

Cervical length at 23 weeks of gestation: relation to demographic characteristics and previous obstetric history

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ABSTRACT

Objectives To examine the feasibility of introducing routine measurement of cervical length at 23 weeks of gestation, to establish the distribution of cervical lengths in a routine population of singleton pregnancies and to examine the relation between cervical length and demographic characteristics and previous obstetric history.

Methods Cervical length was measured by transvaginal sonography at 23 weeks of gestation in women with singleton pregnancies attending for routine antenatal care. The distribution of cervical lengths was established and the significance of differences in median cervical length between subgroups according to maternal age, ethnic origin, maternal ponderal index, cigarette smoking, alcohol drinking, drug abuse and previous obstetric history was calculated. In addition, 100 women were asked to complete a questionnaire aimed to assess the degree of discomfort, pain or embarrassment caused by the scan. In 100 pregnancies, cervical length was measured in each patient by two of four operators to determine intraobserver and interobserver variabilities.

Results During the study period, 2702 (80%) of the 3358 women attending for a 23-week scan agreed to participate in the study and, in all cases, the cervical length was measured successfully. The median cervical length was 38 mm and in 1.6% of cases the length was 15 mm or less. More than 90% of the women reported that the procedure was associated with no or only mild discomfort and embarrassment, whilst 85% found the ultrasound scan to be equally or less uncomfortable than a speculum examination. Measurement of cervical length was highly reproducible and, on 95% of occasions, the difference between two measurements by the same observer and by two observers was ≤ 3.5 mm and ≤ 4.2 mm, respectively. Cervical length was significantly shorter in women of Afro-Caribbean origin compared to Caucasians, those aged less than 20 years,

those with a low ponderal index, those with a history of previous miscarriage or preterm delivery and in drug abusers.

Conclusions Transvaginal sonographic measurement of cervical length is highly reproducible and it is associated with a minimal degree of discomfort to the patients. At 23 weeks, the median cervical length is 38 mm and, in 1.6% of the population, the length is 15 mm or less. There is an association between cervical length and demographic characteristics and previous obstetric history.

INTRODUCTION

Preterm delivery is the leading cause of neonatal death¹. The risk for this pregnancy complication varies with the maternal characteristics, such as ethnic origin, age, ponderal index, cigarette smoking and drug abuse, as well as previous obstetric history. Recent evidence suggests that routine assessment of cervical length at 22–24 weeks of gestation provides sensitive prediction of spontaneous preterm delivery^{2,3}.

The aims of the present study were to examine the feasibility of introducing routine measurement of cervical length at 23 weeks of gestation, to establish the distribution of cervical lengths in a routine population of singleton pregnancies and to examine the relation between cervical length and demographic characteristics and previous obstetric history.

PATIENTS AND METHODS

Recruitment of patients and measurement of cervical length

At King's College Hospital, London, women attending for routine antenatal care are offered the option of having two

ultrasound examinations; the first is at 10–14 weeks of gestation and the second at 23 weeks. During a 14-month period (January 1997 to March 1998), women attending for the 23-week scan were offered the option of having transvaginal sonographic assessment of the cervix. Written informed consent was obtained from those agreeing to participate in the study which was approved by the hospital ethics committee.

The women were asked to empty their bladder and were placed in the dorsal lithotomy position. A speculum examination was first carried out and a dry swab was taken from the posterior vaginal fornix for bacteriology as described by Nugent and colleagues⁴. Transvaginal sonography with a 5-MHz transducer (Aloka 1700, Aloka Co. Ltd., Tokyo, Japan) was carried out by one of five sonographers who had received the Fetal Medicine Foundation Certificate of competence in cervical assessment. The probe was placed in the anterior fornix of the vagina and a sagittal view of the cervix, with the echogenic endocervical mucosa along the length of the canal, was obtained (Figure 1). Care was taken to avoid exerting undue pressure on the cervix. 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 os⁵. Each examination was performed during a period of about 3 min to observe any cervical changes; such changes that may be due to contractions are observed in less than 1% of patients and, in such cases, the shortest measurement is recorded. The presence or absence of funneling at the internal os was recorded.

