Uterine Artery Resistance Index above 95 Percentile : Prevalence and Adverse Perinatal Outcome Prediction in Pregnancies Complicated by Hypertensive Disorders

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Abstract

Uterine artery resistance index (UARI) was determined in a cohort of pregnant women complicated by a hypertensive disorder. The prevalence of the value above 95 percentile (UARI95) and its prediction of adverse perinatal outcomes were evaluated. Fifty-eight women were included in the study. The prevalence of UARI95 in this group of women was 27.6 per cent. The correlations between mean UARI95 and adverse perinatal outcomes were: 31.6 per cent sensitivity, 74.4 per cent specificity, with only 60.3 per cent accuracy. The mean UARI95 does not qualify as a reliable screening test for adverse perinatal outcomes in pregnancies complicated by hypertensive disorders.

Key word : Uterine Artery Resistance Index, Gestational Hypertension, Hypertensive Disorder, Doppler Ultrasonography

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Hypertensive disorders have been found in 3.7 per cent of pregnant women, rendering it to be one of the most common complications in pregnancy(1). This group of disorders includes pregnancy-induced hypertension (PIH), chronic hypertension and chronic hypertension superimposed by PIH. The major pathology of these disorders involves vasoconstriction.

Normally, uterine blood flow increases ten fold in a pregnant condition due to decreased vascular resistance(1). In pregnancies complicated by a hyper-

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tensive disorder, abnormal placentation induces regional vasospasm of uteroplacental circulation. This phenomenon results in increased vascular resistance and decreased placental blood flow which in turn impair fetal growth and induce fetal hypoxia and can cause perinatal death.

For the past two decades, Doppler ultrasonography has become an important tool in maternal fetal medicine especially in blood flow evaluation. It is noninvasive and can be performed on several vessels. With this technique, blood flow evaluation can be estimated using several indices and this is potentially useful in the management of a pregnancy at risk of impaired fetal or uteroplacental blood flow. Umbilical artery Doppler study in pregnancies complicated by a hypertensive disorder was found to be able to significantly reduce adverse perinatal outcomes, cesarean section rate due to fetal distress and perinatal deaths[2,3].

Regarding uterine artery Doppler study, a high S/D ratio and a high pulsatility index especially with a presence of diastolic notch have been found to correlate with adverse perinatal outcomes such as stillbirth, premature birth, intrauterine growth retardation, operative delivery for fetal distress, neonatal intensive care unit admission and a low Apgar score in pregnancy-induced hypertension, chronic hypertension, and superimposed preeclampsia[4-6].

However, in a low risk group, it was demonstrated that Doppler flow study was not beneficial[7]. As for normal pregnancy, Kurmanavicius et al (1997) performed a study to develop a normogram of resistance indices of umbilical artery, fetal middle cerebral artery and uterine artery by gestational age. The value of mean uterine artery resistance index higher than 95 percentile (mean UARI95) for each gestational age is derived from the formula 0.683 - (0.00288 x weeks of gestation)[8].

The authors set out to study the prediction ability of mean UARI higher than 95 percentile in perinatal outcomes in pregnancies with a hypertensive disorder.

MATERIAL AND METHOD

Pregnant women with a hypertensive disorder (pregnancy-induced hypertension, chronic hypertension or superimposed preeclampsia) were included in the present study. Resistance indices were derived from both uterine arteries in each case and a mean value was obtained. The study was performed within 7 days prior to delivery. The mean UARI95 was determined for each gestational age according to Kurmanavicius et al[8]. Prevalence of cases with UARI95 or higher was determined and its correlation with adverse perinatal outcomes was studied. In the present study, adverse perinatal outcomes included meconium in the amniotic fluid, fetal distress, perinatal asphyxia and the need for admission into the newborn intersive care unit (NICU).

RESULTS

Fifty-eight women were recruited in the study with demographic data shown in Table 1. The women were primigravida, slightly hypersthenic and of low socioeconomic status in more than half of the subjects. Hypertension commenced at 37 weeks gestation or later in 58.6 per cent of cases. Delivery took place between 37 to 42 weeks in the majority of cases (81%) and 17 per cent were preterm birth. Table 2 demonstrates the mean UARI and the prevalence of cases with mean UARI95 or higher in each group of patients categorized by the disorder. Prevalence of cases with a mean UARI95 or higher was highest in the most severe group, namely women with severe preclampsia. The prevalence, however, was not significantly different among the three groups ($p = 0.53$).

In the present study, 32 cases were found to have an adverse perinatal outcome, i.e., 10 cases with perinatal asphyxia, 8 cases with meconium in amniotic fluid, 8 cases with fetal distress and another 6 cases were admitted to the NICU. The mean UARI values in these cases were not different from those without adverse perinatal outcomes as demonstrated in Table 3.

