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REVIEW ARTICLE

Ultrasonic Diagnosis in Preterm Labor

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ABSTRACT

Ultrasound diagnosis of the preterm birth was discussed in the measurement of uterine cervical length, its significance for the prediction of preterm birth, fetal growth estimation for the study on fetal maturity and fetal lung immaturity assessment with noninvasive ultrasonic techniques for the prediction and treatment of neonatal respiratory distress syndrome.

Keywords: Cervical anatomy, Cervical length, Transvaginal ultrasound, Estimated fetal growth, Fetal lung immaturity.

INTRODUCTION

Since 75% of perinatal mortality are expected to be caused by preterm births, the prevention of preterm birth is one of the most important issues in perinatal medicine.

Preterm labor is defined as the delivery before 37 weeks of pregnancy caused by premature uterine contraction and dilatation of uterine cervical canal. Since its prevention is the prolongation of pregnancy duration with the tocolysis after the detection of inflammatory signs, monitoring of uterine contraction and to discover the shortening of uterine cervix with transvaginal sonography, where the diagnosis of uterine cervix will be the most direct and practical way of preterm labor prediction. The uterine cervical assessment by transvaginal sonography has been evaluated extensively and its effectiveness has been reported in considerable number of articles.[1-3]

However, in order to obtain the correct evaluation, we have to pay close attention to the detailed change of the anatomy of the cervix during pregnancy, when we measure the cervical length. This paper summarizes the anatomical changes of the uterine cervix as pregnancy progresses, and the method of correct measuring of cervical length using transvaginal ultrasound. In addition, fetal growth estimation for the assessment of the fetal maturation and fetal lung immaturity noninvasively diagnosed by ultrasound were discussed for the prevention and treatment of neonatal respiratory distress syndrome.

The Cervix of Pregnant Uterus in Preterm Birth

Anatomical Changes of the Uterine Cervix during Pregnancy

It is important to have the knowledge on the alteration of uterine cervix during pregnancy. Figure 1 shows the transvaginal scan ultrasonic image of uterine cervix before 20 weeks of gestation, where the uterine isthmus still exists, which is the tissue between anatomical internal os and histological internal os. We can recognize the cervical gland that is located between the

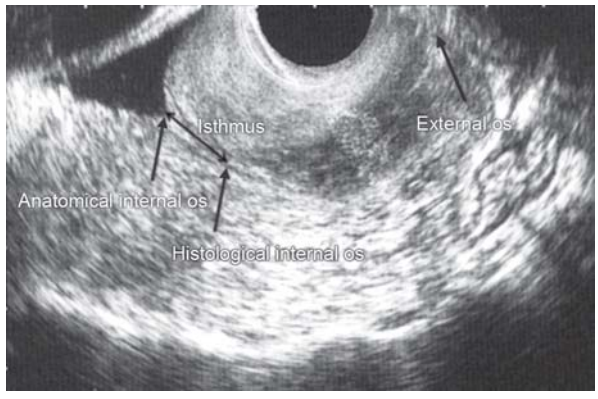

Fig. 1: The transvaginal ultrasound scan of uterine cervix before 20 weeks of pregnancy. The anatomical internal os, histological internal os, isthmus, external os and cervical gland are shown in the image

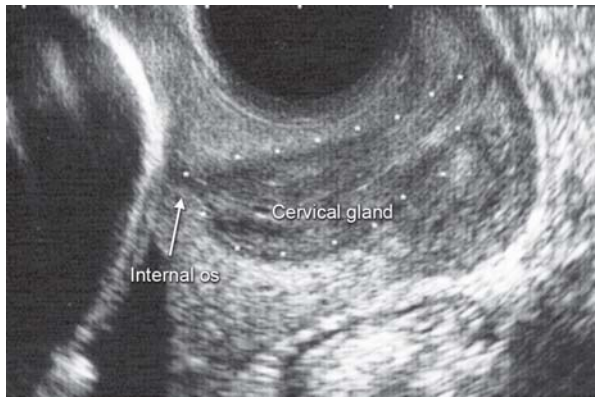

Fig. 2: The ultrasonic image of uterine cervix after 20 weeks of gestation. In this stage, the isthmus has effaced and replaced by lower uterine segment. Lower edge of amniotic cavity contacts with the histological internal os

histological internal os and external os, as relatively hypoechoic part (*) that is in Figure 2. Lower edge of amniotic cavity contacts with the anatomical internal os in this stage.