Patient characteristics, including demographic data and previous obstetric and medical history, were obtained from the patients at their first antenatal visit to the hospital by midwives and were entered into a computer database. Similarly, the ultrasound findings were recorded in the database at the time of the scan. Gestational age was determined

from the menstrual history and confirmed from the measurement of fetal crown–rump length at the first-trimester scan.

A computer search was made to identify all singleton pregnancies that had a 23-week cervical assessment. The distribution of cervical lengths was tested for normality using the Kolmogorov–Smirnov test. Unpaired Student's *t* test was used to calculate the significance of differences in mean cervical length between subgroups and the χ^2 test was used to determine the significance of differences between subgroups in the percentage of cases with cervical length ≤ 15 mm (Figure 1b); this cut-off identifies a very high-risk group for preterm delivery³. Multiple linear regression analysis was used to determine those variables that provided a significant independent contribution in explaining the variance in cervical length. In this model, maternal age and ponderal index were used as continuous variables; cigarette smoking, drug and alcohol abuse and cervical surgery were scored as 1 (for yes) or 0 (for no); ethnic group was scored as 0 for Caucasians and 1 for non-Caucasians; obstetric history was scored as 0 for primigravidae, for those with previous deliveries at term and those with previous fetal losses at less than 16 weeks, 1 for those with a previous spontaneous delivery at 33–36 weeks, 2 for those with a previous spontaneous delivery at 24–32 weeks, and 3 for those with a previous spontaneous miscarriage at 16–23 weeks.

Patient acceptability

At the end of the screening procedure, 100 women who were examined consecutively were asked to complete a questionnaire aimed to assess the acceptability of the procedure. They were asked to record the degree of discomfort, pain or embarrassment caused by the scan and to

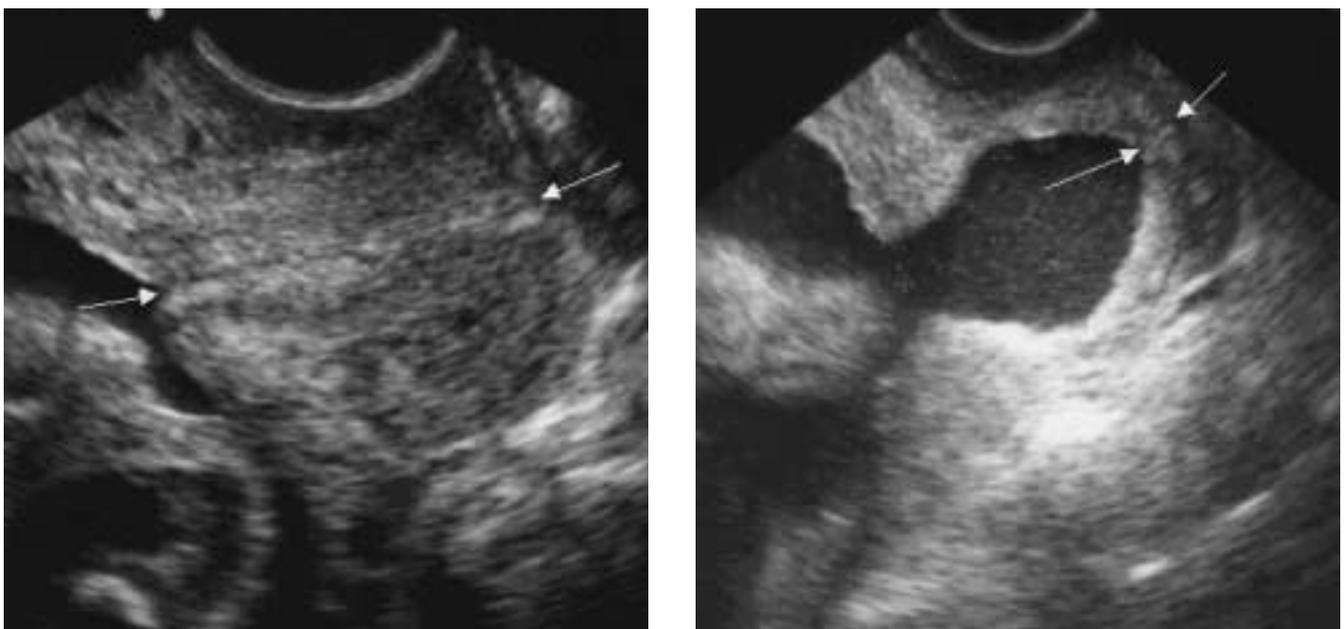


Figure 1 Measurement of cervical length by transvaginal sonography. On the left is a normal cervix and on the right there is severe shortening with marked funneling

compare the degree of discomfort to that caused by the speculum examination.