Performances of the mean UARI95 in prediction of adverse perinatal outcomes in pregnant women complicated by hypertensive disorders are shown in Table 4. The overall accuracy of UARI95 in predicting any adverse fetal outcome was 60 per cent with a low sensitivity and slightly high specificity. Considering each category of the disorder, the accuracy was lowest in the mild preeclampsia group and was about 70 per cent in the severe preclampsia and chronic hypertension groups (Table 5).

DISCUSSION

This study aimed to determine the prevalence of UARI95 in pregnancies complicated by a hypertensive disorder and its association with adverse

Table 1. Demographic data of all the women.

General data	Number	%
Age (years)		
< 20	4	6.9
20-30	29	50.0
> 30	25	43.1
Parity		
Primipara	32	55.2
Multipara	26	44.8
Body mass index (kg/m^2)		
< 27	26	44.8
≥ 27	32	55.2
Onset of hypertension (gestational age in weeks)		
< 34	14	24.2
34-36	10	17.2
≥ 37	34	58.6
Gestational age in weeks at delivery		
< 34	2	3.4
34-36	8	13.8
37-42	47	81.0
> 42	1	1.7

Table 2. Mean UARI and proportion of cases with mean UARI95 in each disorder.

Disorder	Number (cases)	Mean UARI ± SD	Range	P-value*	Proportion of cases with Mean UARI95	%	P-values**
Mild preeclampsia	37	0.53 ± 0.96	0.40-0.74	0.32	10/37	27.0	0.53
Severe preeclampsia	10	0.57 ± 0.14	0.40-0.83		4/10	40.0	
Chronic hypertension	11	0.58 ± 0.83	0.39-0.68		2/11	18.2	
Total	58	0.53 ± 0.10	0.39-0.83		16/58	27.6	

* unpaired *t*-test
** chi-square test

Table 3. Mean UARI in cases with and without a particular adverse perinatal outcome.

Perinatal outcome	Number (cases)	Mean UARI ± SD	P-value*
Meconium in the amniotic fluid			
No	50	0.54 ± 0.11	0.32
Yes	8	0.50 ± 0.76	
Fetal distress			
No	50	0.54 ± 0.10	0.66
Yes	8	0.52 ± 0.10	
Perinatal asphyxia			
No	48	0.53 ± 0.97	0.51
Yes	10	0.55 ± 0.13	
Admission to NICU			
No	52	0.52 ± 0.93	0.02
Yes	6	0.62 ± 0.15	

* unpaired *t*-test

Table 4. Accuracy of UARI95 in predicting an adverse perinatal outcome in pregnancies complicated by a hypertensive disorder.

Perinatal outcome	Sensitivity	Specificity	PPV	NPV	Accuracy
Meconium in the amniotic fluid	25	72	12.5	85.7	65.5
Fetal distress	37.5	74	18.8	88.1	69
Perinatal asphyxia	40	75	25	85.7	69
Admission to NICU	50	75	18.8	92.9	72.4
Any outcome	31.6	74.4	37.5	69	60.3

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

Table 5. Accuracy of UARI95 in predicting any adverse perinatal outcome in pregnancies complicated by a hypertensive disorder according to the type of disorder.

Type of Disorder	Sensitivity	Specificity	PPV	NPV	Accuracy
Mild preclampsia	18.2	69.2	20	66.7	54.1
Severe preclampsia	60	80	75	66.7	70
Chronic hypertension	33.3	87.5	50	77.8	72.7

perinatal outcomes. In normal placentation, with the trophoblast invasion into the endometrium, maternal blood vessels especially spiral arteries respond by vasodilatation. In pregnancies with a hypertensive disorder, inadequate invasion of maternal spiral arteries leads to a lower degree of vasodilatation and finally to vasoconstriction, resulting in increased vascular resistance. This process may lead to adverse perinatal outcomes due to uteroplacental insufficiency(9).

For the past two decades, blood flow studies have been attempted to determine a suitable technique to predict adverse pregnancy outcomes using several parameters. In Thailand, a few studies have addressed these aspects. The authors therefore were interested in the roles of blood flow studies in predicting the adverse perinatal outcomes in pregnancies with a hypertensive disorder. The authors selected uterine artery indices because these arteries are expected to exhibit vasospasm in these pregnant women. The prevalence of pregnancies with UARI higher than 95 percentile was determined and the correlation between the RI higher than 95 percentile with adverse perinatal outcomes were studied.

