[原著] Risk assessment of threatened preterm labor and prediction of premature cervical dilatation from the ultrasonographically determined morphological shape of the cervix

Risk assessment of threatened preterm labor and prediction of premature cervical dilatation from the ultrasonographically determined morphological shape of the cervix

Bilquis Qureshi, Kaoru Inafuku, Masahiro Higashi and Koji Kanazawa

Department of Obstetrics and Gynecology
Faculty of Medicine, University of the Ryukyus, Okinawa, Japan

(Received on March 25, 1997, accepted on April 22, 1997)

ABSTRACT

The present study was designed to develop a screening technique for early detection of women at risk for threatened preterm labor from the morphological shape of the cervix at the level of internal os. The shape was determined by transvaginal ultrasonography. Ultrasonographic evaluation of the morphological status of the cervix was performed in 57 randomly selected subjects between 16-24 weeks of pregnancy who had no sign or symptom of uterine contraction and no cervical dilatation. Ultrasonographically, the cervix, at the level of internal os was classified into 3 types: convex, flat and concave. Cervical length was measured from the internal to the external os. Subjects were monitored with a tocodynamometer to indicate the presence of uterine contraction. If contraction occurred once every 10-15 minutes before 33 weeks of gestation, it was considered as threatened preterm labor. The Chi-square test, Student's t-test and Anova were used for statistical analysis. Among the 57 subjects, 25 women showed a convex type of cervix, 17 women showed a flat type, and 15 women showed a concave type. Twenty seven (47.4%) women developed threatened preterm labor (7 with convex, 10 with flat and 10 with concave type). Twenty two women (38.6%) developed premature cervical dilatation (2 with convex, 7 with flat and 13 with concave type). Compared to the convex type, the concave and the flat type of cervix had a greater incidence of threatened preterm labor ($p<0.05$ for both types) and premature cervical dilatation ($p<0.001$ and $p<0.05$ for concave and flat type, respectively). The concave and flat types showed a positive predictive value of 86.7% and 41.2%, respectively, for premature cervical dilatation. Our results suggest that threatened preterm labor can be assessed in early pregnancy by ultrasonographic determination of the morphological shape of the cervix.*Ryukyu Med. J., 17 (1)31~36, 1997*

Key words: transvaginal ultrasonography, cervical shape, threatened preterm labor

INTRODUCTION

Preterm delivery is one of the major causes of perinatal morbidity and mortality. Although the survival rate of preterm birth has increased with the improvement of neonatal care, prevention of preterm birth has not yet been achieved. Assessment of cervical status is regarded as an important factor in the identification and management of patients at risk for preterm delivery[1] and digital examination had been used as the primary indicator for cervical scoring for many years. Since the early 1980s, transvaginal ultrasonography has been used extensively for pelvic imaging as it is a non invasive technique. The objectivity of the sonographical examination has made it useful for the assessment of cervical status in gravid uterus, especially in evaluating the risk of cervical incompetence and threatened preterm labor[2]. To date, cervical shortening and funneling of the internal os have been considered as the principal indicators for identification of threatened preterm labor[3-5]. Some authors have described the V shape and U shape of the cervix after dilatation and showed its relation to the outcome of pregnancy[6]. Despite these findings, cervical assessment has not become a routine screening approach for preterm delivery risk assessment[7]. Meanwhile the risk scoring system has been able to diagnose only 30% of patients with spontaneous preterm labor early enough for them to become candidates for intervention in arresting preterm delivery[8].