Repeatability of measurements

In a study involving 100 pregnancies, cervical length was measured on each patient by two of four well-trained operators who had previously carried out at least 150 transvaginal cervical assessments. To assess repeatability of different components of variability, six measurements of cervical length were made on each patient. The first operator generated the appropriate image and measured cervical length in the usual way and then generated a new image and repeated the measurement (intraobserver repeatability). This second image was frozen on the screen but the calipers were removed and the second operator reset the calipers and made a measurement (caliper placement repeatability). The process was then repeated with the operators reversed (interobserver repeatability). Thus, six measurements were obtained: A1, A2, BP, B1, B2 and AP, where A and B represent the two operators, 1 and 2 indicate the two normal measurements, and P indicates the measurement that involved only placement of the calipers. Numeric displays on the screen were covered so that the operators were blinded to the actual measurement and were unaware of results obtained by the previous operator.

Repeatability of cervical length measurements and between-observer comparisons was assessed using the four normal measurements on each patient (A1, A2, B1 and B2 described above). Intraobserver variation was analyzed by calculating the standard deviation (SD) of the differences between A1 and A2 and between B1 and B2 from the 200 pairs of measurements. Interobserver variation was analyzed by calculating the SD of the differences between the means of pairs of measurements made by two observers on the same patient (100 observations of the mean of A1 and A2 compared to the mean of B1 and B2). Caliper placement repeatability was assessed from the SD of the 200 pairs of between-observer differences (A2 – BP or B2 – AP).

RESULTS

During the study period, 3358 women with singleton pregnancies attended for a scan at 22–24 (median 23) weeks of gestation and 2702 (80%) of these agreed to participate in the study. In all cases, the cervical length was measured successfully. The cervical length was approximately normally distributed with some skewness at the lower end (Figure 2). The median (and mean) value was 38 mm, and the 5th and 1st centiles were 23 mm and 11 mm, respectively. In 18.6%, 8.1%, 3.4% and 1.6% of cases, the cervical length was ≤ 30 mm, ≤ 25 mm, ≤ 20 mm and ≤ 15 mm, respectively.

Funneling of the cervical canal at the level of the internal os was observed in 217 (8.0%) of the cases; funneling was observed in all 43 cases with cervical length ≤ 15 mm, in 65 (37.1%) of 175 with cervical length of 16–25 mm, in 87 (7.4%) of 1172 with cervical length of 26–38 mm and in 22 (1.7%) of 1312 with cervical length greater than 38 mm.

The mean cervical length was significantly shorter in women of Afro-Caribbean origin compared to Caucasians, in women aged less than 20 years, those with a low ponderal index and drug abusers (cannabis ($n = 6$), cocaine ($n = 5$), heroin ($n = 6$)) (Table 1). In terms of obstetric history, 31% of the patients had no previous pregnancies, 19% had only had one or more miscarriages and/or termination of pregnancy before 16 weeks of gestation, 44% had one or more term deliveries, with or without previous fetal losses before 16 weeks, 3% had at least one previous spontaneous preterm delivery at 33–36 weeks, 2% had at least one previous spontaneous preterm delivery at 24–32 weeks, 1% had at least one previous miscarriage at 16–23 weeks, 1% had at least one previous termination at 16–23 weeks; some patients in the latter four groups may also have had first-trimester losses or term deliveries. The groups are compared for mean cervical length in Table 1.