The patients were categorized into three groups according to the type of hypertensive disorders namely pregnancy-induced hypertension, chronic hypertension and those with superimposed preclampsia. Considering the whole group, the prevalence of cases with UARI95 or higher was 27.6 per cent. As the name implies, the incidence of UARI95 or higher will be 5 per cent in normal population. The higher incidence in the studied women can be explained by pregnancy with hypertension being associated with an increased vascular resistance resulting in decreased placental blood flow. This is expected to be associated with higher adverse perinatal outcomes. However, in the present study, performance of UARI95 turned out to be less beneficial than expected with an overall accuracy of only 60 per cent, 32 per cent sensitivity and 74 per cent specificity. The least accuracy was found in the mild preclampsia group. This could be due to the least severe nature of this group. In severe preclamptic or chronic hypertensive patients, the performance of UARI95 was slightly better due to the more severe or long standing nature of the pathology with more effect on vascular resistance and the fetus. Nonetheless, due to low sensitivity, UARI95 is not suitable as a screening test to predict adverse perinatal outcomes in pregnancies complicated by a hypertensive disorder. On the other hand, 87.5 per cent specificity was achieved in the chronic hypertensive group. Thus, fetal health in cases of a normal mean UARI should be good. All in all, though, the mean UARI95 does not qualify as a reliable screen-

ing test for adverse perinatal outcomes in pregnancies complicated by hypertensive disorders. Perhaps a complete analysis of uteroplacental hemodynamics should involve more than one parameter or even more than one vessel, that is, to include the uterine, umbilical and fetal middle cerebral arteries(10).

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REFERENCES

1. Cunningham FG, Gant NF, Leveno KJ, et al. Hypertensive disorders in pregnancy. In: Obstetrics, 21st ed. Stamford: Appleton & Lange; 2001: 567-618.
2. Zarko A, James PN. Doppler ultrasonography in high-risk pregnancies: Systemic review with meta-analysis. Am J Obstet Gynecol 1994; 172: 1379-87.
3. Karsdorp VHM. Abnormal Doppler velocities in the umbilical artery. Eur J Obstet Gynecol Reprod Biol 1998; 80: 129-31.
4. Adiel F, Harold S, George F, et al. Uterine artery Doppler velocimetry in pregnant women with hypertension. Am J Obstet Gynecol 1986; 154: 806-13.
5. Alexander DK, Mary P, Nicholas V, Melissa S. Interrelationship and clinical significance of increased resistance in the uterine arteries in patients with hypertension or preeclampsia or both. Am J Obstet Gynecol 1992; 166: 601-6.
6. Hernandez-Andrade E, Brodszki J, Lingman G, Gudmundsson S, Molin J, Marsal K. Uterine artery score and perinatal outcome. Ultrasound Obstet Gynecol 2002; 19: 438-42.
7. Olivier I, Javques M, Jeans-Claude F, Jeans-Marie M. Prediction of preeclampsia, low birth weight for gestation and prematurity by uterine artery blood flow velocity waveform analysis in low risk nulliparous women. Br J Obstet Gynaecol 1998; 105: 422-9.
8. Kurmanavicius J, Florio I, Wisser J, et al. Reference resistance indices of the umbilical, fetal middle cerebral and uterine arteries at 24-42 weeks of gestation. Ultrasound Obstet Gynecol 1997; 10: 12-20.
9. Jenn MY, Yuh CY, Kuo GW. Central and peripheral hemodynamics in severe preeclampsia. Acta Obstet Gynecol Scand 1996; 75: 120-6.
10. Joern H, Funk A, Rath W. Doppler sonographic findings for hypertension in pregnancy and HELLP syndrome. J Perinat Med 1999; 27: 388-94.

ค่าดัชนีความต้านทานในหลอดเลือดแดงยูเทอรีนที่สูงกว่า 95 เปอร์เซนต์ไทล์ : ความชุกและการทำนายผลร้ายต่อทารกแรกเกิดในการตั้งครรภ์ที่มีความดันโลหิตสูง

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ได้ศึกษาดัชนีความต้านทานในหลอดเลือดแดงยูเทอรีน ในสตรีตั้งครรภ์ที่มีภาวะความดันโลหิตสูง ความชุกของค่าที่สูงกว่า 95 เปอร์เซนต์ไทล์ (UARI95) และการทำนายผลร้ายต่อทารกแรกเกิด โดยมีสตรีตั้งครรภ์ 58 คนในการศึกษานี้ ความชุกของ UARI95 ในสตรีกลุ่มนี้ เท่ากับ 27.6% ความสัมพันธ์ระหว่าง การมี UARI สูงกว่า 95 เปอร์เซนต์ไทล์ กับผลร้ายต่อทารกแรกเกิด คือความไว 31.6%, ความจำเพาะ 74.4% และความถูกต้องเพียง 60.3% การตรวจว่าผู้ป่วยมีค่า UARI สูงกว่า 95 เปอร์เซนต์ไทล์ ไม่ใช่การตรวจกรองที่ดี เพื่อทำนายผลร้ายต่อทารกแรกเกิด ในสตรีตั้งครรภ์ที่มีความดันโลหิตสูง

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