The purpose of this study was to develop a screening technique for identifying women at risk for threatened

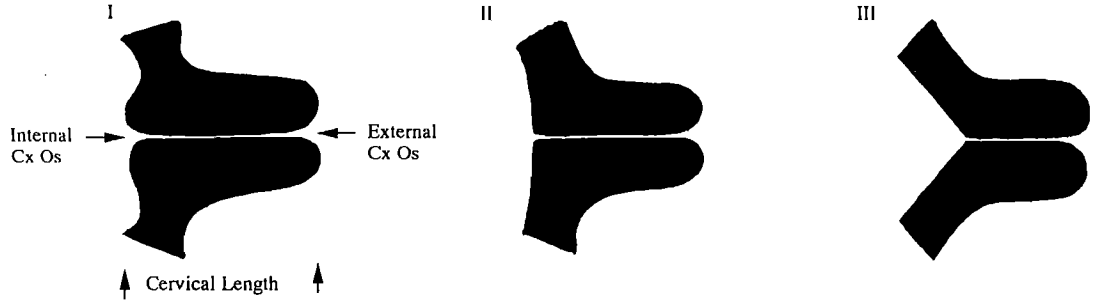

Fig. 1 Schematic representation of the morphological shape of the uterine cervix.
I) Convex, II) Flat III) Concave. Cx: Cervix

preterm labor and premature cervical dilatation by determining the shape of the cervix ultrasonographically. Serial changes of the cervical status from the morphological shape at the level of internal os in gravid uterus has not been described previously. We studied the morphological status of the cervix before the development of uterine contraction and cervical dilatation in early pregnancy.

MATERIALS AND METHODS

The study was performed from January 1995 until April 1996 in the outpatient clinic of our University Hospital. The heterogeneous study group consisted of 61 pregnant women who were chosen randomly, regardless of age, parity and past obstetrical history. Women with placenta previa, uterine anomaly, or previous cervical conization were excluded from the study. There were two twin pregnancies.

All the women were informed about the study program and consent was obtained. A prospective serial ultrasonographic assessment of the morphological status of the cervix was then started in women in the absence of symptoms of uterine activity. The first ultrasonographical examination was performed in every patient between 16-24 weeks in the dorsolithotomy position. The ultrasonography was done with an optimally filled bladder as an over distended bladder may artificially elongate the relatively compliant pregnant cervix[9]. Scans were performed using an Aloka 3000 scanner with a 5MHz sector scanner attached to the ultrasonography unit. First, the internal os was visualized in a sagital plane and the shape of the cervix was assessed. Then the transducer was rotated until the cervical canal was visualized with the sonolucency of the endocervical canal. The cervical length was measured by a hand caliper from the internal os to the external os. In women complaining of slight lower abdominal tension, the presence of uterine contraction was determined with a tocodynamometer before performing ultrasonography. If uterine contraction was present the examination was postponed because, as described by some authors[10], transient uterine contraction may present a sonographical appearance which falsely simulates cervical dilatation. We examined the women for more than 5 min to determine the shape since there can be dynamic change in cervical status within a few minutes[11,12]. The women suspected of asymptomatic threatened preterm labor from the sonographic findings were monitored with a tocodynamometer to exclude occult uterine activity. In the women who showed occult uterine contraction, the examination was cancelled and a reexamination was planned for their next visit. Thus, through ultrasonography of the gravid uterus, we observed three types of morphological features in the upper part of the cervix at the level of internal os of endocervical canal. Ultrasonographically, the cervix was classified as follows: *convex type*, defined as when the cervix gives a round appearance; *flat type*, defined as when the cervix appears flattened; and *concave type*, defined as when there is a small beaking at the level of internal os (Fig. 1).

Women with symptomatic threatened preterm labor complaining of lower abdominal pain were also monitored with a tocodynamometer. The women with threatened preterm labor were defined as those having either weak or strong uterine contractions once every 10-15 min.

Digital examination was done to diagnose dilatation of internal os. Internal cervical os $\geqq$1 cm was regarded as a sign of premature cervical dilatation if found before 33 weeks of gestational age, since it is suggested that there is an increased risk of preterm delivery if dilatation is $\geqq$1 cm between 28-34 weeks[13]. Dilatation after 33 weeks was not regarded as premature. However, dilatation in the mid second trimester in the cases of cervical incompetence was considered as premature and included in the data.

