Reference Ranges for Doppler Indices of Uterine Arteries in Pregnant Women During 22-28 Weeks' Gestation : A Study at King Chulalongkorn Memorial Hospital

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Abstract

Color pulsed Doppler ultrasound was used to examine the uterine arteries of a total of 265 normal pregnant women during 22-28 weeks' gestation at the Division of Maternal-Fetal Medicine, King Chulalongkorn Memorial Hospital. Reference ranges for pulsatility index (PI) were determined and throughout this gestational range, the mean values were nearly constant and lower than 0.9 and the upper limit of 95 per cent confidence interval (CI) for the PI values were lower than 1.0. In conclusion, the authors have established the reference ranges for PI of uterine arteries in the late second to early third trimester of pregnancy in Thai pregnant women. This could be beneficial for the baseline data in the evaluation of pregnant women complicated with preeclampsia and fetal growth restriction.

Key word : Reference Ranges, Uterine Artery, Doppler Indices, Pregnancy

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Currently, the utility of Doppler ultrasound, as a noninvasive method for assessment of the uteroplacental resistance prior to fetal or maternal compromise is very attractive. Preeclampsia and fetal growth restriction (FGR), the two serious complications associated with significant morbidity and mortality during the latter half of pregnancy are believed to result from impaired placentation[1]. The physiological basis for this abnormal finding is due to failure of trophoblastic invasion of the maternal

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spiral arteries during the second trimester leading to increased uteroplacental resistance[2]. Several Doppler ultrasonographic studies of the uterine arteries, either in selected or unselected populations, have demonstrated that high impedance to flow (increased resistance index (RI) and pulsatility index (PI) or the presence of an early diastolic notch) during the late second trimester is associated with subsequent preeclampsia, FGR and related complications. This high impedance to flow is also valuable in the prediction of these complications[3-10].

Normal reference ranges for uterine artery Doppler indices have been published by several groups in Western countries[11-13]. However, these Doppler indices in Thai pregnant women have not been established. Therefore, the aim of this study was to establish reference ranges for PI of the uterine arteries in normal Thai pregnant women during 22-28 weeks' gestation.

MATERIAL AND METHOD

Uterine artery color Doppler ultrasound was performed on pregnant women during 22-28 weeks' gestation who attended routine antenatal clinics or came for a routine fetal anatomy ultrasound scan at Division of Maternal-Fetal Medicine, Department of Obstetrics and Gynecology, Faculty of Medicine, King Chulalongkorn Memorial Hospital, Chulalongkorn University. Measurements were made at randomly assigned gestational age, so that approximately an equal number of women, were measured at each week. Each woman of gestational age was measured only once.

During the study (November 2000 through September 2001), a total of 265 normal pregnant women were recruited into the study with informed consent. The study protocol was approved by the Faculty Ethical Committee. All met the inclusion criteria consisting of a normal singleton pregnancy and known definite gestational age. Women with hypertension, abnormal fetal growth, fetal anomalies, preterm delivery and the presence of an early diastolic notch from Doppler measurements were excluded from the study.

Color pulsed Doppler ultrasound was performed with an Aloka SSD-2000 (Aloka Co., Tokyo, Japan), using a 3.5-MHz transducer and 100-Hz high-pass filter. The right and left uterine arteries were identified at the apparent crossover with the external iliac arteries. The pulsed-wave Doppler was used to obtain waveforms from each uterine artery near the external iliac artery, before division of the uterine artery into branches. When three similar consecutive waveforms were obtained, the PI was measured, and the mean PI of the two vessels was calculated. All measurements were performed by two of the authors (T.D. and V.P.).

The data were subsequently analyzed for means and 95 per cent confidence interval (CI) at each week of gestation using SPSS statistical package version 10.0 for Windows (SPSS Inc, Chicago, USA). The relationship of the mean PI and gestational age was also examined by regression analysis.

