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Sonography Cervical Assessment in Twin Pregnancy Correlation with Gestational Age at Delivery

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Abstract

Objective: Observe and correlate the funneling of upper cervical canal by ultrasound and likelihood of cervical incompetence and premature delivery in twin pregnancy. **Materials and methods:** Retrospective study in twin pregnancies deliveries in 1997, in king Faisal specialist hospital and research center, Riyadh, Saudi Arabia. A total of 67 twin pregnancies underwent routine ultrasound for fetal assessment, when the cervix closed, long; and short, funneling. The time of ultrasound was divided in three groups by gestational age: from 18 to 22 weeks; from 22 to 26 weeks and from 26 to 30 weeks. The gestational age at delivery was our outcome parameter and subdivided the patients in 4 groups, group 1: patients delivered before 24 weeks (n = 4); group 2: delivered between 24 and 34 weeks (n = 16); group 3: delivered between 34 weeks and 36 weeks and 6 days (n = 18); and group 4: delivered with gestational age equal or above 37 weeks (n = 29). The data was analyzed statistically using Pearson chi square method and p value below 0.05 was considered significant. **Results:** There was no significant difference among the 4 subgroups in maternal age, body mass index, parity, previous history of preterm delivery or presence of urinary/vaginal infection in actual pregnancy. There was stronger history of mid trimester abortion in patients delivered before 34 weeks of gestational age. Considering the cervical sonographic findings, the diagnosis of funneling between 18 - 22 weeks was higher among the group delivered before 34 weeks of gestational age (1 and 2) comparing to other groups (3 and 4) with p value equal to 0.016. The finding in ultrasound justifies the results of higher aggressive management in patients from groups 1 and 2 comparing with groups 3 and 4; admission to hospital (p = 0.007);

emergency cerclage (p = 0.04), complete hospital bed rest (p = 0.002). **Conclusion:** Cervical assessment during routine ultrasound in twins pregnancy seems to be useful for prediction of preterm delivery and counseling the patient without risk factors regarding cervical cerclage. Because of restricted number of patients, especially group 1 (11 = 4), we suggest further study with bigger sample and prospective trial for valued conclusion.

Keywords

Cervix, Twin Pregnancy, Ultrasonography, Cervical Assessment, Delivery

1. Introduction

Approximately 1% of all pregnancies have two fetuses and approximately 2% of all newborns are twins [1]-[6]. These 2% of all births account for approximately 12% of all preterm births and an even higher proportion (15%) of neonatal mortality [2]. Although about 10% of all pregnancies end before term, nearly 30% of twins are born before 37 weeks gestation with a mean gestational at delivery of 35 or 36 weeks. Twins, therefore, account for a disproportionate share of preterm births and neonatal morbidity and mortality [1] [2]. Twins are such a powerful risk factor for preterm birth that it is not clear if the usual risk factor for preterm birth such as black race, maternal thinness, prior preterm birth, various types of pelvic infection, and various demographic characteristics such as age, marital status, and educational level, is important risk factors in the face of a twin pregnancy. The length of the cervix may be useful in predicting the risk of premature delivery, with a shorter cervix predicting a higher risk. Traditional methods to evaluate the cervix in pregnancy are limited and unsatisfactory. Digital examination, the standard method, suffers from large variation among examiners [3] [4]. In contrast, ultrasonographic examination of the cervix has been used to predict risk of preterm delivery and risk of cervical incompetence and to follow up patients known to be at risk for preterm delivery [2] [4]. We have observed that funneling of the upper cervical canal is associated with an increased likelihood of cervical incompetence whereas shortening of the cervical canal without funneling is not specific for incompetent cervix [5].

2. Objective

Correlate the funneling of upper cervical canal and likelihood of preterm delivery in twin pregnancy.

