Comparison of Uterine Artery Doppler Indices in the Prediction of Preeclampsia and Foetal Growth Restriction in High Risk Pregnancies at 20 - 24 Weeks of Gestation

Surekha Narayan Khandale[1], Aashima Mittar Sen Garg[2], Gaurav Mangal[3], Swati Patel[4]

[1]Assistant Professor, Department of Obstetrics and Gynaecology, Indira Gandhi Government Medical College, Nagpur, Maharashtra, India. [2]Junior Resident, Department of Obstetrics and Gynaecology, Indira Gandhi Government Medical College, Nagpur, Maharashtra, India. [3]Consultant Radiologist, Department of Radiology, Shradha Diagnostic Centre, Sikar, Rajasthan, India. [4]Junior Resident, Department of Obstetrics and Gynaecology, Indira Gandhi Government Medical College, Nagpur, Maharashtra, India.

ABSTRACT

BACKGROUND

Foetal growth restriction is the second most common cause of low birth weight after prematurity. Hypertensive disorders are some of the most common medical complications and are associated with a substantial increase in maternal perinatal morbidity and mortality. Evidence suggests that these conditions generally manifest later in pregnancy, but their underlying pathophysiology is established early in pregnancy. This finding has sparked great interest in the search for tests to predict them early in pregnancy before these complications occur.

METHODS

The study was carried out on 200 pregnant women of 20 - 24 weeks gestation in the Department of Obstetrics and Gynaecology, Indira Gandhi Government Medical College, Nagpur, from September 2017 to October 2019. All three doppler indices were studied and these patients were followed up till delivery, and details of pregnancy events, labour and delivery, and neonatal outcome were noted. The abnormal pregnancy outcomes considered were preeclampsia and foetal growth restriction.

RESULTS

Uterine diastolic notch shows high sensitivity (77.76%), specificity (94.52%), positive predictive value (84%), and negative predictive value (92%) in the prediction of pre-eclampsia and it also has high sensitivity (73.68%), specificity (86.42%), positive predictive value (56.9%), and negative predictive value (93.33%) in the prediction of foetal growth restriction as compared to abnormal PI and RI. Hence, uterine diastolic notch is associated with maternal morbidity and increased adverse perinatal outcome.

CONCLUSIONS

Women with abnormal uterine artery Doppler (at 20-24 weeks of gestation), are recommended intensive antenatal surveillance, adequate rest, nutritional supplements and institutional delivery as they may require intensive care at the time of delivery and baby may also require neonatal intensive care.

KEYWORDS

Diastolic Notch, Preeclampsia, Foetal Growth Restriction, Uterine Artery Doppler

BACKGROUND

Hypertension is the most common high-risk obstetric complication seen in pregnancy. It occurs in about 10% of all pregnant women worldwide[1]. Pre-eclampsia is a leading cause of maternal and perinatal morbidity and mortality. In India, the prevalence of hypertensive disorders is 7.8% and that of pre-eclampsia is 5.4%.

Foetal growth restriction is the second most common cause after prematurity, of low birth weight[2]. It is associated with a substantial increase in perinatal morbidity (3 times) and mortality (8 times). It is seen in about 24% of newborns. Owing to its long-term complications, growth restricted foetuses represent an enormous potential burden for both the affected individual and the society.

The pathogenesis of the disease involves abnormal development of small uterine vessels. Uterine artery blood flow reflects hemodynamic changes that occur at the maternal side of the placenta[3]. These physiologic changes of the placental bed spiral arteries extend only to the deciduo-myometrial junction. In pre-eclampsia the spiral arteries may remain unconverted throughout their decadal and myometrial length.

By colour Doppler velocimetry in a healthy pregnancy uterine artery shows low diastolic Doppler indices during the 1st 10 weeks of pregnancy depicted as early diastolic notch which disappear with significant increase in diastolic flow. During 2nd trimester corresponding to 2nd trophoblastic invasion in the presence of high resistance in uteroplacental circulation presence of diastolic notch during second trimester can be studied as a predictor of foetal growth retardation. Abnormal uterine artery Doppler studies in both the first and second trimester have shown to be associated with subsequent perinatal complications.

Therefore, this study has been done to predict Foetal Growth Restriction and pre-eclampsia by screening the antenatal women at risk by uterine artery doppler in 2nd trimester 20-24 weeks.

Objectives

1. To study the flow velocity waveforms in the uterine arteries at 20-24 weeks of gestation
2. To predict the development of Pre-eclampsia and Foetal growth retardation in the antenatal women with high risk pregnancy by uterine artery Doppler (uterine artery notch, RI, PI) in 2nd trimester (20 - 24 weeks).
3. To study the antenatal complications (pre-eclampsia and foetal growth restriction).
4. To study the perinatal outcome.