Figure 2 is the ultrasonic image of uterine cervix after 20 weeks of gestation. In this stage, the isthmus has effaced and

replaced by lower uterine segment. Lower edge of amniotic cavity contacts with the histological internal os. It is important to distinguish the histological os from the anatomical one, when we measure the cervical length before 20 weeks of pregnancy, because the cervical length is measured between the histological internal os to external os.

Measurement of the Uterine Cervix

As the subjects of measurement, we recommend the uterine cervical length in all pregnant women, including low risk cases as a screening for risk assessment of preterm delivery.

As for the time of measurement, there are various reports and it is difficult to decide which weeks of pregnancy is the best for the timing. If the timing in our institution is recommended, we measure the uterine cervical length from16 to 26 weeks of gestation at every prenatal check.

How to measure the cervix? In case when the histological internal os is closed, distance from it to the external os is measured along the cervical canal. And when the histological internal os is open, we measure the distance from the lowest part of amniotic cavity to the external os as the cervical length. We have to pay attention to exclude the distance from the vaginal wall to the external os (Fig. 3). Table 1 summarizes the matters to be attended at the time of measurement.

Significance of the Measurement of Uterine Cervix

Figure 4 is referred from the first and very famous report that indicates the significance of measuring the uterine cervix and its effectiveness for the prevention of preterm delivery.[1] Solid line indicates distribution of the cervical length values measured by transvaginal ultrasound at 24 weeks of gestation. Solid bar indicates the relative risk of spontaneous delivery before 35 weeks of gestation according to the cervical length less than 1, 5, 10, 25, 50, 75 percentile. Figure 5 shows the duration of pregnancy according to the cervical length which was ≤ 25 mm or >25 mm at the 24th week.[1]

This report concluded that the risk of spontaneous preterm delivery increased in women who were found to have a short cervix by vaginal ultrasonography during pregnancy. In another report, it was indicated that the rate of preterm birth less than 33 weeks of gestation increased when the cervical length was shorter than 20 mm (Fig. 6).[2] Current review articles being searched from Medline, PubMed, Embase and the Cochrane Library conclude that the common cut-off of the cervical length is 25 mm, and short cervical length measured by transvaginal ultrasonography in asymptomatic high-risk women predicts spontaneous preterm birth at < 35 weeks.[3]

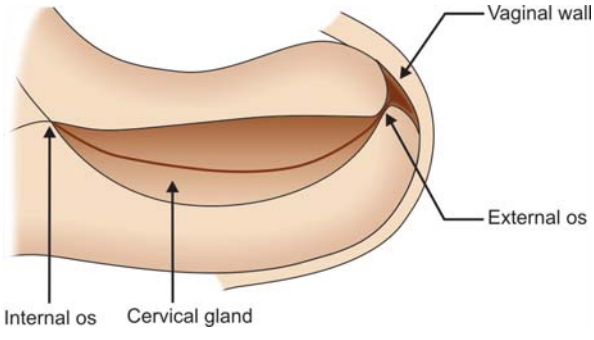

Fig. 3: Solid line indicates distribution of the cervical length values measured by transvaginal ultrasound at 24 weeks of gestation. Solid bar indicates the relative risk of spontaneous delivery before 35 weeks of gestation according to the cervical length less than 1, 5, 10, 25, 50, 75 percentile [*Referred from: Iams JD, et al Network. N Engl J Med 1996;334(9):567-72*]

Table 1: The matters to be attended in the measurement of cervical length

1. Measure after urination
2. Do not compress the cervix by the ultrasound probe
3. Obtain the measurement view on the midsagittal view
4. Detect the correct histological internal os
5. Consider the dynamic change of cervix.