3. Methods

This study was retrospective study in 1997 for sixty-seven twin pregnancies had routine ultrasound around 18 - 20 weeks where cervix was observed as also in following ultrasound. Gestational age when cervix was observed was be-

tween 18 - 22 weeks, 22 - 26 weeks and 26 - 30 weeks. Data collected included information about obstetrical history and parity. Previous history of preterm delivery, presence of urinary tract or vaginal infection, body mass index, history of previous second trimester abortion and transvaginal ultrasonographic assessment of the cervix. The ultrasound images were analyzed to assess changes in the cervix that are associated with spontaneous prematurity and to evaluate ultrasonography as an indicator of the risk of premature delivery in twin pregnancy. The length of the cervix was measured with a transvaginal ultrasound trans-abdominal ultrasound were not used because the size of the maternal bladder has an unpredictable effect or the measurement of cervical length each examination was performed in twin pregnancy shows if there is funneling or not. "Funnel" is defined as a protrusion of the amniotic membranes 3 mm or more into the internal cervical os as measured along the lateral border of the funnel. Each woman was required to undergo an ultrasonographic examination at 18 - 22 weeks for gestational age dating if not done previously and to rule out placenta previa and serious congenital anomalies. Gestational age was based on the last menstrual period and the earliest ultrasonographic biparietal diameter agreed within 10 days if not the biparietal diameter was used to define gestational age. Outcome of the study divided according to gestational age at delivery (Table 1).

4. Results

A total of 204 endo-vaginal ultrasonographic examinations were performed in 67 patients with twin pregnancy. There was no significant difference among the 4 subgroups in maternal age, body mass index, parity, previous history of preterm deliveries of presence of urinary tract infection or vaginal infection in actual pregnancy there was stronger history of mid-trimester abortions in patients delivered before 34 weeks of gestational age. Considering the cervical sonographic finding, the diagnosis of funneling between 18 - 22 weeks was higher among the group delivered before 34 weeks of gestational age. Considering the cervical sonographic finding the diagnosis of funneling between 18 - 22 weeks was higher among the group delivered before 34 weeks of gestational age around 75% were delivered less than 24 weeks and 12.5% delivered between 24 to 34 weeks group (1 and 2). Comparing to other group (3 and 4) were around 6.9% reached to 37 weeks and above with p value equals to 0.015. The rate of

Table 1. Outcome of the study divided according to gestational age at delivery.

Group 1	<24 weeks
Group 2	24 - 34 weeks
Group 3	34 - 36 weeks
Group 4	37 weeks and above

spontaneous delivery before 24 weeks was 50% among the woman who had a vaginal sonographic assessment for funneling between 22 - 26 weeks and 18.75% who had delivery between 24 - 34 weeks. None of these groups reached beyond 34 weeks with statistically significant (p = 0.0114). Low to high risk of preterm twin delivery with cervical funneling, ultrasound finding justify the results of higher aggressive management in group 1 and 2 comparing with group 3 and 4 including admission to the hospital with statistically significant (p = 0.002}. Emergency cerclage (p = 0.04}, and tocolysis (p = 0.007}.

5. Discussion

Cervical incompetence is difficult to ascertain because the clinical history and physical findings prior pregnancy losses or early preterm labor present no clear history of cervical incompetence. However, sonograms can provide an objective method to assess the anatomy of the cervix and its internal os. Kushnir, *et al.* [6] assessed cervical length using vaginal ultrasonography and applied the normative cervical length to active antepartum management for early detection and prevention of preterm delivery. To avoid empirical use of cervical cerclage, a new method has been described using vaginal ultrasound to evaluate the asymptomatic incompetent cervix. Our data suggests that the funneling of the cervix is an indirect indicator of its competence and should be seen as a continuous rather than a dichotomous variable. The patients with cervical funneling the greater likelihood of preterm delivery. There were 67 sets of twins in this analysis with a preterm delivery rate of nearly 50%. None of the traditional demographic or obstetric risk factors was significantly associated with spontaneous preterm birth in any gestational age window. At 24 weeks' gestational age, however, the cervical funneling was significantly more common among twin than singleton pregnancies, and was significantly associated with a spontaneous preterm birth of <24, <26, <34, <36 weeks gestational age. Transvaginal ultrasonography allows detailed examination of the internal os, cervical funneling of the upper part has been shown to predict preterm delivery in asymptomatic women at low risk for preterm labor. In our experience, the technique is simple to learn and surely takes more than five minutes to perform. The examination is generally well tolerated by women. Reassuringly, serial examination of the cervix does not appear to increase the risk of preterm delivery [7]. Due to high risk of preterm twin delivery with cervical funneling, ultrasound finding justifies the result of higher aggressive management in patient before 24 and 26 weeks of gestation including admission to the hospital, tocolysis and cervical cerclage. The authors estimated that only l in 28 of the women who underwent cervical cerclage benefited from the procedure. Careful patient selection is essential, therefore, particularly as the technique carries the risk of serious complications including maternal septicemia [8]. Delaying suture insertion until evidence of cervical changes at scan appears to be safe, therefore, and is consistent with evidence from studies of emergency cerclage for women presenting with advanced cervical dilatation in the