The patients who showed a convex cervix were scanned once again in their second visit. In patients with a flat or concave cervix the ultrasonographical examination was repeated within one or two weeks. The results of vaginal culture were recorded. The type of intervention and the gestational age at which it was initiated in patients with threatened preterm labor were noted. The outcome of pregnancy was also recorded. Chi-square test was used for quantitative statistical

Table 1 Clinical characteristics of the subjects in the three morphological categories of the cervix

Cervical shape	No. of cases	Age	Gravida	Parity	Gestational age at 1st evaluation (wks.)
Convex	25	31.5±4.5	1.6±1.3	0.9±0.8	19.5±2.8
Flat	17	32.4±4.9	1.5±0.9	0.9±0.8	19.9±3.4
Concave	15	33.3±4.6	2.3±1.8	1.2±0.9	20.5±4.1

All variables are non significant.

Table 2 Obstetrical background of the study sample

Cervical shape	Nonparous women	Parous women	Habitual abortion	Preterm delivery	Traumatic delivery
Convex	10	15	0	0	1
Flat	6	11	0	2	0
Concave	2	13	3	5*	1

*Three of 5 women had a history of both preterm delivery and habitual abortion.

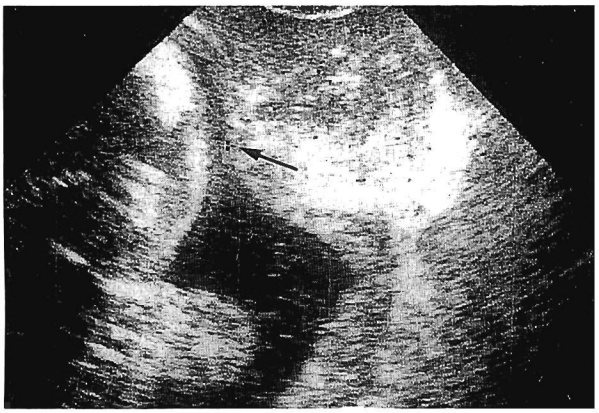

Fig. 2 Transvaginal ultrasonography showing convex type cervix at 18 weeks of pregnancy. At the level of internal os (arrow) the cervix gives round appearance.

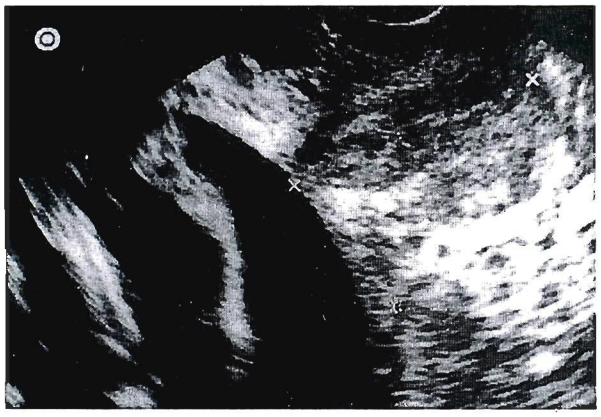

Fig. 3 Transvaginal ultrasonography of the flat cervix imaged at 18 weeks of gestation. The cervix appears flattened at the level of internal os. Cervical length is shown in between the two asterisk.

analysis. The Student's t-test and Anova were utilized for qualitative analysis.

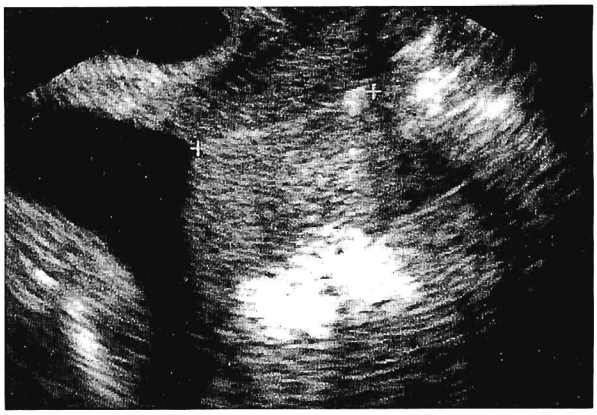

Fig. 4 Transvaginal ultrasonography of the concave cervix imaged at 20 weeks of gestation. The cervix shows a small beaking at the level of internal os. The two asterisk limits the endocervical canal.

