ORIGINAL RESEARCH

The role of uterine artery Doppler in screening for preeclampsia in 11 to 13 weeks and 21 to 24 weeks

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Abstract
In pre eclampsia there is failure of trophoblastic invasion which increases the vascular resistance and decreases the uteroplacental and fetoplacental perfusion. The uteroplacental and fetoplacental perfusion can be studied non-invasively by means of Doppler ultrasound.Pre eclampsia isthe most important cause for maternal and perinatal morbidity and mortality. It is necessary to predict preeclampsiato decrease the incidence and adverse outcomes of the same. A prospective study was done in the department of obstetrics and gynaecology including100 women with singleton pregnancy between 11 to 13 weeks of gestation without exclusion criteria and were divided in to two equal group: those with previous history of preeclampsia and FGR (N= 50) in study group and without any previous history of preeclampsia and FGR included in controlgroup. Pregnant women in both the group underwent doppler examination at 11 – 13 weeks and 21 to 24 weeks and uterine artery pulsatility index was determined and development of preeclampsia and perinatal outcome was noted in both the groups. In studygroup, 13 women developed preeclampsia in that 9 had abnormal doppler, 10 developed FGRin that 7 had abnormal doppler, 9 (18%)had preterm delivery in that 5 had abnormal doppler and 8(16%) NICU admission in that 7 had abnormal doppler and 4 (8%) neonatal death 3 had abnormal doppler. In controlgroup, 3 women developed preeclampsia in that 1 had abnormal doppler, 2 developed FGRin that none had abnormal doppler, 4 had preterm delivery in that 1 had abnormal doppler and 2 NICU admission in that 1 had abnormal doppler and no neonatal death.

Keywords: Pre eclampsia; FGR; Uterine artery; Pulsatility index

Introduction

Hypertensive disorders is a multisystem disease which affects 5 to 10% of all pregnancies and it forms the triad, along with haemorrhage and infection, which contribute to maternal morbidity and mortality rates. Preeclampsia is a multisystem disorder and represents a major threat to fetus and mother when it emerges. Apart from its most dreaded complication of progressing into eclampsia, preeclampsia by itself can result in substantial perinatal and maternal morbidity.[1] PEis related topathogenic evidence of placental hypoperfusion and ischemia. There is failure of the perivascular and endovascular trophoblastic invasion into the spiral arteries in PE cases, and failure of maternal spiral arteriesto become low-resistance vessels. Uteroplacental blood flow can be studied by Doppler ultrasound non-invasively. Flow resistance in the uterine arteries (UtAs) decreases progressively during the first and second trimesters in normal pregnancy. However, in pregnancieswith PE or IUGR, flow resistance in the UtAs fails to decrease before clinical signs of the disease become apparent. These findings are supported by histological studies that show that theDoppler resistance index is inversely related to the percentage of vessels that demonstrate trophoblastic invasionpre-eclampsia is assumed to be a consequence of impaired Trophoblastic invasion of the maternal spiral arteries and their conversion from narrow muscular vessels into wide non-muscular channels.[2] The physiologicalprocess of trophoblastic invasion is reflected in the observation from Doppler ultrasound studies that impedance to flow in the uterine arteries decreases withgestation between 16 and 24 weeks and remains constant thereafter.

Inpregnancies that subsequently develop pre-eclampsia the pulsatility index (PI) in theuterine

arteries is increased in both the first and second trimesters of pregnancy.[3]

The aim of this screening study was to investigate whether the rate of decrease inPI between 11 and 24 weeks' gestation is steeper in pregnancies with a normal outcome than in those developing pre-eclampsia, and if so whether this measurement could improve the prediction of preeclampsia provided by a single early assessment of the uterine arteries. Over the last 25 years, a number of Doppler ultrasound studies have confirmed that increased blood flow resistance in the UtAs is associated with a greater risk of the subsequent development of PE and/or FGR5, especially severe early-onset types, with sensitivities of 80 - 90%. While there is no effective therapeutic intervention for the prevention of PE and/or FGR, the UK National Institute for Health and Care Excellence (NICE) guideline points out that a woman's degree of risk for PE should be evaluated so that an appropriate plan for subsequent scheduling of antenatal appointments and ultrasound growth scans can be formulated. [4]

Methodology

Source of Data

This is a prospective cohort study. All the patients with inclusion criteria attending to department of obstetrics and gynaecology were included.