second trimester, in a high proportion of cases the pregnancy continues to viability [9] [10].

Theories of premature labor based on an understanding of the cervix as uniformly competent may underestimate the importance of the cervix, and overestimate the role of uterine activity, in pathogenesis of prematurity. Uterine activity is known to vary widely among normal pregnancies [11] and could also, affect the risk of prematurity in a continuous manner. Just as contraction—based theories of premature labor have led to trials of prophylactic tocolytic agents, our finding raises but do not resolve the question of the appropriate role of cervical cerclage in women with cervical funneling. To evaluate the role of the ultrasonographic diagnosis of cervical incompetence further, we suggest that the method should be subjected to a randomized trial in pregnant women with presence of cervical funneling in twin pregnancy without cerclage comparing to selective cervical suture insertion. The pathophysiology of cervical incompetence is not clearly defined. It is probably not on specific abnormality but rather a spectrum of different degrees of anatomic deficiency, including congenital connective tissue defects. Multiple small lacerations as a result of trauma, gross cervical tears, and congenital malformations, such as those seen in patients with diethylstilbestrol exposure. Varying patterns of uterine contractions as a result of the effects of physical activity and multiple gestation further contribute to cervical incompetence. The final common pathway for cervical incompetence as a result of these factors is painless dilatation of the cervix. As in all areas of medicine, a correct diagnosis is essential to obtain the optimal therapeutic result. Therefore, pre-pregnancy evaluation and appropriate selection of patients for operation as are paramount. Scheduled cervical cerclage in the early second trimester for the patient has cervical funneling in twin gestation offers a further safe guard because cervical dilatation usually has not yet taken place and the membranes are not exposed. This not only protects the gestational sac, but also simplifies the operative procedure and reduces blood loss.

The early second trimester is also preferred because early spontaneous abortion for other causes is no longer a problem. Ultrasonographic verification of fetal viability on the same time of cervical assessment should be done before the operation is performed. A recent review of cervical incompetence by Goldenberg *et al.* [12]. Cities fetal survival rates after cerclage of 75% to 85%. In our series of treated twin pregnancies, 50% were carried to 24 weeks, 12.5% carried between 24 - 34 weeks and 6.9% reached to 37 weeks and above. We have struggled with the question whether a short funneling cervix discovered at 24 or 28 weeks precedes the pregnancy and represents an inherent characteristic of the mother or whether the cervix funneled during the pregnancy in relation to pregnancy-related risk factors. Because it is unlikely that women who become pregnant with twins had congenitally short funneling cervices comparison study was done by Goldenberg, *et al.* between women who became pregnant with singleton pregnancy and twin pregnancy he found that many women who had twins as