RESULTS

Uterine artery color Doppler ultrasound was performed in 265 normal pregnant women. It was possible to record flow velocity waveforms satisfactorily in all women. The mean intraobserver and interobserver coefficients of variation between examinations were found to be 5 per cent and 8 per cent, respectively. The mean maternal age was 27.1±5.3 years, ranging from 16 to 44 years. Most (55.1%) were nulliparous. No maternal or fetal complications were observed in any of them.

No relationship was found between the mean PI and gestational age. The mean values of PI from 22 to 28 weeks were nearly stable and lower than 0.9. The upper limit of 95 per cent CI of PI values were lower than 1.0 in all gestational weeks. The PI with 95 per cent CI are presented in Table 1. The results are presented graphically in Fig. 1.

DISCUSSION

With the advent of Doppler ultrasound, it has become possible to study the hemodynamics of the uteroplacental circulation in normal pregnancy

Table 1. Pulsatility index (PI) and 95 per cent confidence interval of the uterine artery in normal pregnancy.

Week	No	Pulsatility Index (PI) Mean	95% CI
22	35	0.805	0.735, 0.874
23	36	0.885	0.809, 0.961
24	43	0.805	0.747, 0.864
25	44	0.824	0.773, 0.876
26	43	0.814	0.754, 0.874
27	30	0.831	0.756, 0.906
28	34	0.748	0.695, 0.801

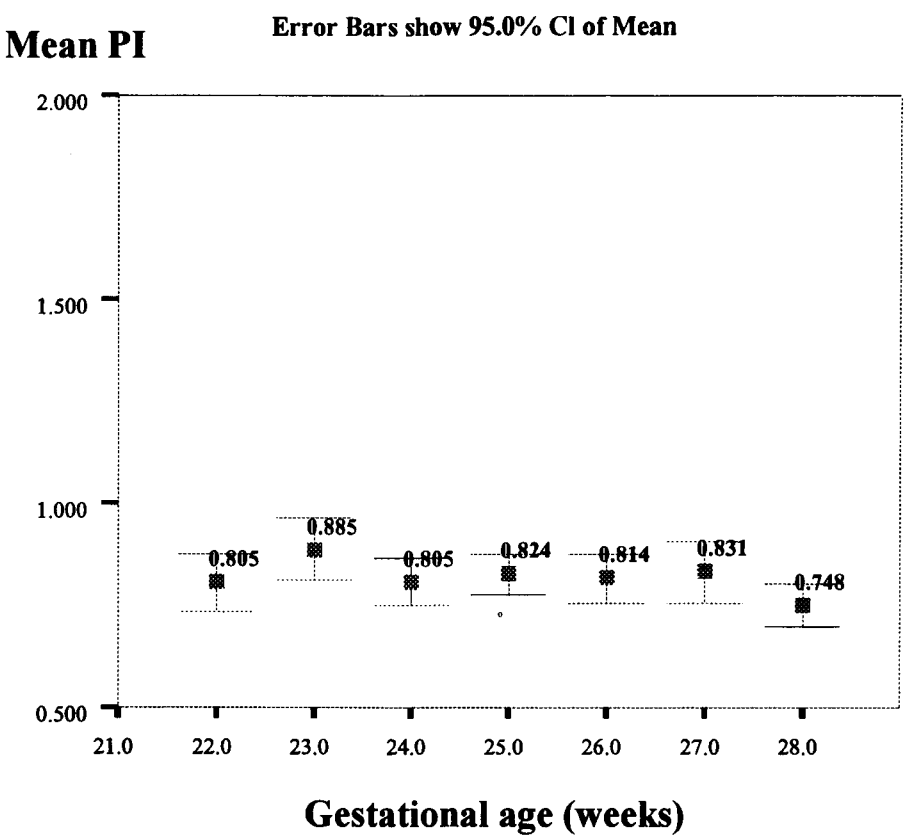

Fig. 1. Pulsatility index (PI) and 95 per cent confidence interval of the uterine artery during 22-28 weeks' gestation.

and in a variety of clinical conditions. Several studies have examined the value of Doppler assessment of the uteroplacental circulation in the prediction of preeclampsia, FGR and related complication as previously mentioned[3-10].

