlling for initial cervical length at the 16- to 18-week scan.

In a secondary analysis of the Network study of high-risk women, we reasoned that, if cervical length was a reasonable surrogate for the competency status of the cervix, then spontaneous preterm birth associated with shortened cervical length should preferentially occur earlier as opposed to later in gestation.22 In unselected populations, the frequency of spontaneous preterm birth increases throughout gestation and is highest in the period just prior to term (37 weeks').23 Instead, we observed an inverse relationship, in that a shortened cervical length (defined as < 25 mm and 25-29 mm) was preferentially associated with birth in the midtrimester as opposed to later preterm birth. Only in women with longer cervical lengths (≥ 30 mm) did we observe the typical delivery pattern associated with the natural history of spontaneous preterm birth. We further hypothesized that, if cervical length were a biologically credible measure of reproductive performance, it should also predict the interval from the measurement of the shortest observed cervical length to delivery. Here, we confirmed a very strong positive correlation ($P < .0001$, $r^2 = .42$) between cervical length and the scan-to-delivery interval. These analyses suggest that shortened mid-trimester cervical length implies a clinically significant component of diminished

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Figure 5. Receiver operating characteristic curves of cervical length cutoffs for the prediction of spontaneous preterm birth less than 35 weeks’ gestation. Solid line depicts the performance at the initial 16- to 18-week evaluation before any dynamic shortening. Dashed line depicts the shortest ever observed cervical length from 16 weeks’ to 23 weeks’ 6 days’ gestation and also considers any recognized dynamic shortening. For comparison, the solid dots on the curves represent a cervical length cutoff of less than 25 mm. (Reprinted with permission.17 Copyrighted 2003, American Medical Association.)
cervical competence which may be amenable to therapeutic interventions.

**Cervical Ultrasound and the Incompetent Cervix**

Recently, clinicians have sought to diagnose cervical incompetence and recommend cerclage based on nonreassuring cervical ultrasonographic findings in the midtrimester. As the above-mentioned studies confirm, we recognize a compelling theoretical basis for the presumption that shortened midtrimester cervical length may indicate clinically significant decreased cervical competence. Nevertheless, the diagnosis of cervical incompetence with ultrasonography has been extremely problematic. A review of published criteria for the sonographic diagnosis of cervical incompetence indicates marked disparity among investigators (Table 2).7-24-39 Confounding the interpretation of many of these reports has been the use of non-blinded or retrospective study designs, differences among study populations and uncontrolled interventions. Moreover, in contemporary models of cervical competence as a continuum, the associated adverse obstetric outcome could result from premature cervical ripening related to exogenous processes such as infection, inflammation, hormonal effects, genetic (multifactorial) predisposition or even occult uterine activity. Therefore, the underlying cause of diminished cervical competence might not be uniformly related to inherent mechanical weakness. Thus, the response to mechanical support (ie, cerclage) is impossible to predict accurately.

As cervical length and the risk of spontaneous preterm birth are inversely related along a continuum (Fig 4), regardless of the population studied, selecting an appropriate action point for intervention has been difficult. When vaginal sonography is used to measure cervical length as a screening test in low-risk or unselected populations, the positive predictive values at nominal cutoffs (eg, <25 mm) are generally too low to be clinically relevant.40 Even though the negative predictive values tend to be quite high, the overall clinical utility of this observation is suspect.