their most important risk factor for spontaneous preterm birth, a short cervix and funneling most likely developed during the pregnancy and not before [13]. There is an extensive literature on the diagnosis of incompetent cervix and its treatment with cerclage. Unfortunately, there is little information regarding clinical assessment of patients who have cervical cerclage in place. These patients are at increased risk for a number of complications in particular preterm delivery [1] [2] methods of assessing patients in the course of prenatal care after cervical examination are generally taught by attending physicians to residents and vary by institution and region. Approaches commonly used include regular digital cervical examinations, sterile speculum examinations or ultrasonographic examinations. Some clinicians avoid any vaginal examinations because of concerns regarding disturbing the cervix. For most of these approaches, there is little literature to support the particular practice. Vaginal ultrasonographic assessment of the cervix has been suggested to improve follow-up and outcome for cervical cerclage patientsl1 [14]. "Quinn" used vaginal ultrasonography to evaluate 21 patients with cervical cerclage [15]. Ten were delivered preterm and seven of these deliveries were associated with ultrasonographic findings of dilatation of the internal cervical os and herniation of the membranes to the level of the cerclage. Transvaginal ultrasonographic examination of the cervix is a precise method of evaluating the cervix and cervical canal and has significant advantages result from examination [16] with an empty bladder and from improved vision in comparison with other methods. Frank Anderson, *et al.* [17] studied 32 patients with a diagnosis of incompetent cervix and cervical cerclage in place seven of nine patients who were delivered preterm were identified by abnormal ultrasonographic findings. It is not clear whether this result is significantly different from that of "Quinn". It is important to note that the finding of shortening of the upper cervical segment or funneling of the internal cervical os and upper cervical canal associated with a 5.8 times greater likelihood of preterm delivery. It is not clear whether one measurement or the other should be the preferred approach for evaluating patients with incompetent cervix. The observation of funneling of the internal os is somewhat more subjective. It has been noted that the shape of the funneled internal os may vary, however, this finding is subjective and cannot be easily reduced to a simple measurement [18]. The investigators have reported that the finding of cervical funneling is associated with an increased risk of preterm delivery and that in those patients in whom intervention (*i.e.*, Bed rest or tocolysis) was initiated there was an improved outcome [19]. In our patient management was examined by the attending physician who was aware of endo-vaginal ultrasonographic findings. The patients were placed on bed rest or tocolytic therapies, we were unable to determine the effectiveness of this intervention to reduce the risk of preterm delivery. In this study group, we found tocolysis prevent 43% of preterm labor between 24 - 34 weeks. We conclude that endo-vaginal ultrasonographic evaluation of the cervix previous information to detect the livelihood of preterm delivery in patients with

incompetent cervix and cervical cerclage in place. Current approach is to perform endo-vaginal examination at 4 weeks intervals from cervical cerclage. If shortening of the upper cervical segment or funneling of the internal os is observed, our practice recommended limited activity for the patient and eased surveillance for signs and symptoms of preterm labor. However, it is important to state that there is currently no evidence that this approach is effective in altering the outcome of the pregnancy. Further study certainly warranted to determine whether ultrasonography can be used to evaluate the effectiveness of such prevention. In a large study using serial ultrasonography during pregnancy, ayers *et al.* [20] constructed a normogram from measurement in control women and combined cervical cerclage and aggressive tocolyte therapy in a cohort of women with prior-second trimester loss. This group included 30 women with Mullerian abnormalities. 29 women with diethylstilbestrol exposure and 29 women with a normal hysterogram by using the criteria of a cervical length of <2 sds, below the mean of shortening by >50% of initial length. 70% of the at-risk group received cerclage. Both diagnosis and discrimination were excelled because delivery occurred after 35 weeks in 97% of the cerclage group and 95% of the non-cerclage group. Among twins at 24 weeks, short cervix with funneling is a better predictor of early spontaneous preterm birth than positive fibronectin test. That a large percentage of women carrying twins already had a short cervix at 24 weeks and the rapid increase in the percentage of women with a short cervix between 24 and 28 weeks suggest that for twin, cervical shortening is a strong and early predictor of preterm birth. The fetal fibronectin test became a more powerful predictor only closer to birth. That is, at 28 or 30 weeks, suggests that for twins the shortening of the cervix may precede the disruption of the basement membrane, of which the presence of fetal fibronectin in the vagina or cervix is believed to be a marker [13]. A positive fetal fibronectin test and short cervix carried relatively similar risk for spontaneous preterm birth because, however, a short cervix was relatively more common among women carrying twins than was a positive fetal fibronectin test, the former tended to be significantly associated with spontaneous preterm birth, whereas the later generally was not. Women with a short funneling cervix, however, generally had negative fetal fibronectin tests—when both tests were positive, risk for spontaneous preterm birth increased substantially. Robert l, *et al.* [13] in prospective evaluation of twin pregnancy, depending on gestational age both cervical lengths as assessed by means of ultrasound scan and the presence of cervical or vaginal fetal fibronectin were significant predictors of spontaneous preterm birth. Most of the traditional risk factors were not significantly associated with spontaneous preterm birth. Jay d, *et al.* in prospective multi-center study of pregnant women, he used vaginal ultrasonography to measure the length of the cervix and the incidence of spontaneous delivery before 35 weeks gestation. There were 185 subjects at 24 weeks (6.3%) and 232 subjects at 28 weeks (9.2%) whose cervix had a funnel at the internal cervical os on ultrasound examination, a finding reported to indicate an increased risk of