METHODS

A total of 200 women fulfilling the inclusion criteria with high-risk pregnancy attending antenatal clinic in Indira Gandhi government medical college, Nagpur were subjected to uterine artery Doppler study after taking the informed consent. Women with high-risk pregnancy between 22 and 24 weeks of gestation were studied in this prospective study over a period of two years from September 2017 to October 2019. With colour Doppler, uterine artery flow velocity forms were studied I.e. uterine notch, PI (pulsatility index) and RI (resistance index). The development of uterine artery notch, PI and RI more than 95th percentile from standard values were classified as abnormal. The accurate gestational age (GA) was estimated by the last menstrual period (LMP) with 28–30 days regular cycles. When a woman did not fulfil these criteria, accurate expected date of delivery (EDD) was calculated by ultrasound examination before 20 weeks of GA.

These patients were then followed up for ultrasonography to confirm the Doppler findings and final readings were recorded. The review of relevant biochemical investigations was done. We included the patients with history of preeclampsia or eclampsia in previous pregnancy, IUGR, stillbirth or abruptio placentae or pre-existing medical disorders like: Diabetes, Renal disease, Epilepsy, Autoimmune disease, Thrombophilia, and Hypertension. We excluded the patients with congenital anomaly of foetus, multiple gestations, with unreliable LMP details and not confirmed by early ultrasound, conceived in lactational amenorrhoea, intrauterine death at the time of first Doppler examination, who lost follow up or have not given consent.

These patients were followed up till delivery, and details of pregnancy events, labour and delivery, and neonatal outcome were noted. The abnormal pregnancy outcomes considered were Preeclampsia and foetal growth restriction. Abnormal perinatal outcomes considered were intrauterine death, five minutes Apgar score, Neonatal intensive care unit (NICU) admission, and birth weight.

RESULTS

Risk Factors	Number	Percentage
Age<20	34	16.6%
>35 (primi)	20	10%
BMI>30	12	6.6%
H/O Chronic HTN	12	6.6%
H/O Renal Disease	6	3.3%
H/O Diabetes Mellitus	6	3.3%
H/O Pre-Eclampsia, FGR, IUD	86	43%
Family H/O PIH	12	6.6%
H/O Autoimmune Disease	4	2%
H/O Epilepsy	8	4%
Total	**200**	**100%**

Table 1. Distribution of Cases According to High Risk Factors

Doppler Indices	Preeclampsia Present	Preeclampsia Absent	Total Cases
Uterine notch			
Present	42 (84%)	8 (16%)	50
Absent	12 (8%)	138 (92%)	150
PI> 95th Centile			
Present	40 (50%)	40 (50%)	80
Absent	14 (11.67%)	106 (88.33%)	120
RI>95th Centile			
Present	38 (54.28%)	32 (45.79%)	70
Absent	16 (12.30%)	114 (87.69%)	130

Table 2 Distribution of Cases Based on the Development of Preeclampsia

Doppler Indices	FGR Present	FGR Absent	Total
Uterine notch			
Present	28 (56%)	22 (44%)	50
Absent	10 (6.67%)	140 (93.33%)	150
PI> 95th Centile			
Present	30 (37.50%)	50 (62.54%)	80
Absent	8 (6%)	112 (94%)	120
RI>95th Centile			
Present	27 (38.57%)	43 (61.42%)	70
Absent	11 (8.4%)	119 (91.50%)	130

Table 3. Distribution of Cases Based on the Development of FGR

Perinatal Outcome	Uterine Notch (50)	PI> 95th Centile (80)	RI>95th Centile (70)
Vaginal delivery	38 (76%)	70 (87.5%)	60 (85.7%)
Caesarean section	12 (24%)	10 (12.5%)	10 (14.3%)
Preterm	18 (36%)	25 (31.25%)	15 (21.42%)
Term	32 (64%)	55 (68.75%)	55 (78.57%)
Birth WT >2.5 KG	20 (40%)	60 (75%)	60 (85.70%)
Birth WT <2.5 KG	30 (60%)	20 (25%)	10 (14.30%)
Live	37 (74%)	72 (90%)	62 (88.57%)
Stillbirth	2 (4%)	1 (1.25%)	1 (1.43%)
Neonatal death	11 (22%)	7 (8.75%)	7 (10%)
NICU admission	27 (54%)	18 (22.5%)	18 (25.71%)
No admission in NICU	23 (46%)	62 (77.5%)	52 (74.29%)
APGAR>7	23 (46%)	18 (22.5%)	18 (13.85%)
APGAR<7	27 (54%)	62 (77.50%)	52 (86.15%)

