Prediction of Preterm Delivery in the Second Trimester

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OBJECTIVE: The aim of this study was to estimate the probability of spontaneous delivery at 34 weeks or less according to cervical assessment by transvaginal scan associated with previous obstetric history.

METHODS: Ultrasound transvaginal cervical length and presence of funneling were evaluated in 1,958 singleton pregnancies between 21 and 24 weeks of gestation. For the prediction of preterm delivery, the results of cervical assessment were analyzed in association with the previous obstetric history of preterm delivery, spontaneous miscarriage, and curettage. Sensitivity, specificity, and positive and negative predictive values for the various cutoff cervical lengths in the groups with or without previous history of preterm delivery were calculated. Multivariable regression analysis was used to identify the predictive factors for preterm delivery at 34 weeks or less.

RESULTS: The incidence of spontaneous delivery at gestational age of 34 weeks or less was 3.4%. The mean cervical length was 30.1 mm (standard deviation 10.1 mm) in the group with previous history of prematurity (n = 180) and 35.8 mm (standard deviation 7.9 mm) in the group without previous history of prematurity ($P < .001$). The mean cervical length in the group of patients who delivered at or before 34 weeks was 23.8 mm, and for patients who delivered after 34 weeks it was 35.6 mm ($P < .001$). The mean gestational age at delivery was significantly lower in the group with funneling compared with the group without funneling (33.5 weeks versus 38.8 weeks, $P < .001$). Logistic regression analysis demonstrated that cervical length, funneling, and history of previous preterm delivery were independent contributors for preterm delivery.

CONCLUSION: Ultrasound cervical assessment may be useful in the prediction of preterm delivery, but it should also be considered in association with the obstetric history of prematurity. (Obstet Gynecol 2005;105:532–6. © 2005 by The American College of Obstetricians and Gynecologists.)

LEVEL OF EVIDENCE: II-2

In the last decade, transvaginal ultrasound for visualization of the cervix has become an important tool in obstetric antenatal care. The measurement of cervical length in the second trimester of pregnancy is one of the strategies that have been developed to identify high-risk patients for preterm labor.[1–3] Despite of the variety of screening methods proposed to reduce prematurity, the rate of spontaneous preterm birth has not decreased in the last 30 years, remaining around 11% in United States and 4% in France.[4,5]

Transvaginal ultrasonography of the cervix provides a noninvasive method for evaluating cervical status, including length and anatomical appearances, such as funneling. The presence of a short cervix and/or funneling increases the risks for preterm delivery, particularly the severe forms of preterm birth.[1,6,7]

Another risk factor for prematurity is the occurrence of a previous obstetric history of preterm delivery. Many score risk systems have been proposed as screening for preterm delivery, and a previous preterm birth is considered the main factor in the recurrence of a preterm delivery.[8–10]

In a search of the MEDLINE database from 1978 to 2004, using the key words "preterm delivery," "cervical length," and "previous obstetric history," we observed a lack of studies combining cervical ultrasound parameters and previous obstetric history in the calculation of risks for preterm birth. In the present study we evaluated the risks of preterm delivery at 34 weeks or less, taking into account the cervical length and the presence of funneling from transvaginal scan at 21–24 weeks and the previous obstetric history.

PATIENTS AND METHODS

This was a historical cohort study involving 2,391 pregnant women attending the antenatal clinic of the obstetric department of São Paulo University between January 1998 and June 2001. Patients were offered an anomaly scan between 21 and 24 weeks of pregnancy and the option of having a transvaginal scan to measure cervical length. Written informed consent was obtained from

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those who agreed to participate in the study which had been approved by the Hospital Ethics Committee.

For the cervical examination, women were asked to empty their bladders and were placed in the dorsal lithotomy position. Transvaginal sonography with a 5-MHz transducer (Toshiba Eccocce, Tokyo, Japan) was performed. The probe was placed in the anterior fornix of the vagina, and a sagittal view of the cervix and visualization of the endocervical mucosa along the length of the canal were obtained. The calipers were used to measure the distance between the triangular area of echodensity at the external os and the V-shaped notch at the internal os. Each examination lasted about 3 minutes to permit the observation of any cervical changes, and in such cases, the shortest measurement was recorded.[1] Funneling was considered as present or absent and defined as bulging of the membranes into the endocervical canal protruding at least 25% of the entire cervical length.