The percentage of women with a very short cervix (≤ 15 mm) was significantly increased in women of

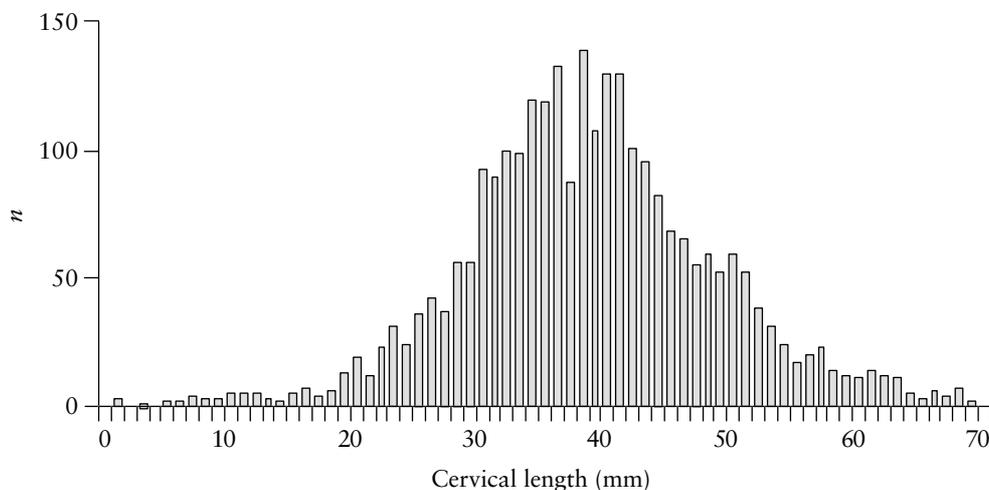


Figure 2 Frequency distribution of cervical length at 23 weeks of gestation in a routine population of 2702 singleton pregnancies

Table 1 Cervical length at 23 weeks of gestation and patient characteristics. For previous obstetric history, patients are grouped according to the pregnancy resulting in the earliest spontaneous delivery between 16 and 36 weeks

Patient characteristics	n (%)	Cervical length		Mean difference (95% CI)	p Value
		Mean (SD) (mm)	Comparison of groups		
<i>Ethnic group</i>					
1 Caucasian	1288 (47.7)	39.5 (9.2)	1 vs. 2	-2.12 (-2.90 to 1.35)	< 0.0001
2 Afro-Caribbean	1285 (47.5)	37.4 (10.7)	2 vs. 3	2.67 (0.76 to 4.59)	< 0.01
3 Other	129 (4.8)	40.1 (9.2)	1 vs. 3	0.55 (-1.12 to 2.22)	NS
<i>Age (years)</i>					
1 < 20	193 (7.1)	35.6 (9.0)	1 vs. 2	3.10 (1.65 to 4.54)	< 0.0001
2 20–35	2140 (79.2)	38.7 (9.9)	2 vs. 3	0.46 (-0.73 to 1.65)	NS
3 > 35	369 (13.7)	39.1 (10.9)	1 vs. 3	3.56 (1.86 to 5.25)	< 0.0001
<i>Ponderal index</i>					
1 < 19.8	174 (6.5)	36.0 (8.9)	1 vs. 2	2.43 (0.91 to 3.94)	< 0.005
2 19.8–26	1595 (59.0)	38.4 (9.7)	2 vs. 3	0.84 (0.03 to 1.66)	< 0.05
3 > 26	933 (34.5)	39.2 (10.5)	1 vs. 3	3.27 (1.78 to 4.76)	< 0.0001
<i>Cigarette</i>					
1 Smoker	423 (15.7)	37.9 (9.5)	1 vs. 2	0.78 (-0.26 to 1.82)	NS
2 Non-smoker	2279 (84.3)	38.6 (10.1)			
<i>Alcohol</i>					
1 Drinker	51 (1.9)	40.3 (11.0)	1 vs. 2	-1.78 (-4.55 to 0.99)	NS
2 Non-drinker	2651 (98.1)	38.5 (10.0)			
<i>Illicit drugs</i>					
1 User	17 (0.6)	33.8 (8.7)	1 vs. 2	4.79 (0.02 to 9.57)	< 0.05
2 Non-user	2685 (99.4)	38.6 (10.0)			
<i>Cervical surgery</i>					
1 Cone biopsy	8 (0.3)	34.6 (8.3)	1 vs. 3	3.92 (-3.03 to 10.87)	NS
2 Laser surgery	44 (1.6)	38.3 (9.6)	2 vs. 3	0.27 (-2.71 to 3.26)	NS
3 None	2650 (98.1)	38.5 (10.0)	1 and 2 vs. 3	0.83 (-1.92 to 3.58)	NS
<i>Obstetric history</i>					
1 Primigravidae	826 (30.6)	38.5 (9.3)	1 vs. 2	0.04 (-0.74 to 0.83)	NS
2 Multigravidae	1876 (69.4)	38.5 (10.3)			
3 Fetal loss at < 16 weeks	510 (18.9)	37.2 (10.5)	1 vs. 3	-1.31 (-2.43 to -0.20)	< 0.05
4 Delivery at ≥ 37 weeks	1196 (44.3)	39.5 (10.1)	1 vs. 4	1.00 (0.15 to 1.85)	< 0.05
5 Delivery at 33–36 weeks	75 (2.8)	36.0 (9.2)	1 vs. 5	-2.51 (-4.71 to -0.32)	< 0.05
6 Delivery at 24–32 weeks	39 (1.4)	35.3 (11.2)	1 vs. 6	-3.22 (-6.23 to -0.20)	< 0.05
7 Termination at 16–23 weeks	36 (1.3)	37.4 (11.7)	1 vs. 7	-1.14 (-4.27 to 2.00)	NS
8 Miscarriage at 16–23 weeks	20 (0.7)	33.9 (11.6)	1 vs. 8	-4.60 (-8.74 to -0.45)	< 0.05