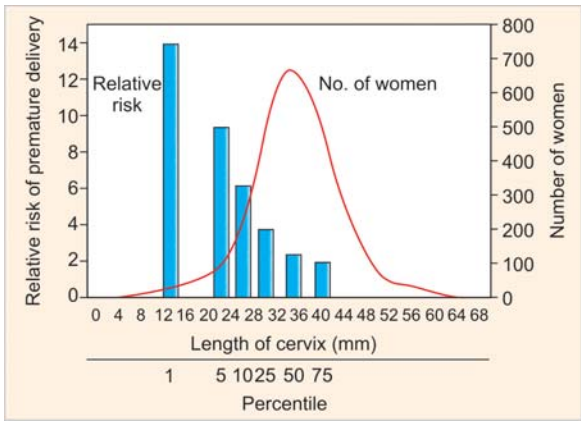

Fig. 4: The duration of pregnancy according to the cervical length which was ≤ 25 mm or > 25 mm at 24-week[1]

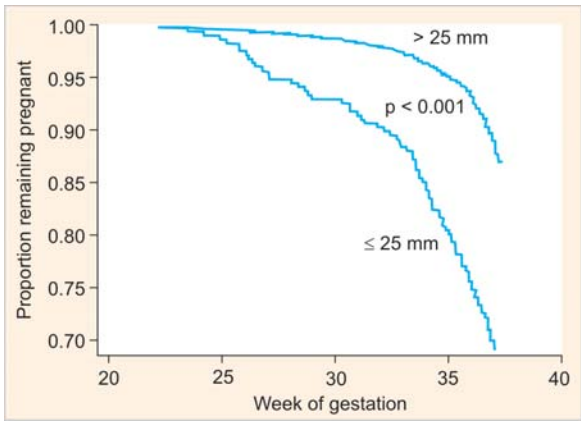

Fig. 5: The rate of preterm birth less than 33 weeks of gestation increased when the cervical length was shorter than 20 mm[1] [*Cited from: To MS, et al. Ultrasound Obstet Gynecol 2001;18(3):200-03*]

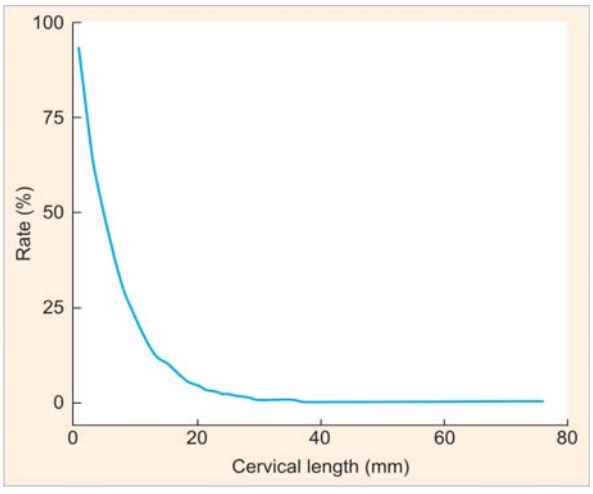

Fig. 6: The measurement of uterine cervix, the distance from the vaginal wall to the external os was excluded[2]

Fig. 7: The funneling of uterine cervix. The internal os (A) is dilated to form a funnel-like cervical canal which is indicated by white lines

Funneling Dilatation of the Internal os

The cervical length is shortened in the case of funnel-like widening of uterine internal os (Fig. 7), where the imminent premature rupture of the membrane (PROM) may be present when the lower end of amniotic membrane appears in the external os and observed by visual vaginal examination with the specula when the funneling reaches to the external os (Fig. 8). Although, frequently, there is the hidden higher PROM in the uterine cavity, the funneling also causes PROM and premature birth. The treatment with cervical cerclage may be indicated for the widened external os exposing the amniotic sac containing amniotic fluid.