premature delivery [21]. Among these women, the mean length of the funnel was 16.0 ± 9.1 mm at 24 weeks and 14.3 ± 8.0 mm at 28 weeks. Parity had no effect on the frequency of funneling. Funneling correlated with increased risk of preterm delivery both at 24 weeks and at 28 weeks. The clinical value of funneling as a predictor of preterm delivery was similar to that of the cervical length, but the data on funneling are confounded to substantial variation among centers. Nevertheless, funneling remained a significant predictor of premature delivery.

Our findings confirm those of previous studies between the cervical funneling measured by ultrasonography during pregnancy, and the frequency of preterm delivery. The diagnosis of cervical incompetence is notoriously difficult. Clinical assessment alone is unreliable [1], but there have been no tests which accurately confirm or exclude the diagnosis. Serial vaginal examinations of the cervix in pregnancy have also proved to be of little value [2], in part because the earliest changes arise in the upper cervix and cannot be detected digitally [3] transvaginal ultrasonography does allow detailed examination of the entire cervix [4], and thus provides an opportunity to improve the accuracy of the diagnosis of cervical incompetence. In our study serial transvaginal ultrasound scans, with emergency cerclage for persistent dilatation of the internal os. The purpose of this study is to explore the hypothesis that serial transvaginal ultrasonography improves the accuracy of the cervical incompetence, and allows a significant proportion of women to avoid unnecessary cervical cerclage.

6. Conclusions

Cervical assessment during routine ultrasound in twin pregnancy seems to be useful for prediction of preterm delivery and counseling the patient without risk factors regarding cervical cerclage. Because of restricted number of patients especially group 1 (n = 4), we suggest further study with bigger sample and prospective trial for valued conclusions. Most known risk factors for spontaneous preterm birth were not significantly associated with spontaneous preterm birth of twins. Current approach is to perform endo-vaginal ultrasound. If shortening of the upper cervical segment or funneling of the internal os is observed, our practice recommends limited activity for the patient and ceased surveillance for signs and symptoms of preterm labor. In addition to elective cervical cerclage, we recommended emergency cerclage even in those with a prolapsed amniotic sac. Theories of premature labor based on an understanding of the cervix as uniformly competent may under-estimate the importance of the cervix, and overestimate the role of uterine activity which is known to vary widely among normal pregnancies and could also affect the risk of prematurity in a continuous manner. Just as construction-based theories of premature labor have led to trials of prophylactic tocolytic agents.

Traditional methods to evaluate the cervix in pregnancy are limited to an unsatisfactory. Digital examination, the standard method suffers from large varia-