Inclusion Criteria

- Singleton pregnancy at 11 to 13 weeks of gestation with normal fetus
- Body mass index <30kg/m2
- Pregnant women with history and physical findings suggestive of PIH, IUGR, PIH plus IUGR in previous pregnancies

Exclusion Criteria

- Cardiovascular disease
- Multiple gestations
- Fetuses with congenital anomalies
- Renal disease
- Essential hypertension prior to pregnancy and other high risk pregnancies
- Smoking and alcohol and drug addiction chronic diseases and of treatment with aspirin and heparin or antihypertensives before enrollment

Methods of Collection of Data

All the pregnancies with inclusion criteriawill be subjected to Doppler examination after recording the clinical history of the patients, clinical examination and ultrasound after taking informed consent gestational age is calculated by CRL measurement at the time of first trimester scan UA doppler recording were obtainedprospectively twice, first at 11 to 14 weeks of Gestation and second at 20 to 24 weeks of gestation.

All scan performed by experiencedradiologist. In first trimester ultrasound will be used to perform UA doppler examinationvarious indices will be calculated like pulsatality index and resistance index of both right and left UAand In second trimester scan will be obtained.

All data thus calculated will be charted in predesigned proforma and tabulated and analyzed with appropriate statistical tests. The different parameters were determined as normal or abnormal for gestational age by using previous studies as reference values. The mode of delivery will be tabulated whether vaginal or caesarean.

Perinatal outcome will also be studied in the form of perinatal death, mean, birth weight and admission to neonatalIntensive Care Unit(NICU).

Results

Table1:Uterine artery doppler parameters between study group and control group

Trimester	Parameter	Study group		Control group		P value
		Mean	SD	Mean	SD	
I	U/A (R)	2.1	0.7	1.8	0.4	0.004*
	U/A(L)	2	0.7	1.7	0.5	0.023*
	U/A(A)	2.1	0.7	1.7	0.4	0.007*
II	U/A (R)	1.2	0.5	0.9	0.3	0.004*
	U/A(L)	1.2	0.6	0.9	0.4	0.002*
	U/A(A)	1.2	0.5	0.9	0.3	0.002*
Independent t-test (*-Significant)						

In study group mean uterine artery PI was 2.1 in first trimester and 1.2 in second trimester while incontrol group mean uterine artery PI was 1.8 in first trimester and 0.9 in second trimester.

Difference of PI in study and control group is statistically significant.

Table2:Difference in Doppler U/A parameters during first and second trimesters in study group and control group

Parameter	Study group		Control group		P value
	Mean difference	SD	Mean difference	SD	
Difference in U/A (R)	0.9	0.3	0.9	0.4	0.497

Difference in U/A(L)	0.8	0.4	0.8	0.4	0.524
Difference in U/A(A)	0.8	0.3	0.8	0.3	0.983

Mean difference in PI between the study and control group is 0.8

Table 3: Uterine Artery Pulsatility Index in study and control groups

Pulsatility Index	Study group		Control group	
	N	%	n	%
Normal	31	64.6	43	88.0
Abnormal	17	35.4	6	12.0
Total	48	100	49	100.0
Chi square p value=0.006* (Significant)				

In study group 17 out of 48 had developed abnormal doppler, remaining 31 had normal Doppler While In control group out of 6 out of 49 had abnormal Doppler and remaining 43 had normal Doppler which is statistically significant.

Table 4: Uterine Artery Pulsatility Index and hypertension in study and control groups

Pulsatility Index	Study group (n=48)				Control group (n=49)			
	Hypertension							
	Present		Absent		Present		Absent	
	n	%	N	%	n	%	N	%
Normal	4	30.8	27	77.1	2	66.7	41	89.1
Abnormal	9	69.2	8	22.9	1	33.3	5	10.9
Total	13	100	35	100	3	100	46	100
Chi square P value	0.003				0.250			

In study group 17 had abnormal doppler in that 9 patient developed HTN and 4 pregnant women whohad normal doppler had HTN which is statistically significant.

While in control group 3 developed HTN and out of which 1 had abnormal doppler and 2 had normalDoppler which is statistically not significant.