NS, not significant; CI, confidence interval

Afro-Caribbean origin and in those with a low or high ponderal index (Table 2).

Multiple regression analysis demonstrated significant independent contributions in explaining cervical length by ethnic origin, past obstetric history, maternal age and ponderal index (Table 3).

Acceptability study

Out of the 100 women questioned about the acceptability of the transvaginal scan, 94% reported that the procedure was associated with no or only mild discomfort and 98% reported no or only mild embarrassment (Figure 3). The degree of pain experienced by the women was recorded on a linear scale measuring 10 cm with 0 representing no pain and 10 representing extremely severe pain; the median score was 0.5 (range 0–6.5). Compared to the speculum examination, the ultrasound scan was recorded as being less, equally or more uncomfortable by 50%, 35% or 15%, respectively (Figure 3).

Repeatability of measurements

The cervical length was successfully measured by both operators in all 100 cases, and a total of 600 measurements were made. The median cervical length in the 100 patients, using the mean of four measurements (A1, A2, B1, B2) was 38 mm. The standard deviation of differences between repeat readings by the same observer, pooled across the four observers, was 1.76 mm. Likewise, the between-observer standard deviation was 2.13 mm for the mean of two measurements. Consequently, on 95% of occasions, the difference between two measurements by the same observer (intraobserver) would not differ by more than 3.5 mm and the corresponding number for two observers (interobserver) would be 4.2 mm. There was a significant relationship between mean cervical length and both within-observer difference and between-observer difference (Figure 4). When we considered only measurements below the median (38 mm), the intraobserver and interobserver standard deviations were 1.3 mm and 1.7 mm, respectively. The between-observer SD when the image was fixed was

Table 2 Incidence of cervical length of 15 mm or less at 23 weeks of gestation. The relative risk (RR) was calculated as a proportion of the percentage of women with a short cervix in the overall population (1.6%)