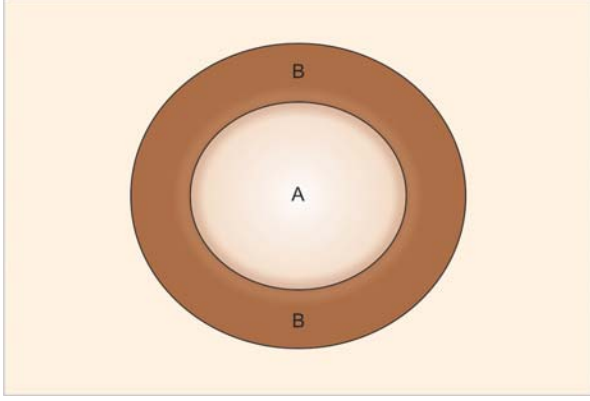

Fig. 8: Visible lower end of amniotic sac (B) circulated by the dilated cervix (A) in the vagina when the funneling dilatation reaches to the external os

Fetal Growth in Preterm Birth

The preterm fetus before 37 weeks of pregnancy is physiologically smaller than the term fetus and there may be organic or functional immaturity in further earlier preterm infant. Since, the immaturity of preterm fetus roughly estimated by the fetal age and pregnancy weeks, the gestational weeks at the birth of preterm infant is primarily significant to assess the maturity of the preterm infant. Ultrasonically estimated fetal weight also depends on parameters like the length, diameter and circumference of fetal body parts in various fetal weight estimating equations.[4] For example, fetal weight is estimated by using the Shinozuka's equation;[5] the estimated fetal weight = 1.07 (BPD^3) + 3.42 (APD × TD × FL), where BPD is biparietal diameter of fetal head, APD and TD are anteroposterior and transverse diameters of the fetal abdomen, and FL is the fetal femur length obtained by fetal B-mode studies. The equation is utilized in the automated fetal weight estimation in ultrasound B-mode devices. The estimated Japanese fetal weight is evaluated on the standard mean and ± 1.5, 2.0 SD fetal growth curves in normal pregnancy (Fig. 9).[6]

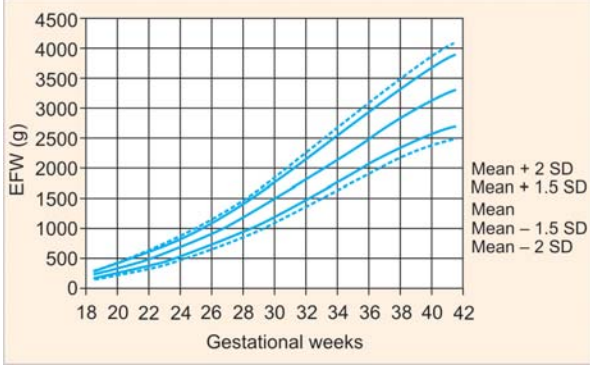

Fig. 9: An example of standard birth weight. The 90%, median, 10% of Japanese male infantile birth weight in 2,000 are shown. The estimated fetal weight is evaluated comparing to the standard weight. Dotted line: multiparous; straight line: primiparous pregnancies *(Cited from: Kozuma S, in Jap Soc Ultrasonics Medicine edited, New Ultrasound Medicine, Igaku Shoin, Tokyo 2000, Vol 4, pp 88)*

Maturity of Fetal Lung in Preterm Birth

Neonatal respiratory distress syndrome (RDS) is an important complication of the preterm birth, and the immaturity of fetal lung tends to precede the RDS. Chemical and physical examinations of amniotic fluid disclosed the immaturity of fetal lung before the birth, while the fluid was obtained by invasive amniocentesis. Although magnetic resonance image and spectroscopy were applied for the noninvasive detection of fetal lung immaturity, more simple technique was hoped. Therefore, ultrasonically detected fetal parameters were applied to assess fetal lung maturity, e.g. fetal respiratory movement, fetal nasal flow color Doppler signal detected at fetal respiratory movement,[7] mature pulsed Doppler arterial flow velocity curves,[8] and so on.

Ultrasonic tissue characterization was also studied for the fetal lung immaturity diagnosis. Frequency components of ultrasound images were analyzed, and some relation was found.[9] The texture of fetal lung B-mode image also showed the relation to fetal lung maturity.[10] The gray level value showed the relation to fetal lung maturity,[11] while the gray level varied according to the gain of ultrasound device.