Patients' characteristics, including demographic data and previous obstetric and medical history, were obtained from the patients at the time of ultrasound scan and fed into a computer database. Similarly, the ultrasound findings were recorded into the database at the time of the scans. The results of the cervical evaluations were not written on the patients' and doctors' reports. Their original doctors provided routine antenatal care. Gestational age was determined from the date of the last menstrual period and confirmed by the measurement of the crown-to-rump length at the first-trimester scan. History of previous preterm delivery was defined as delivery before 37 weeks. Preterm delivery was defined as delivery occurring at 34 weeks of pregnancy or less. Data regarding pregnancy outcome were obtained from the fetal ultrasound database, hospital charts, and the patients themselves by telephone contact.

The mean values for maternal age, cervical length, and gestational age were calculated. The *t* test and χ^2 analysis were used to evaluate the differences in the means and percentages between the studied groups. The sensitivity, specificity, and positive and negative predictive values for the various cutoff cervical lengths in the groups with or without previous history of preterm delivery were calculated. Multivariable regression analysis was used to identify the predictive factors for preterm delivery.

RESULTS

A total of 1,958 cases were analyzed. Patients who had an elective preterm delivery (n = 46), defined as those who had their delivery anticipated due to maternal disease or fetal indication, or cases with missing outcomes (n = 387) were excluded from the study.

The mean maternal age was 26 years (standard deviation [SD] 6.24 years). Cervical examination was performed between 21 and 24weeks (mean 23.4 weeks). The mean gestational age at delivery was 38.5 weeks (SD 2.07).

The mean cervical length was 35.3 mm (SD 8.29 mm) in the general population, 35.8 mm (SD 7.9 mm) in the group without previous history of prematurity, and 30.1 mm (SD 10.1 mm) in the group with previous history of prematurity (n = 180, $P < .001$).

A total of 31 (1.5%) cases presented funneling in the cervical examination, with mean cervical length of 16.7 mm (range 6.6–31.7 mm) compared with 35.6 mm (range 1.0–64 mm) in the group without funneling ($P < .001$). The mean gestational age at delivery was significantly lower in the group with funneling compared with the group without funneling (33.5 weeks versus 38.8 weeks, $P < .001$). In the group with previous history of prematurity, the mean gestational age at delivery was 37.5 weeks compared with 38.8 weeks in the group without previous history of prematurity ($P < .001$). In cases with funneling without previous history of prematurity, the mean cervical length was 18.7 mm and 14.5 mm when associated with previous history of preterm

Table 1. Gestational Age at Delivery in Relation to Maternal Demographic Data

	Delivery ≤ 34 Weeks (n = 66)	Delivery > 34 Weeks (n = 1,892)	*P*
Maternal age (mean y)	27.2	26.6	.407
Race			
White	25 (37.8)	917 (48.5)	.711
Nonwhite	41 (62.1)	975 (51.5)	.141
History			
Preterm delivery	25 (37.9)	155 (8.2)	.001
Miscarriage ≥ 15 wk	5 (7.6)	32 (1.7)	.007
Miscarriage < 15 wk	17 (25.8)	320 (16.9)	.061
Curettage	12 (18.2)	223 (11.8)	.116

Data, except for maternal age, are presented as number (percentage) of subjects.

Table 2. Incidence of Delivery at ≤ 34 Weeks According to Different Strata of Cervical Length

Cervix	n	%	Delivery ≤ 34 Weeks		Mean Gestational Age at Birth (wk)
			n	%	
≤ 10 mm	10	0.5	5	50	33.1 ± 5.3
11–15 mm	29	1.5	18	62	33.4 ± 3.9
16–20 mm	42	2.2	11	26.2	36.5 ± 3.3
21–25 mm	128	6.5	4	3.1	38.4 ± 2.3
26–30 mm	275	14	4	1.5	38.7 ± 1.8
> 30 mm	1,474	75.3	24	1.6	39 ± 1.7

delivery ($P < .001$). The respective mean gestational age at delivery in these groups was 33.3 weeks (range 26–40 weeks) and 33.6 weeks (range 30–38 weeks) ($P < .01$).