Patient characteristics	Total	n (%)	RR	Comparison of subgroups	d.f.	p Value
<i>Ethnic group</i>						
1 Caucasian	1288	6 (0.5)	0.29		2	< 0.0001
2 Afro-Caribbean	1285	36 (2.8)	1.76	1 vs. 2	1	< 0.0001
3 Other	129	1 (0.8)	0.49	1 vs. 3	1	NS
<i>Age (years)</i>						
1 < 20	193	3 (1.6)	0.98		2	NS
2 20–35	2140	31 (1.4)	0.91			
3 > 35	369	9 (2.4)	1.53			
<i>Ponderal index</i>						
1 < 19.8	174	5 (2.9)	1.81		2	< 0.05
2 19.8–26	1595	16 (1.0)	0.63	1 vs. 2	1	< 0.05
3 > 26	933	22 (2.4)	1.48	2 vs. 3	1	< 0.01
<i>Cigarette</i>						
1 Smoker	423	3 (0.7)	0.44		1	NS
2 Non-smoker	2279	40 (1.8)	1.10			
<i>Alcohol</i>						
1 Drinker	51	0			1	NS
2 Non-drinker	2651	43 (1.6)	1.00			
<i>Illicit drugs</i>						
1 User	17	0			1	NS
2 Non-user	2685	43 (1.6)	1.00			
<i>Cervical surgery</i>						
1 Cone biopsy	8	0			2	NS
2 Laser surgery	44	0				
3 None	2650	43 (1.6)	1.00			
<i>Obstetric history</i>						
1 Primigravidae	826	8 (1.0)	0.61		6	< 0.01
2 Multigravidae	1876	35 (1.9)	1.17	1 vs. 2	1	NS
3 Fetal loss at < 16 weeks	510	16 (3.1)	1.97	1 vs. 3	1	< 0.01
4 Delivery at ≥ 37 weeks	1196	13 (1.1)	0.68	1 vs. 4	1	NS
5 Delivery at 33–36 weeks	75	2 (2.7)	1.68	1 vs. 5	1	NS
6 Delivery at 24–32 weeks	39	2 (5.1)	3.22	1 vs. 6	1	NS
7 Termination at 16–23 weeks	36	1 (2.8)	1.75	1 vs. 7	1	NS
8 Miscarriage at 16–23 weeks	20	1 (5.0)	3.14	1 vs. 8	1	NS

d.f., degrees of freedom; NS, not significant

Table 3 Multiple regression analysis to demonstrate significant independent contributions in explaining the variance in cervical length

Patient characteristics	β (95% CI)	p Value
Obstetric history	-1.97 (-2.95 to -0.98)	< 0.0001
Ethnic group	-2.04 (-2.83 to -1.26)	< 0.0001
Ponderal index	0.15 (0.07 to 0.23)	< 0.0001
Maternal age	0.15 (0.09 to 0.22)	< 0.0001
Cervical surgery	-1.71 (-4.44 to 1.02)	NS
Smoking	-0.74 (-1.79 to 0.32)	NS
Drug abuse	-3.71 (-8.44 to 1.03)	NS
Alcohol consumption	0.57 (-2.20 to 3.34)	NS

NS, not significant; CI, confidence interval

1.49 mm (95% of the time the two readings would not differ by more than ± 3 mm). Therefore, only a part of the between-observer variation is due to placing of the calipers; the remaining difference presumably reflects variation in obtaining the image and/or true changes in cervical length during the scan.

DISCUSSION

This study has demonstrated the feasibility of transvaginal sonographic assessment of the cervix at the time of the routine 23-week scan. The examination takes less than 5 min to complete and it is associated with a minimal degree of discomfort to the patients. In our study, 80% of the women agreed to have cervical assessment and more than 90% of these reported that the procedure was associated with no or only mild discomfort and embarrassment, whilst 85% found the ultrasound scan to be equally or less uncomfortable than a speculum examination. Measurement of cervical length was highly reproducible and, on 95% of occasions, the difference between two measurements by the same observer and by two observers was 3.5 mm or less and 4.2 mm or less, respectively; the variability of measurements was less when the cervical length was below the median.