Table 4. Distribution of Cases Based on Perinatal Outcome

	Sensitivity	Specificity	PPV	NPV
Notch	77.76%	94.52%	84%	92%
PI>95th	74%	72%	50%	80%
RI>95th	67.8%	77.78%	54.2%	86.15%

Table 5. Diagnostic Performance of Uterine Notch, PI, RI in the Prediction of Preeclampsia

	Sensitivity	Specificity	PPV	NPV
Notch	73.68%	86.42%	56.9%	93.3%
PI>95th	78.95%	69.14%	37.7%	93.3%
RI>95th	71.05%	73.46%	38.57%	91.54%

Table 6. Diagnostic Performance of Uterine Notch, PI, RI in the Prediction of Foetal Growth Restriction

In the study period, we enrolled 200 pregnant females who fulfilled the inclusion criteria. In our study, maximum cases belonged to the age group of 21-30 years (50%), 30% were <20 years of age and 20% were between 31-40 years of age. As far as parity is concerned, 49% were primigravida and others were multigravidas.

DISCUSSION

In this prospective study in a setup of tertiary level care centre, which includes women from rural and urban sectors, the predictive values of various Doppler indices have been evaluated. Out of 200 patients, 50 patients had abnormal uterine artery Doppler and 70 patients had abnormal PI and 80 patients had abnormal RI.

In this study, out of 50 patients who had diastolic notch, 42 (84%) patients developed pre-eclampsia and 16% did not develop pre-eclampsia. While 8% developed pre-eclampsia despite of absent diastolic notch. In a similar study done by Sujatha Sharma et al[4] 2011, did a study on uterine artery notching on colour Doppler ultrasound and roll over test in prediction of PIH and found patients having uterine artery notch developed pre-eclampsia in 83.33% and 16.66% patients did not develop pre-eclampsia. While 28.72% developed pre-eclampsia despite of absent diastolic notch.

In our study, 50 patients who had uterine artery diastolic notch, 28 (56%) developed foetal growth restriction and out of 150 patients, 10 (6.67%) patients developed foetal growth restriction without diastolic notch. As compared to this study, Anupama Dave et al[5] studied the role of uterine artery Doppler in prediction of foetal growth restriction in high risk pregnancies in 2017 and found total Diastolic notch positive cases 20/100 out of which 60% developed FGR and out of 80/100 Diastolic notch negative cases, only 4 cases (5%) developed FGR.

In our study, out of 80 patients with high PI, 40 (50%) patients developed pre-eclampsia and 30 (37.5%) patients developed FGR. Out of 120 patients, 14 (11.67%) patients developed pre-eclampsia and 8 (6%) developed FGR with normal pulsatility index.

In 2011, Jimmy E. et al,[6] studied the Bilateral Uterine Artery Notching in the Risk Assessment for Pre-eclampsia, Small-for Gestational- Age, and Gestational Hypertension and found that patients with mean uterine artery PI>95th centile developed early onset pre-eclampsia (57.9%), late onset pre-eclampsia (13.8%), and SGA without pre-eclampsia (11.6%) whereas 3.6% patients did not develop any antenatal complication despite of raised PI. This study was comparable to our study in terms of development of pre-eclampsia but not FGR.

In our study, perinatal outcome was studied in patients with abnormal Doppler. The patients who had diastolic notch, abnormal PI, RI; 76%, 87.5%, 85.7% were delivered by vaginal route and 24%, 12.5%, 14.29% were delivered by caesarean section respectively. The patients who had diastolic notch, abnormal PI, RI; 36%, 31.25%, 21.42% delivered preterm and 64%, 68.75%, 78.57% delivered at term respectively. The patients who had diastolic notch, abnormal PI, RI; in 54%, 22.5%, 25.71% cases, baby needed NICU admission. This shows that uterine artery notch is associated with poor perinatal outcome.

When uterine artery notching is used as main index in prediction of Preeclampsia, the sensitivity, specificity and negative predictive value of uterine notch for predicting pre-eclampsia are similar to Bower et al[7] (78%, 96%, 99.5%), Ratna Siri et al[8] (78.6%, 89.9%, 99.1%), Bhattacharya et al[9] (78.6%, 99%, 99.6%) respectively and positive predictive value is comparable to Sujatha S et al i.e. 83.3%.

When uterine artery notching is used as main index in prediction of FGR, our study was comparable to Anupama D et al (75%, 90%, 60%, 90%) and specificity and negative predictive value were also comparable with Steel AC et al[10] (91.3%, 99.4%), Elisa L et al[11] (91%, 99%), Verma and Gupta et al[12] (84.1%, 91.7%), Samuel parry et al[13] (82.4%, 96.2%) respectively.