tion among examiners. In contrast, transvaginal ultrasonography is a reproducible method of examination during pregnancy because it is unlikely that women who become pregnant with twins had congenitally shorter cervices in comparison with women who become pregnant with singletons, and because we observed a substantial increase in the percentage of women with short cervices between 24 and 28 weeks, it seems likely that among many women who have preterm birth, a short cervix most likely develops during the pregnancy and not before. The diagnosis of cervical incompetence is notoriously difficult. Clinical assessment alone is unreliable, but there have been no tests which accurately confirm or exclude the diagnosis except serial vaginal examinations of the cervix in pregnancy by ultrasound because the earliest changes arise in the upper cervix and cannot be detected digitally. Transvaginal ultrasound does allow detailed examination of the entire cervix and thus provides an opportunity to improve the accuracy of the diagnosis of cervical incompetence. Also, vaginal ultrasound has a promising role to play in understanding the pathogenesis of prematurity and in caring for women with a history of preterm delivery. The purpose of this study is to explore the hypothesis that serial transvaginal ultrasonography improves the accuracy of the diagnosis of cervical incompetence and allows a significant proportion of women to avoid unnecessary cervical cerclage. We believe our data support the contention that cervical competence is a continuum and provide a theoretical and practical foundation for additional investigation of the cervix in the pathogenesis of spontaneous preterm birth, for twin pregnancy and the role of transvaginal ultrasonography in detailed examination of the cervix and improvement of the accuracy of the diagnosis of cervical incompetence. In our center, the technique is simple to learn and rarely takes more than five minutes to perform. Serial examination of the cervix does not appear to increase the risk of preterm delivery, and these data show delaying active intervention until cervical changes are evident ultrasonically allowed more than one third of the women to avoid admission to the hospital or cervical cerclage or tocolysis. To evaluate the role of the ultrasonographic diagnosis of cervical incompetence, further study certainly warranted to determine whether ultrasonography can be used to evaluate the effectiveness of such prevention.

7. Ethical Approval and Informed Consent

Has been provided from King Faisal Specialist Hospital and Research center, Riyadh, Saudi Arabia.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Ho, S.K. and Wu, P.Y.K. (1975) Perinatal Factors and Neonatal Morbidity in Twin

Pregnancies. *American Journal of Obstetrics & Gynecology*, **122**, 979-987. https://doi.org/10.1016/0002-9378(75)90360-9

[2] Gardner, M.O., Goldenberg, R.L., Cliver, S.P., Tucker, J.J., Nelson, K.G. and Copper, R.L. (1995) The Origin and Outcome of Preterm Twin Pregnancies. *Obstetrics & Gynecology*, **85**, 553-557. https://doi.org/10.1016/0029-7844(94)00455-M

[3] Medearis, A.L., Jonas, H.S., Stockbauer, J.W. and Danke, H.R. (1979) Perinatal Deaths in Twin Pregnancy. *American Journal of Obstetrics & Gynecology*, **134**, 413-421. https://doi.org/10.1016/S0002-9378(16)33083-6

[4] Fowler, M.G., Kleinman, J.C., Kiely, J.L. and Kessel, S.S. (1991) Double Jeopardy: Twin Infant Mortality in the United States, 1983 and 1984. *American Journal of Obstetrics & Gynecology*, **165**, 15-22. https://doi.org/10.1016/0002-9378(91)90215-D

[5] Mercer, B.M., Goldenberg, R.L., Das, A., Moawad, A.H., Iams, J.D., Meis, P.J., Copper, R.L., Johnson, F., Thom, E., McNellis, D., Miodovnik, M., Menard, M.K., Caritis, S.N., Thurnau, G.R., Bottoms, S.F. and Roberts, J. (1996) The Preterm Prediction Study: A Clinical Risk Assessment System. *American Journal of Obstetrics & Gynecology*, **174**, 1885-1895. https://doi.org/10.1016/S0002-9378(96)70225-9

[6] Kushnir, O. and Vigil, D.A. (1990) Vaginal Ultrasonographic Assessment of Cervical Length Changes during Normal Pregnancy. *American Journal of Obstetrics & Gynecology*, **162**, 991-993. https://doi.org/10.1016/0002-9378(90)91302-S

[7] Bivins, H.A., Newman, R.B., Ellings, J.M., Hulsey, T.C. and Keenan, A. (1993) Risks of Antepartum Cervical Examination in Multifetal Gestations. *American Journal of Obstetrics & Gynecology*, **169**, 22-25. https://doi.org/10.1016/0002-9378(93)90125-3