The mean cervical length of 38 mm was similar to that of other studies that measured cervical length at 20–24

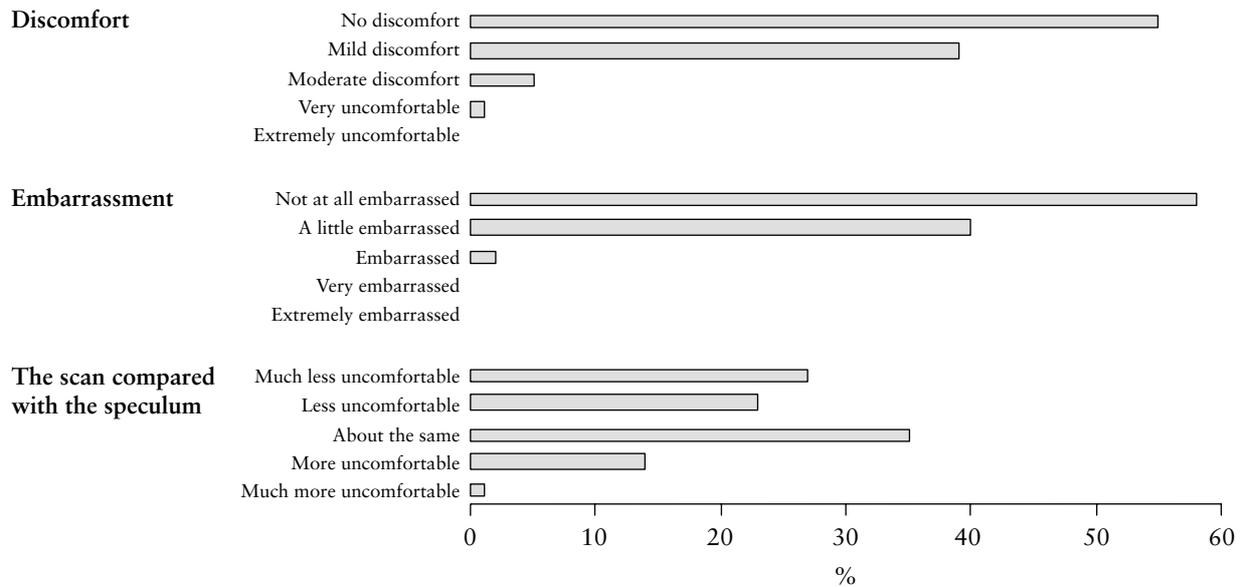


Figure 3 Acceptability of transvaginal sonographic assessment of cervical length. The responses to questions on degrees of discomfort and embarrassment and comparison of the scan to the speculum examination are given as percentages

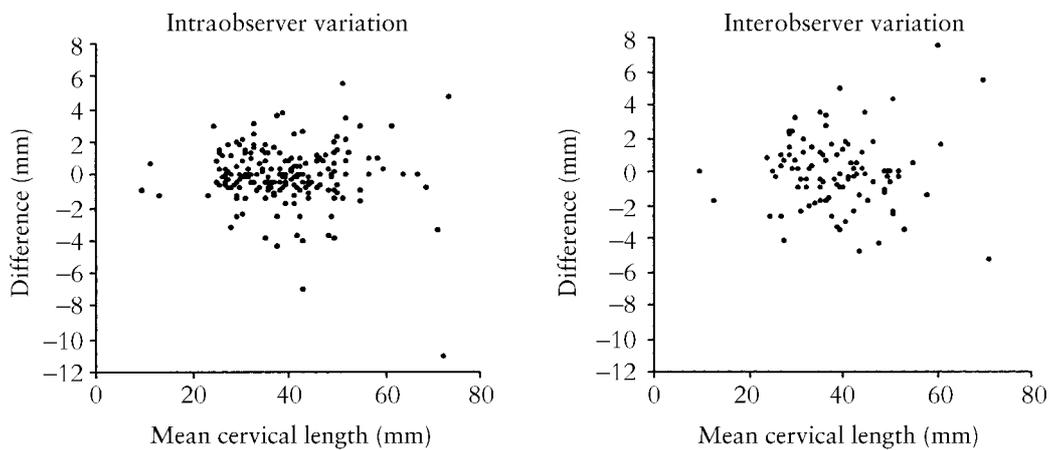


Figure 4 Relationship between mean cervical length and intraobserver difference (left) and interobserver difference (right)

Table 4 Previous studies of low-risk populations providing sufficient data to allow calculation of median or mean cervical length at 20–24 weeks of gestation