RESULTS

Among the 61 patients, 4 patients were excluded as they had been transferred (for their own convenience) to some other hospitals for delivery. The total number of subjects was therefore 57. The mean age of the study group was 32.3±4.6 yrs., mean gravida 1.7±1.4, and mean parity 0.98±0.83. Thirty nine women were multipara and 18 were nullipara. Among these 57 cases, 25 (44%) showed a convex type of cervix (Fig. 2), 17 (30%) showed a flat type (Fig. 3) and 15 (26%) showed a concave type (Fig. 4) in the initial examination. Table 1 presents the Mean ±SD value of the age, gravida, parity and gestational age at 1st evaluation in women of the three morphological categories of the cervix. There was no significant variance among the three groups. Table 2 shows the obstetrical background of the study sample. Six of 15 women with concave type, 2 of 17 with flat type and 1 of 25 with convex type had a poor obstetrical background of habitual abortion, preterm delivery and traumatic delivery.

Table 3 Flow chart showing the sequences of premature cervical dilatation and outcome

Cervical shape	No. of subjects	Developed TPL	Cervical dilatation	Intervention for TPL	Preterm delivery
Convex	25	7 (28.0)	2 (8.0)[a]	7 (28.0)	0
Flat	17	10 (58.8) *	7 (41.2)[b]	11 (64.7)	1 (5.9)
Concave	15	10 (66.7) *	13 (86.7)[c]	10 (66.7)	2 (13.3)
Total	57	27 (47.4)	22 (38.6)	28 (49.1)	3 (5.3)

TPL: Threatened preterm labor , *$p<0.05$, [a-c] $p<0.001$, [a-b] $p<0.05$, [b-c] $p<0.01$.
The figure inside the parenthesis represents the percentage value

Table 4 Predictive value of premature cervical dilatation by the morphological shape

Cervical shape	No. of subjects	Cervical dilatation +	Cervical dilatation −	PPV %	NPV %
Convex	25	2	23		92.0
Flat	17	7	10	41.2	
Concave	15	13	2	86.7	
				62.5	

PPV: Positive predictive value, NPV: Negative predictive value.

Twenty seven women (47.4%) of the study sample developed threatened preterm labor. of these 27 women, 7 had a convex type, 10 a flat type and 10 a concave type cervix (Table 3). The incidence of threatened preterm labor was significantly higher in the concave and a flat types than in the convex type ($p<0.05$). Twenty two (38.6%) of 57 women developed premature cervical dilatation (Table 3). Of these 22 women, 2 showed a convex type cervix, 7 a flat type and 13 a concave type. The incidence of premature cervical dilatation was significantly higher in the concave ($p<0.001$) and flat types ($p<0.05$) than in the convex type. The incidence was also higher in the concave than in the flat type ($p<0.01$). There were 4 cases of cervical incompetence with mid second trimester cervical dilatation in the concave group in whom cervical cerclage was performed. Only 2 women in the concave group did not develop premature cervical dilatation. In one of these 2 cases, intervention was done for uterine contraction and the other had an uneventful pregnancy outcome. Therefore, the highest rate of premature cervical dilatation was found in the concave group among the three categories. The mean gestational age at which premature cervical dilatation developed in the study sample was 27.8±4.9 weeks.

Gestational age at which intervention was initiated for threatened preterm labor showed no significant difference among the three categories. There was no preterm delivery in the convex group, one in the flat group and 2 in the concave group.