There were 66 (3.4%) cases of spontaneous preterm delivery at 34 weeks or less (23–34 weeks). This group presented with a mean cervical length of 23.8 mm (SD 7.9 mm). In the group that delivered after 34 weeks, the mean cervical length was 35.6 mm (SD 7.8 mm, $P < .01$).

Table 1 presents the percentages of delivery before 34 weeks and after 34 weeks in relation to maternal demographic data. The mean cervical length did not differ between the groups with previous history of abortion before 15 weeks (34.2 mm) and at or after 15 weeks (32.4 mm) and curettage (33.7 mm) compared with the group without a previous history (35.3 mm). Table 2 describes the mean gestational age at delivery and percentages of birth at 34 weeks or less according to the different strata of cervical length in the entire population (with and without a history of preterm delivery).

In Tables 3 and 4, we describe the sensitivity, specificity, and positive and negative predictive values according to cervical length in the group with and without a previous history of preterm delivery. The prevalences of preterm delivery in the subgroups with and without a previous history of preterm delivery were 13.9% and 2.3%, respectively.

In the multivariable logistic regression analysis of the possible predictive factors for preterm delivery (previous history of prematurity, miscarriage before 15 weeks, miscarriage after 15 weeks, curettage, cervical length, and funneling), only cervical length (odds ratio [OR] 1.12, 95% confidence interval [CI] 1.08–1.16, $P < .001$), funneling (OR 6.29, 95% CI 2.52–15.71, $P < .001$), and previous history of preterm delivery (OR 2.71, 95% CI 1.44–5.09, $P < .02$) were significantly associated with birth at or before 34 weeks. Figure 1 presents the probabilities of delivery at or before 34 weeks, taking into account cervical length, presence of funneling, and previous history of preterm delivery.

DISCUSSION

In the present study, the main factors involved in the prediction of preterm delivery were short cervix, funneling, and previous obstetric history of prematurity. In the literature, a high-risk population for spontaneous preterm delivery includes those with a previous history of preterm births, late miscarriage, conization, maternal diethylstilbestrol treatment, uterine malformation, short cervix in the second trimester, or a current multiple pregnancy.[11] In our study, we tested the previous obstetric history of prematurity, miscarriages before 15 weeks and at or after 15 weeks, and curettage, and although there were a significantly greater number of preterm delivery in the group with a previous history of late miscarriages and preterm birth, only a previous history of prematurity increased the risk for a new preterm delivery. Many risk scoring systems were developed to identify women at high risk for preterm delivery.[12,13] However, these risks systems are based mainly on the previous obstetric history of preterm birth, considering approximately 15% of the population as high risk with a low positive predictive value (40%).[14] Therefore, screening programs based only on the obstetric history do not

Table 3. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value for Preterm Delivery at ≤ 34 Weeks According to Cervical Length in the Group Without a Previous History of Preterm Delivery

Cervical Length	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
≤ 10 mm	7.3	99.8	50	97.8
≤ 15 mm	29.3	99.4	54.6	98.4
≤ 20 mm	39.0	98.3	34.8	98.6
≤ 25 mm	46.3	92.3	12.5	98.7
≤ 30 mm	53.7	78.6	5.6	98.6

Table 4. Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value for Preterm Delivery at ≤ 34 Weeks According to Cervical Length in the Group With Previous History of Preterm Delivery

Cervical Length	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
≤ 10 mm	8.0	98.7	50	86.9
≤ 15 mm	44.0	96.1	64.7	91.4
≤ 20 mm	72.0	89.0	51.4	95.2
≤ 25 mm	76	75.5	33.3	95.1
≤ 30 mm	80.0	54.2	22.0	94.4

have a good accuracy. To improve the detection rate of preterm delivery, we considered not only previous obstetric history, but also 2 other predictive factors (cervical length and funneling). We observed that the presence of a previous preterm birth was an additional important risk factor when compared with the same cervical length for a woman without a previous history of prematurity. For example, for a pregnant woman with a cervical length of 20 mm, the positive predictive value for preterm delivery was 51.4% if there is a previous history of prematurity, and for the same cervical length without a previous premature birth, it was 34.8%.