[8] Kuhn, R.J.P. and Pepperell, R.J. (1977) Cervical Ligation: A Review of 242 Pregnancies. *Australian and New Zealand Journal of Obstetrics and Gynaecology*, **17**, 79-83. https://doi.org/10.1111/j.1479-828X.1977.tb02634.x

[9] Macdougall, J. and Siddle, N. (1991) Emergency Cervical Cerclage. *BJOG*: *An International Journal of Obstetrics & Gynaecology*, **98**, 1234-1238. https://doi.org/10.1111/j.1471-0528.1991.tb15395.x

[10] Mitra, A.G., Katz, V.L., Bowes, W.A. and Carmichael, S. (1992) Emergency Cerclages: A Review of 40 Consecutive Cases. *American Journal of Perinatology*, **9**, 142-145. https://doi.org/10.1055/s-2007-999307

[11] Moore, T.R. (1994) Diurnal Patterns of Uterine Activity in Normal Human Pregnancy. *Obstetrics & Gynecology*, **83**, 517-523. https://doi.org/10.1097/00006250-199404000-00006

[12] Goldenberg, R.L., Mercer, B.M., Meis, P.J., Copper, R.L., Das, A. and Mcnellis, D. (1996) The Preterm Prediction Study: Fetal Fibronectin Testing and Spontaneous Preterm Birth. *Obstetrics & Gynecology*, **87**, 643-648. https://doi.org/10.1016/0029-7844(96)00035-X

[13] Goldenberg, R.L., Thom, E., Moawad, A.H., Johnson, F., Roberts, J. and Caritis, S.N. (1996) The Preterm Prediction Study: Fetal Fibronectin, Bacterial Vaginosis, and Peripartum Infection. *Obstetrics & Gynecology*, **87**, 656-660. https://doi.org/10.1016/0029-7844(96)00034-S

[14] Parulekar, S.G. and Kiwi, R. (1982) Ultrasound Evaluation of Sutures Following Cervical Cerclage for Incompetent Cervix Uteri. *Journal of Ultrasound in Medicine*, **1**, 223-228. https://doi.org/10.7863/jum.1982.1.6.223

[15] Quinn, M.J. (1992) Vaginal Ultrasound and Cervical Cerclage: A Prospective Study. *Ultrasound in Obstetrics & Gynecology*, **2**, 410-416. https://doi.org/10.1046/j.1469-0705.1992.02060410.x

[16] Andersen, H.F. (1991) Transvaginal and Transabdominal Ultrasonography of the Uterine Cervix during Pregnancy. *Journal of Clinical Ultrasound*, **19**, 77-83. https://doi.org/10.1002/jcu.1870190204

[17] Anderson, H.F. (1994) Prediction of Cervical Cerclage Outcome by Endovaginal Ultrasonography. *American Journal of Obstetrics & Gynecology*, **171**, 1102-1106. https://doi.org/10.1016/0002-9378(94)90044-2

[18] Brown, J.E., Thieme, G.A., Shah, D.M., Fleischer, A.C. and Boehm, F.H. (1986) Transabdominal and Transvaginal Endosonoraphy Evaluation of the Cervix and Lower Uterine Segment in Pregnancy. *American Journal of Obstetrics & Gynecology*, **155**, 721-726. https://doi.org/10.1016/S0002-9378(86)80006-0

[19] Michaels, W.H., Montgomery, C., Karo, J., Temple, J., Ager, J. and Olson, J. (1986) Ultrasound Differentiation of the Competent from the Incompetent Cervix: Prevention of Preterm Delivery. *American Journal of Obstetrics & Gynecology*, **154**, 537-546. https://doi.org/10.1016/0002-9378(86)90598-3

[20] Ayers, J.W.T. (1988) Sonographic Evaluation of Cervical Length in Pregnancy. *American Journal of Obstetrics & Gynecology*, **71**, 939-944.

[21] Nageotte, M.P. (1988) Quantitation of Uterine Activity Preceding Preterm, Term and Postterm Labor. *American Journal of Obstetrics & Gynecology*, **158**, 1254-1259. https://doi.org/10.1016/0002-9378(88)90353-5