Fig. 5 demonstrates the cervical length measured during 25-33 weeks of gestational age in the three types. The cervical length showed significant difference between the convex and the flat types ($p<0.01$) and between the convex and concave types ($p<0.01$). The cervical length was also significantly different between the flat and the concave type ($p<0.05$).

Table 4 shows the predictive values for premature

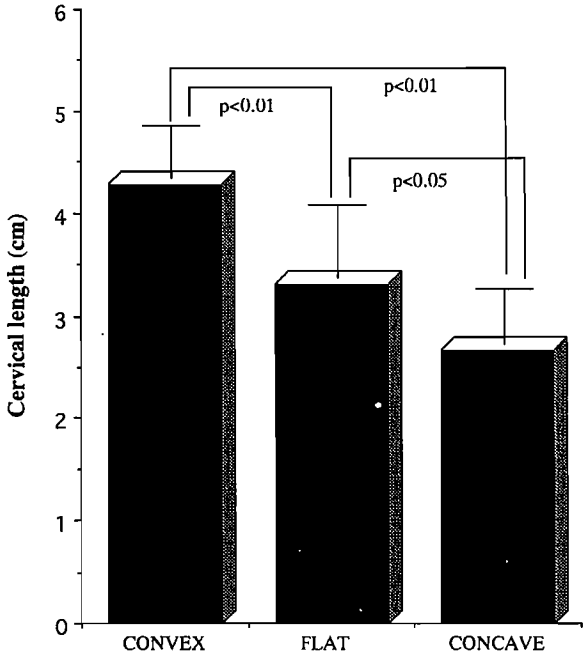

Fig. 5 Cervical length in the three morphological categories of the cervix measured between 25-33 weeks of gestation.

cervical dilatation based on the morphological shape of the cervix. The negative predictive value of the convex type was 92.0%, while the positive predictive values of the concave and the flat types were 86.7% and 41.2%, respectively, both indicative of high risk cases. For the concave and the flat types combined, the positive predictive was found to be 62.5%.

DISCUSSION

This study showed morphological changes of the cervix throughout pregnancy. We observed three categories

of morphological features at the level of internal os. A greater number of subjects (44%) showed a convex type cervix at the initial examination, which we think is the normal pattern in early pregnancy. Thirty percent of the study sample showed a flat type and 26% showed a concave type of the cervix.

Twenty seven women (47%) developed overt symptom of threatened preterm labor, a relatively high figure. The reason might be that women at risk are often referred to our University Hospital. The percentage of women developing threatened preterm labor was higher in the concave and the flat group in comparison to the convex group, indicating a significant relationship between threatened preterm labor and status of the cervix. The percentage of women developing premature cervical dilatation was also higher in the concave and the flat type than in the convex type. Thus, the high positive predictive value for premature cervical dilatation was revealed in the concave and the flat shapes. In contrast, the high negative predictive value of the convex shape indicates that women with this type are at less risk for premature dilatation of the cervix.

Ultrasonographically measured cervical length has been established as a parameter of assessment of preterm labor in many studies[7,14-16]. The current study also showed a similar relationship with the cervical shape as well as the length. In the convex type, the cervical length was longer than the flat and the concave type.

Iams *et al.*[17] in their study, suggested that cervical competence is a continuous rather than a categoric variable; their findings were based on assessment of previous obstetric performance. Although our study was not designed to show the predictive value of previous obstetric performance to the outcome of current pregnancy, we also found that women in the concave group had had a significantly poorer obstetric background in comparison to the other two groups. Concerning their conclusion, our finding is similar to that of Iams *et al.*

We had one preterm delivery in the flat type cervix group and 2 in the concave type. To better predict whether women with sonographically assessed flat or concave type cervix are at risk of preterm delivery, the ideal study design would be a large observational cohort study in which each pregnancy would to be allowed to deliver without any intervention. As such a study was not possible for us, we could not assess the predictive value of cervical shape to preterm delivery. From our study we can say that the shape of the cervix could reliably indicate the risk of threatened preterm labor and premature cervical dilatation.