When RI is used as a main index in prediction of pre-eclampsia our study is comparable to Bhattacharya et al as far as sensitivity and positive predictive value are concerned i.e. 70%, 53.8% respectively in terms of raised RI predicting the pre-eclampsia whereas specificity and negative predictive value i.e. 77.75%, 88.3% respectively were comparable with Samuel parry et al.

Table 13: When RI is used as a main index in prediction of FGR, the specificity and negative predictive value I.e. 77.3%, 99.6% comparable to Samuel parry et al.

When PI is used as main index in prediction of pre-eclampsia, the specificity and negative predictive value I.e. 74.8%, 88.3% respectively were comparable with Samuel parry et al and sensitivity was comparable with Barati et al[14] which was 79%.

When PI is used as main index in prediction of FGR, the positive and negative predictive value I.e. 37%, 93.33% were comparable with Jimmy E et al 22.9%, 90.7% whereas specificity and negative predictive value I.e. 69.14%, 93.3% were comparable with Samuel parry et al i.e. 74.7%, 96.7% respectively.

CONCLUSIONS

Preeclampsia and foetal growth restriction are the main challenges encountered to date. The presence of abnormal uterine artery Doppler between 20 - 24 weeks is a risk factor for the development of pre-eclampsia, FGR, and adverse perinatal outcome. Among uterine artery notch, abnormal resistance index, and abnormal pulsatility index, uterine artery notch is a very reliable criterion to predict the outcome of the foetus.

In this study, we have assessed the role of Doppler ultrasonography and found it to be a useful technique for the evaluation of foetal well-being, and predicting perinatal outcome.

Women with abnormal uterine artery Doppler (at 20 - 24 weeks of gestation), are recommended intensive antenatal surveillance, adequate rest, nutritional supplements, and institutional delivery as they may require intensive care at the time of delivery and baby may also require neonatal intensive care.

REFERENCES

[1]　National Health Portal India, 2016.

[2]　Arun R. National Portal Health India. Published in 2018.

[3]　Zeek PM, Assali NS. Vascular changes in the decidua associated with eclamptogenic toxemia of pregnancy. Am J Clin Pathol 1950; 20(12):1099-1109.

[4]　Sharma S, Singh S, Gujral U, et al. Uterine artery notching on color Doppler ultrasound and roll over test in prediction of pregnancy induced hypertension. J Obstet Gynaecol India 2011; 61(6):649-651.

[5]　Dave A, Joshi R, Sooruthiya S, et al. Role of uterine artery Doppler in prediction of FGR in high risk pregnancies in 20-24 weeks. International Journal of Reproduction, Contraception, Obstetrics and Gynecology 2017;6(4):1388-1391.

[6]　Espinoza J, Kusanovic PJ, Bahado-Singh R, et al. Should bilateral uterine artery notching be used in the risk assessment for preeclampsia, small-for-gestational-age and gestational hypertension? J Ultrasound Med 2010; 29(7):1103-1115.

[7]　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(1):78-83.

[8]　Ratanasiri T. Prediction of preeclampsia in a low-risk population using diastolic notch of uterine arteries. J Med Assoc Thai 2004; 87(Suppl 3):S29-S33.

[9]　Bhattacharya SK, Kundu S, Kabiraj SP. Prediction of preeclampsia by mid trimester uterine artery Doppler velocimetry in high risk and low risk women. J Obstet Gyanecol India 2012; 62(3):297-300.

[10] Steel SA, Pearce JM, McParland P, et al. Early Doppler ultrasound screening in prediction of hypertensive disorders of pregnancy. Lancet 1990; 335(8705):1548-1551.

[11] Llurba E, Carreras E, Gratacós E, et al. Maternal history and uterine artery Doppler in the assessment of risk for development of early- and late-onset preeclampsia and intrauterine growth restriction. Obstet Gynecol Int 2009;2009:275613.

[12] Verma D, Gupta S. Prediction of adverse pregnancy outcomes using uterine artery Doppler imaging at 22-24 weeks of pregnancy: a North Indian experience. Turk J Obstet Gynecol 2016; 13(2):80-84.

[13] Parry S, Sciscione A, Haas DM, et al. Role of early second- trimester uterine artery Doppler screening to predict small-for-gestational-age babies in nulliparous women. Am J Obstet Gynecol 2017; 217(5):594.e1-594.e10.

[14] Barati M, Shahbazian N, Ahmadi L, et al. Diagnostic evaluation of uterine artery Doppler sonography for the prediction of adverse pregnancy outcomes. Journal of Research in Medical Sciences 2014;19(6):515-519.