Before this new technology is accepted as a standard screening, the baseline data of Doppler indices must be collected. However, there are no standard reference ranges for Doppler indices of uterine arteries in Thai pregnant women. The authors believe that the data presented here can represent the normal Thai population and can be used as baseline data due to its adequate sample size, known exact gestational age and well-selected women with strict criteria in recruitment of normal pregnant women. With regard to the three indices (systolic/diastolic (S/D) ratio, RI and PI) that are commonly used to express the flow velocity waveforms, the authors used the PI because it gives a broader range of values when there is no end-diastolic flow.

In the second trimester of normal pregnancy, impedance to flow in the uterine arteries decreases with gestation which is due to trophoblastic invasion of the spiral arteries. Schulman et al found that the presence of an early diastolic notch disappeared between 20-26 weeks[11]. Values for all Doppler indices decline during the course of pregnancy until 22-24 weeks and then remain stable to term[12,13]. Findings from these investigators show that after 22-24 weeks, there appears to be adequate or complete placentation. Similar to these foregoing studies[11-13], the presnet findings also indicate that the mean values of PI from 22 to 28 weeks remain stable and lower than 0.9.

In the two-stage screening by uterine artery Doppler, Bower et al[9] examined the uterine arteries at 20 weeks of gestation. In those with increased impedance to flow, the Doppler studies were repeated at 24 weeks. Persistent impedance was observed in 5.4 per cent of the patients compared to 16 per

cent at 20 weeks. It was reported that increased impedance provides good prediction of preeclampsia. Furthermore, in terms of low birth weight, abnormal waveforms provide better prediction of severe (below the 3rd centile) rather than mild (below the 10th centile) FGR. In more recent years, a one-stage color Doppler screening program at 23 or 24 weeks has shown that this gestation identifies most women who subsequently develop serious complications of impaired placentation[10,14]. This implies that screening may best be performed at 23 or 24 weeks. Hence, the present study is consistent with this screening gestational period when the process of placentation is fully developed.

In conclusion, the authors have established the reference ranges for PI of uterine arteries in the late second to early third trimester of pregnancy in the hope that it could serve as the baseline data in the evaluation of maternal or fetal complications associated with abnormal placentation in the Thai pregnant population. Obviously, further studies are needed to determine its efficacy.

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REFERENCES

1. Khong TY, De Wolf F, Robertson WB, Brosens I. Inadequate maternal vascular response to placentation in pregnancies complicated by pre-eclampsia and by small-for-gestational age infants. Br J Obstet Gynaecol 1986; 93: 1049-59.
2. Campbell S, Pearce JM, Hackett G, Cohen-Overbeek T, Hernandez C. Qualitative assessment of uteroplacental blood flow: early screening test for high-risk pregnancies. Obstet Gynecol 1986; 68: 649-53.
3. Jacobson SL, Imhof R, Manning N, et al. The value of Doppler assessment of the uteroplacental circulation in predicting preeclampsia or intrauterine growth retardation. Am J Obstet Gynecol 1990; 162: 110-4.
4. Zimmermann P, Eirio V, Koskinen J, Kujansuu E, Ranta T. Doppler assessment of the uterine and uteroplacental circulation in the second trimester in pregnancies at high risk for pre-eclampsia and/or intrauterine growth retardation: comparison and correlation between different Doppler parameters. Ultrasound Obstet Gynecol 1997; 9: 330-8.
5. Bower S, Schuchter K, Campbell S. Doppler ultrasound screening as part of routine antenatal scanning: Prediction of pre-eclampsia and intrauterine growth retardation. Br J Obstet Gynaecol 1993; 100: 989-94.
6. Kurdi W, Campbell S, Aquilina J, England P, Harrington K. The role of color Doppler imaging of the uterine arteries at 20 weeks' gestation in stratifying antenatal care. Ultrasound Obstet Gynecol 1998; 12: 339-45.
7. North RA, Ferrier C, Long D, Townend K, Kincaid-Smith P. Uterine artery Doppler flow velocity waveforms in the second trimester for the prediction of preeclampsia and fetal growth retardation. Obstet Gynecol 1994; 83: 378-86.
8. Irion O, Masse J, Forest JC, Moutquin JM. Prediction of pre-eclampsia, low birthweight for gestation and prematurity by uterine artery blood flow velocity waveforms analysis in low risk nulliparous women. Br J Obstet Gynaecol 1998; 105: 422-9.
9. Bower S, Bewley S, Campbell S. Improved prediction of preeclampsia by two-stage screening of uterine arteries using the early diastolic notch and color Doppler imaging. Obstet Gynecol 1993; 82: 78-83.
10. Albaiges G, Missfelder-Lobos H, Lees C, Parra M, Nicolaides KH. One-stage screening for pregnancy complications by color Doppler assessment of the uterine arteries at 23 weeks' gestation. Obstet Gynecol 2000; 96: 559-64.
11. Schulman H, Fleischer A, Farmakides G, Bracero L, Rochelson B, Grunfeld L. Development of uterine artery compliance in pregnancy as detected by Doppler ultrasound. Am J Obstet Gynecol 1986; 155: 1031-6.
12. Pearce JM, Campbell S, Cohen-Overbeek T, Hackett G, Hernandez J, Royston JP. References ranges and sources of variation for indices of pulsed Doppler flow velocity waveforms from the uteroplacental and fetal circulation. Br J Obstet Gynaecol 1988; 95: 248-56.
13. Weissman A, Jaffa AJ, Lurie S, Har-Toov J, Peyser MR. Continuous wave Doppler velocimetry of the main-stem uterine arteries: The transvaginal