The mean cervical length for the general population was 35.3 mm, which is in accordance with the mean value described in the literature for 21–24 weeks of gestation.[7,15,16] Cervical length measurement was significantly shorter in the group with a previous history of prematurity than in the group without a history of prematurity. Two other studies found a shorter cervical length in a group of patients with previous obstetric history of preterm delivery and midtrimester losses.[1,17] In our study, a previous history of early or late miscarriages and curettage did not have a great impact on the length of the cervix. A previous history of miscarriage at gestational age of less than 15 weeks and curettage were not associated with births at or before 34 weeks. Nevertheless, miscarriage at gestational age of 15 weeks or older and history of preterm delivery did show an association. As described previously, the shorter the cervix, the lower the gestational age at birth.[18–20] In this study, the mean gestational age at delivery was 33.3 weeks for a cervical length of 15 mm or less, and 59% of these cases delivered at or before 34 weeks.

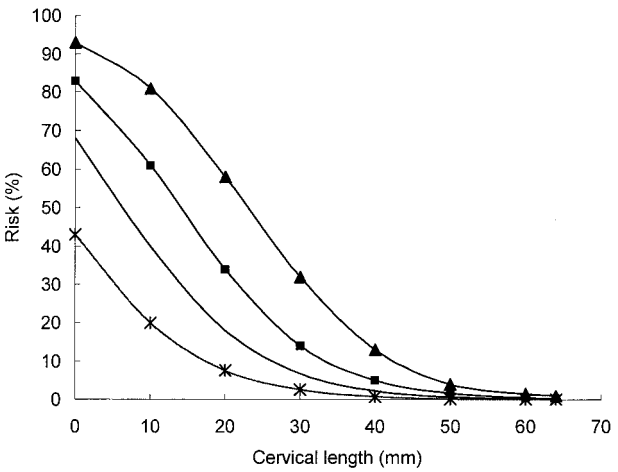

Fig. 1. The probability of delivery at or before 34 weeks according to cervical length (*asterisks*), presence of funneling (*squares*), previous history of prematurity (*solid line*), and presence of funneling combined with a previous history of prematurity (*triangles*).

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We also observed a shorter cervix in the group presenting funneling compared with the nonfunneling group, and these two factors were considered independent variables. Therefore, they could be used independently in the prediction of prematurity. To et al[21] observed funneling in 4% of a population of 6,819 pregnant women, and the rate of spontaneous delivery before 33 weeks was significantly higher among these women (6.9%) compared with those without funneling (0.7%). However, logistic regression analysis demonstrated that funneling did not provide a significant additional contribution to cervical length. In the study by Iams et al,[7] the clinical value of funneling as a predictor of preterm delivery was similar to that of the cervical length. The findings of the studies on funneling with normal cervical length are not uniform regarding the contribution of isolated funneling toward preterm delivery.

We estimated the risk of premature delivery using different parameters, isolated or combined. For a pregnant woman with a cervical length of 20 mm, the risk of delivery at or before 34 weeks was 7%. This risk increased to 34% if funneling was present, and to 59% if she also had a previous history of premature delivery. However, if there was only a short cervix (20 mm) associated with previous history of prematurity, the risk was 18%. Therefore, in a pregnant women with a history of preterm delivery, cervical evaluation in the second

trimester of pregnancy should be considered. This study provides evidence that cervical evaluation in the second trimester of pregnancy is useful in the prediction of preterm delivery, although any previous history of preterm delivery should also be considered.

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