Infectious agent alone can not be a sufficient cause of premature delivery unless there are some other factors associated with it. Failure to prevent premature delivery by an antimicrobial agent as monotherapy clarifies this[18]. Some authors have described short cervical length as being the associated factor[17]. We think that the configuration of the cervix might play a role in this event. The flat or concave type cervix simulates a relatively less competent cervix and may act as a defect in host resistant barrier to microbial invasion as a short cervical length is suggested.

The onset of labor is not a sudden event. Many silent uterine and cervical changes precede the onset[2]. We also observed such changes in cervical status during the ultrasonography. In our study, it was noticed that with the progression of gestation, the cervix changed gradually from convex to flat and at the last trimester, some cases showed a concave type sonographical feature. The clinical signs of ripening of the uterine cervix are well known. Bishop scoring has been used since 1964, to assess cervical ripening to determine the feasibility of inducing labor[19]. In 1965, Wood *et al.*[20] claimed that a short cervix is a predictive sign of premature labor. It is widely considered that evaluation of the gravid cervix plays an important role in the management of a pregnancy at risk for threatened preterm labor and that successful treatment depends to a great extent, on early recognition. Traditionally, the diagnosis of preterm labor is made when a patient with persistent uterine contraction shows a change in cervical configuration on serial digital examination. However, it is difficult to arrest preterm labor when there has already been substantial cervical change. Early evaluation and intervention from the sonographic findings might be helpful in arresting preterm labor although there are always some failures. Moreover, many authors agree that the digital examination is subjective and it has the limitation of variation in assessment among examining physicians. There is also the potential risk of a ruptured membrane and infection in repeated digital examination[21,22]. Anderson *et al.*[7] and Gomez *et al.*[23] in their study, described endovaginal ultrasonography as superior to digital examination for preterm delivery risk assessment. The role of ultrasonography is no longer in question as an important method of assessment of cervical status. We emphasized cervical morphology at the level of internal os as a predictor of cervical dilatation for screening of women at risk of threatened preterm labor.

We conclude that the ultrasonographical shapes of the cervix in early pregnancy could be classified into 3 types, convex, flat and concave; and that the presence of a concave or flat type may be a high risk indicator for development of threatened preterm labor.

ACKNOWLEDGEMENT

We wish to acknowledge the assistance of M. Randall a native English speaker in checking the final manuscript.