approach. Ultrasound Obstet Gynecol 1995; 5: 38-43.
14. Antsaklis A, Daskalakis G, Tzortzis E, Michalas S. The effect of gestational age and placental location on the prediction of pre-eclampsia by uterine artery Doppler velocimetry in low-risk nulliparous women. Ultrasound Obstet Gynecol 2000; 16: 635-9.

ค่าอ้างอิงดัชนีดือพเลอร์ของหลอดเลือดแดงยูเทอรีนในสตรีตั้งครรภ์ช่วงอายุครรภ์ 22-28 สัปดาห์ : การศึกษาที่โรงพยาบาลจุฬาลงกรณ์

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สตรีตั้งครรภ์ปกติจำนวน 265 รายได้รับการตรวจคลื่นเสียงความถี่สูงพัลซด็อพเลอร์ชนิดสืบริเวณหลอดเลือดแดงยูเทอรีนช่วงอายุครรภ์ 22-28 สัปดาห์ ที่หน่วยเวชศาสตร์มารดาและทารกในครรภ์ โรงพยาบาลจุฬาลงกรณ์ เพื่อศึกษาค่าอ้างอิงดัชนีด็อพเลอร์ พบว่าทุกอายุครรภ์ในช่วงที่ทำการศึกษา ค่าเฉลี่ยของ Pulsatility index (PI) มีค่าเกือบจะคงที่และต่ำกว่า 0.9 และค่าสูงสุดของระดับความเชื่อมั่นที่ร้อยละ 95 (95% confidence interval) มีค่าต่ำกว่า 1.0 สรุปการศึกษานี้ได้นำเสนอค่าอ้างอิง PI ของหลอดเลือดแดงยูเทอรีนในสตรีตั้งครรภ์ไทยในช่วงปลายไตรมาสที่สองถึงต้นไตรมาสที่สามของการตั้งครรภ์ ข้อมูลนี้สามารถนำไปใช้ประโยชน์เป็นข้อมูลพื้นฐานในการประเมินสตรีตั้งครรภ์ที่มีภาวะแทรกซ้อนเช่น ภาวะความดันโลหิตสูงขณะตั้งครรภ์และภาวะทารกเจริญเติบโตช้าในครรภ์

คำสำคัญ : ค่าอ้างอิง, หลอดเลือดแดงยูเทอรีน, ดัชนีด็อพเลอร์, การตั้งครรภ์

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