The gray-level histogram width (GLHW) was stable to gain control, the depth of region of interest and the change to new device after calibration, and the fetal lung immaturity was estimated by the ratio of fetal lung and liver in preterm birth cases (Fig. 10). The estimated fetal weight and gestational weeks determined by CRL measurement were also applied for the estimation of fetal lung immaturity. The estimation rate of fetal lung immaturity was 77% by estimated fetal weight, 77% by corrected gestational weeks, 86% by the lung to liver GLHW ratio, and the product of lung to liver GLHW ratio and corrected gestational weeks was 96%.[12] Therefore, noninvasive ultrasonic diagnosis with the tissue characterization achieved the success of fetal lung immaturity diagnosis comparable to chemical and physical tests of invasively obtained amniotic fluid by amniocentesis.

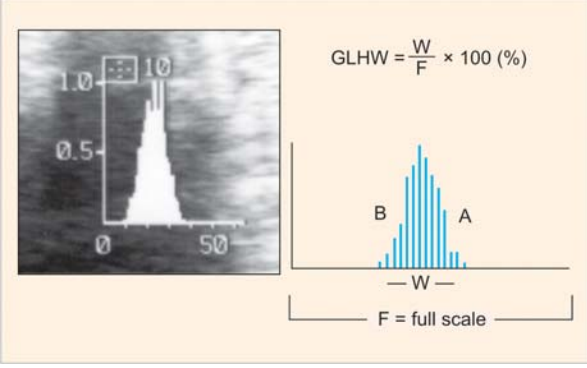

Fig. 10: In manual measurement, the GLHW is obtained when the histogram width measured by a ruler is divided by the full length of gray scale. The GLHW is also determined automatically, which is equivalent to manual measurement (*Cited from a lecture illustration of Maeda K*)

REFERENCES

1. Iams JD, Goldenberg RL, Meis PJ, Mercer BM, Moawad A, Das A, et al. The length of the cervix and the risk of spontaneous premature delivery. National Institute of Child Health and Human Development Maternal Fetal Medicine Unit Network. N Engl J Med 1996;334:567-72.
2. To MS, Skentou C, Liao AW, Cacho A, Nicolaides KH. Cervical length and funneling at 23 weeks of gestation in the prediction of spontaneous early preterm delivery. Ultrasound Obstet Gynecol 2001;18:200-03.
3. Crane JM, Hutchens D. Transvaginal sonographic measurement of cervical length to predict preterm birth in asymptomatic women at increased risk: A systematic review. Ultrasound Obstet Gynecol 2008;31:579-87.
4. Carrera JM, Maeda K, Comas C, Torrents M. Diagnosis of intrauterine growth restriction. In: Carrera JM, Mandruzzato GP, Maeda K (Eds). Ultrasound and Fetal Growth, Parthenon, London 2001;35-69.
5. Shinozuka N. Formulas for fetal weight estimation by ultrasound measurements based on neonatal specific gravities and volume. Am J Obstet Gynecol 1987;157:1140-45.
6. The Japan Society of Ultrasonics in Japan 2003; http://www.jsum.or.jp/committee/diagnostic/pdf/taiji.pdf
7. La Torre R, Cosmi E, Anceschi MH, Piazze JJ, Piga MD, Cosmi, EV. Preliminary report on a new and noninvasive method for the assessment of fetal lung maturity. J Perinat Med 2003;31:431-34.
8. Piazze JJ, Anceschi MM, Picone G, Cereskja A, La Torre R, Cosmi EV. Association between maternal-fetal Doppler velocimetry and fetal lung maturity. J Perinat med 2003;31: 484-88.
9. Sohn C, Stolz W, Bastert G. Diagnosis of fetal lung maturity by ultrasound: A new method and first results. Ultrasound Obstet Gynecol 1991;1:345-48.
10. Prakash KN, Ramarkrishnan AG, Suresh S, Chow TW. An investigation into the feasibility of fetal lung maturity prediction using statistical textural features. Ultrason imaging 2001;23: 39-54.
11. Takesin I, Anderer G, Hellmeyer L, Stein W, Künert M, Schmidt S. Assessment of fetal lung development by quantitative ultrasonic tissue characterization: A methodical study. Prenat Diagn 2004;24:671-76.
12. Serizawa M, Maeda K. Noninvasive fetal lung maturity prediction based on ultrasonic gray level histogram width. Ultrasound Med Biol 2010;36:1998-2003.