Reference	Ultrasonography	n	Cervical length (mm)	Multigravida vs. primigravida*
Ayers et al., 1988 ⁶	transabdominal	24	52	multi similar to primi
Podobnik et al., 1988 ⁷	transabdominal	80	48	—
Andersen et al., 1990 ⁵	transvaginal	19	40	—
	transabdominal	21	43	—
Kushnir et al., 1990 ⁸	transvaginal	24	48	multi similar to primi
Andersen, 1991 ⁹	transvaginal	25	41	multi longer than primi
	transabdominal	25	42	—
Murakawa et al., 1993 ¹⁰	transvaginal	44	37	multi similar to primi
Zorzoli et al., 1994 ¹¹	transvaginal	121	42	multi longer than primi
Iams et al., 1995 ¹²	transvaginal	106	37	—
Iams et al., 1996 ²	transvaginal	2915	35	multi longer than primi
Cook et al., 1996 ¹³	transvaginal	41	42	primi longer than multi
Hasegawa et al., 1996 ¹⁴	transvaginal	78	38	multi similar to primi
Tongsong et al., 1997 ¹⁵	transvaginal	38	42	multi similar to primi

*, cervical length of multigravid (multi) women compared to that of primigravid (primi) women

weeks in low-risk populations (Table 4)^{2,5-15}. Furthermore, our findings that in 18.6%, 8.1%, and 3.4% of cases the cervical length was ≤ 30 mm, ≤ 25 mm and ≤ 20 mm, respectively are similar to the 23.7%, 7.8% and 3.0% reported by Iams and colleagues in their study of 2915 pregnancies at 24 weeks of gestation².

In Western societies, the incidence of preterm delivery is higher in all ethnic minorities, particularly in those of Afro-Caribbean origin, but two studies in the USA in a total of more than 16 000 women reported that, when social and demographic factors were accounted for, maternal race was not a significant risk factor for preterm delivery^{16,17}. In our study, women of Afro-Caribbean origin, compared to Caucasians, had a shorter cervical length and a higher proportion had a length of ≤ 15 mm. Furthermore, multiple regression analysis demonstrated a significant contribution of race in explaining the variation in cervical length having accounted for other demographic characteristics.

We found that cervical length was shorter in women aged less than 20 years. This is compatible with the well-documented increased risk for poorer pregnancy outcome in teenagers. It has previously been suggested that this increased risk is probably due to associated social and behavioral factors rather than intrinsic biological determinants of the young age¹⁸.

The incidence of preterm delivery is higher in women that smoke than in non-smokers^{19,20}. It has been suggested that smoking may induce labor by increasing the amniotic fluid concentration of the inflammatory mediator platelet activating factor; cigarette smoke is a potent inhibitor of the enzyme that degrades platelet activating factor²¹. We found that the mean cervical length in cigarette smokers was not significantly lower than in non-smokers.

In our population, only 0.7% of women admitted to being drug abusers and in this group the cervical length at 23 weeks was decreased. Previous studies have reported an association between drug abuse and preterm delivery²². The risk is particularly high with cocaine²³, which may act through its effect on placental production of prostaglandins²⁴.

The incidence of preterm delivery may be slightly higher in primiparous than in multiparous women^{22,25}. Our data, as well as those from most previous studies reporting on cervical length, showed no significant difference in cervical length between primiparous and multiparous women (Table 4)^{6,8,10,14,15}. In terms of obstetric history, the cervical length was shorter in patients with previous mid-trimester losses or preterm deliveries. These findings are in agreement with those of a previous study examining the relation of cervical length at 23–24 weeks to obstetric history¹². Similarly, our finding that women with a previous cone biopsy had a shorter cervix is compatible with the reported increased risk of preterm delivery after this type of surgery^{22,26,27}.

Low pre-pregnancy maternal weight is associated with an increased risk of preterm delivery, particularly in women who are very underweight (less than 80% of recommended weight for height) and have low weight gain during preg-

nancy^{28,29}. In our study, the median cervical length was shorter and the incidence of very short cervix was higher in women with a low ponderal index.

There is evidence that short cervical length at 23–24 weeks of gestation is associated with increased risk of preterm delivery^{2,3}. This study has demonstrated that significant independent contributions in explaining the variance in cervical length are provided by ethnic group, ponderal index, maternal age and obstetric history.

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