**Table 2. Published Reports of the Sonographic Diagnosis of Cervical Incompetence**

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Population</th>
<th>GA</th>
<th>Criteria for Cervical Incompetence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brook, 24 '81</td>
<td>Elective cerclage</td>
<td>MT</td>
<td>Width of internal os &gt;1.9 cm</td>
</tr>
<tr>
<td>Vaalamo, 25 '83</td>
<td>“At risk”</td>
<td>MT</td>
<td>Detached membranes at internal os bulging into a dilated cervical canal</td>
</tr>
<tr>
<td>Varma, 26 '86</td>
<td>“At risk”</td>
<td>10-32 weeks</td>
<td>Not explicitly stated. Cervical canal width &gt;8 mm implied</td>
</tr>
<tr>
<td>Michaels, 27 '86</td>
<td>“At risk”</td>
<td>N/S</td>
<td>Membrane prolapse &gt;6 mm and “short cervix”</td>
</tr>
<tr>
<td>Ayers, 7 '88</td>
<td>Prior MT loss</td>
<td>N/S</td>
<td>CL &lt;40 mm (~2 standard deviations from the mean)</td>
</tr>
<tr>
<td>Podobnik, 28 '88</td>
<td>“At risk”</td>
<td>MT</td>
<td>Not explicitly stated</td>
</tr>
<tr>
<td>Michaels, 29 '89</td>
<td>DES exposed</td>
<td>N/S</td>
<td>Combination of membrane protrusion, progressive herniation, cervical dilation and shortening</td>
</tr>
<tr>
<td>Michaels, 30 '91</td>
<td>Twin gestations</td>
<td>MT</td>
<td>Combination of cervical shortening, canal dilation and membrane protrusion</td>
</tr>
<tr>
<td>Joffe, 31 '92</td>
<td>History of CI</td>
<td>10-28 weeks</td>
<td>Progressive shortening and beaking of the chorioamnion</td>
</tr>
<tr>
<td>Guzman, 32 '94</td>
<td>“At risk” or history of classic CI</td>
<td>8-25 weeks'</td>
<td>Dilation of the internal os with the membranes protruding into canal or funneling &amp; cervical shortening</td>
</tr>
<tr>
<td>Fox, 33 '96</td>
<td>“At risk”</td>
<td>14-28 weeks’</td>
<td>&gt;1 cm decrease in CL and/or funneling</td>
</tr>
<tr>
<td>Guzman, 34 '97</td>
<td>“At risk”</td>
<td>N/S</td>
<td>CL &lt;10 mm or cervix dilated on physical exam</td>
</tr>
<tr>
<td>Guzman, 35 '97</td>
<td>“At risk”</td>
<td>MT</td>
<td>Progressive cervical changes to a CL &lt;26 mm</td>
</tr>
<tr>
<td>Wong, 36 '97</td>
<td>“High-risk”</td>
<td>17-33 weeks</td>
<td>33% decrease in CL</td>
</tr>
<tr>
<td>Guzman, 37 '98</td>
<td>“At risk”</td>
<td>MT</td>
<td>CL &lt;20 mm with or without fundal pressure</td>
</tr>
<tr>
<td>Kurup, 38 '99</td>
<td>All “urgent” cerclages</td>
<td>N/S</td>
<td>Beaking of amniotic fluid at internal os</td>
</tr>
<tr>
<td>MacDonald, 39 '01</td>
<td>“High-risk”</td>
<td>&lt;24 weeks’</td>
<td>CL &lt;10 mm with or without fundal pressure</td>
</tr>
</tbody>
</table>

Abbreviations: GA, gestational age; MT, midtrimester; CL, cervical length; CI, cervical incompetence; N/S, not stated.
particularly in the absence of effective intervention strategies. However, when used in populations with increased risk for spontaneous preterm birth, the summary predictive values improve, because of the increased population incidence of preterm birth and the greater likelihood that women at high-risk for recurrent spontaneous preterm birth have some degree of diminished cervical competence. We believe that women with a history of early spontaneous preterm birth and a shortened midtrimester cervical length represent an ideal population for a randomized trial of cerclage. Based on our previous findings (Fig 5), a cervical length cutoff of <25 mm would appear to be the optimal action point for such a trial, because it represents the best compromise between sensitivity, specificity, and positive predictive value. A randomized trial of cerclage in a population of women with appreciable risk of recurrent spontaneous preterm birth has the potential to determine whether temporary mechanical support of the cervix can treat a syndrome that has many causes and interactive pathways. Recently, the NICHD approved funding for such a trial, which will be undertaken by a consortium of centers in the United States.

Summary

The cervix has an increasingly recognized role in the etiology of spontaneous preterm birth and has become an appropriate focus of research initiatives. Across numerous investigations and study populations, the relationship between shortened midtrimester cervical length and spontaneous preterm birth is consistent and compelling. This relationship, however, is also influenced by interactions with other components of the preterm birth syndrome. Thus, the real clinical utility of these observations will be appreciated only through further investigation into the underlying pathophysiologic events, which culminate in spontaneous preterm birth and the results of well-designed clinical intervention trials in appropriate populations of women at risk for spontaneous preterm birth.

References

21. Yost N for the NICHD MFMU Network: Mid-trimester vaginal sonography: Ancillary markers for spontaneous