REFERENCES

1) Creasy R.K.: Preterm labor and delivery. In: Creasy R.K., Resnik R. eds. Maternal-fetal medicine: Principles and practice. Philadelphia: WB Saunders. 477-504, 1989.
2) Bartolucci L., Hill W.L., Katz M., Gill P.J. and Kitzmiller J.L.: Ultrasonography in Preterm Labor. Am. J. Obstet. Gynecol. 149: 52-56, 1984.
3) Ayers J.W.T, DeGrood R.M., Compton A.A., Barclay M. and Ansbacher R.: Sonographic evaluation of cervical length in pregnancy. Diagnosis and management of preterm cervical effacement in patient at risk for premature delivery. Obstet. Gynecol. 71: 939-944, 1988.
4) Riley L., Frigoletto F.D. and Benacerraf B.R.: The implications of sonographically identified cervical changes in patients not necessarily at risk for preterm birth. J. Ultrasound Med. 11: 75-79, 1992.
5) Okitsu O., Mimura T., Nakayama T. and Aono T.: Early prediction of preterm delivery by transvaginal ultrasound. Obstet. Gynecol. 2: 402-409, 1992.
6) Brown J.E., Thieme G.A., Shah D.M., Fleischer A.C. and Boehm F.H.: Transabdominal and transvaginal endosonography: Evaluation of the cervix and lower uterine segment in pregnancy. Am. J. Obstet. Gynecol. 155: 721-726, 1986.
7) Andersen H.F., Nugent C.E., Wanty S.D. and Hayashi R.H.: Prediction of risk for preterm delivery by ultrasonographic measurement of cervical length. Am. J. Obstet. Gynecol. 163: 859-867, 1990.
8) Main D.M. and Gabbe S.G.: Risk scoring for premature labor: Where do we go from here? Am. J. Obstet. Gynecol. 157: 789-793, 1987.
9) Mason G.C. and Maresh M.J.A.: Alteration in bladder volume and the ultrasound appearance of the cervix. Br. J. Obstet. Gynaecol. 97: 457-458, 1990.
10) Karis J.P., Hertzberg B.S. and Bowei J.D.: Sonographic diagnosis of premature cervical dilatation. Potential pitfall due to lower uterine segment contractions. J. Ultrasound Med. 10: 83-87, 1991.
11) Hertzberg B.S., Kliewer M.A., Farrell T.A. and DeLong D.M.: Spontaneously changing gravid cervix. Clinical implication and prognostic features. Radiology 196: 721-724, 1995.
12) Parulekar S.G. and Kiwi R.: Dynamic incompetent cervix uteri. Sonographic observations. J. Ultrasound Med. 7: 481-485, 1988.
13) Stubbs T.M., Dorsten J.P.V. and Miller M.C.: The preterm cervix and preterm labor; Relative risks, predictive values and change over times. Am. J. Obstet. Gynecol. 155: 829-834, 1986.
14) Tongsong T., Kamprapanth P., Srisomboon J., Wanapirak C., Piyamongkol W. and Sirichotiyakul S.: Single transvaginal sonographic measurement of cervical length early in third trimester as a predictor of preterm delivery. Obstet. Gynecol. 86: 184-187, 1995.
15) Iams J.D., Paraskos J., Landon M.B., Teteris J.N. and Johnson F.F.: Cervical sonography in preterm labor. Obstet. Gynecol. 84: 40-46, 1994.
16) Murakawa H., Utumi T., Hasegawa I., Tanaka K. and Iuzimori R.: Evaluation of threatened preterm delivery by transvaginal ultrasonographic measurement of cervical length. Obstet. Gynecol. 82: 829-832, 1993.
17) Iams J.D., Johnson F.F., Sonek J., Sachs L., Gebauer C. and Samuels P.: Cervical competence as a continuum: A study of ultrasonographic cervical length and obstetric performance. Am. J. Obstet. Gynecol. 172: 1097-1106, 1995.
18) Eschenbach D.A., Nugent R.P. and Rao A.V., Cotch M.F., Gibbs R.S., Lipscomb K.A., Martin D.H., Pastorek J.G., Rettig P.J., Carey J.C., Regan J.A., Geromanos K.L., Lee M.L.F., Poole W.K. and Edelman R.: A randomized placebo-controlled trial of erythromycin for the treatment of Ureaplasma urealyticum to prevent premature delivery. Am. J. Obstet. Gynecol. 164: 734-742, 1991.
19) Bishop E.P.: Pelvic scoring for elective induction. Obstet. Gynecol. 24: 266-268, 1964.
20) Wood C., Bannerman R.H. Booth R.T. and Pinkerton J.H.M.: The prediction of premature labor by observation of the cervix and external tocography. Am. J. Obstet. Gynecol. 91: 396-402. 1965.
21) Lenihan J.P.: Relationship of antepartum pelvic examinations to premature rupture of the membranes. Obstet. Gynecol. 63: 33-37, 1984.
22) Creatsas G., Pavlatos M., Lolis D., Aravantinos D. and Kaskarelis D.: Bacterial contamination of the cervix and premature rupture of membranes. Am. J. Obstet. Gynecol. 139: 522-525, 1981.
23) Gomez R., Galasso M., Romero R., Mazor M., Sorokin Y., Goncalves L. and Treadwell M.: Ultrasonographic examination of the uterine cervix is better than cervical digital examination as a predictor of the likelihood of premature delivery in patients with preterm labor and intact membrane. Am. J. Obstet. Gynecol. 171: 956-964, 1994.