Table 5: Performance of Doppler parameters in predicting hypertension

Parameter	Trimester	AUC (95% CI)	P value
U/A (R)	I	70.7 (53.7-87.6)	0.828
	II	71.7 (55.9-87.5)	
U/A(L)	I	70.2 (53.9-86.4)	0.514
	II	73.9 (58.1-89.8)	
U/A(A)	I	71.6 (54.9-88.2)	0.988
	II	71.7 (54.9-88.4)	

AUC-Area under the curve from ROC analysis

Interpretation: Though there is small increase in 'Area under the curve' for 2nd trimester Doppler parameters, there is not statistically significant increase in the AUC.

Table 6:Prediction of HTN by Uterine Artery Pi

	Test	Sensitivity	Specificity	PPV	NPV	LR +	LR -
Study	PI	69%	77%	52%	87%	3%	0.4%
Control	PI	33%	89%	16%	95%	2.9%	0.75%

In our study, uterine artery PI in study group has 69% sensitivity, 77% specificity, 52% PPV, 87% NPV, positive likelihood ratio 3% and negative likelihood ratio 0.4% in predicting HTN.

While uterine artery PI in control group has 33% sensitivity, 89% specificity, 16% PPV,95% NPV, positive likelihood ratio 2.9% and negative likelihood ratio 0.75% in predicting HTN.

Table 7:Prediction of FGR by Uterine Artery Pi

	Test	Sensitivity	specificity	PPV	NPV	LR +	LR -
Study	PI	70%	73%	41%	90%	2.59%	0.41%
Control	PI	33%	87%	14%	95%	2.5%	1.14%

In our study, uterine artery PI in study group has 70% sensitivity, 73% specificity, 41% PPV,90% NPV, positive likelihood ratio 2.5% and negative likelihood ratio 0.41% in predicting FGR.

While uterine artery PI in control group has 33% sensitivity, 87% specificity, 14% PPV,95% NPV, positive likelihood ratio 2.5% and negative likelihood ratio 1.14% in predicting FGR.

Table 8: Relative risk of developing preeclampsia in abnormal uterine artery Doppler velocimetry using PI.

	P value	Level of significance
5.3695%CI 2.2-13.	<0.001	Significant

Risk of developing preeclampsia is 5.36 times more in a women with abnormal doppler than in thewomen with normal doppler with 95% CIwith P value <0.001 which is statisticallysignificant

Discussion

Preeclampsia is the most common complication associated with high maternal and perinatalmortality and morbidity and treatment for which is the delivery of placenta.

Uterine artery doppler PI helps in assessing the blood flow in uterine arteries, which will beabnormal in the pregnant women who are destined to develop preeclampsia.

Early screening of preeclampsia using uterine artery doppler which is based on the pathogenicmechanism of the disease and may help in earlyinitiation of prophylactic therapiesAbnormal uterine artery doppler waveforms may also help in identifying the pregnant women who have high risk of preterm delivery and IUGR.

Pregnancies complicated with FGR have a high risk of developing preeclampsia and need more surveillance.

The purpose of this study is to assess the sensitivity of uterine artery doppler in screening of preeclampsia, the result may be used to evaluate whether it is feasible to use this test for the screening of preeclampsia.

In this prospective study first and second uterine artery doppler screening was done in 100 patient singleton pregnancies at 11 – 13 weeks and 21 – 24 weeks, 3 cases (2 in study group and 1 in control)were excluded since they had lost follow up.

Incidence of HTN in this study was 16%, incidence in study group is 27% and in control groupwas 6%. In various other studies incidence varies from 8.18 to 39.2%W. plasencia*et al*[5] incidence of HTN is (166 in 3107) 5.3%, incidence in high risk group is a(23 in 94) 24% and in low risk(143 in 3013) group is 4.7%.

Papageorghiou*et al*[6] conducted uterine artery PI in 8335 cases out of which 401 cases had mean PI> 95th centile and 113 developed HTN and Incidence is4.8%.

In our study majoritypatients who developed PET were between the ages of 20 and 25 years 7 were there in this group, 6 patients between 26 – 30.years, 1 patients was <20 years & 2 patients was >35yearsout of the 17 pregnantwho developed pre-eclampsia. Data suggests that the risk of pre-eclampsia increases by 30% for every additional year over the age of 34. In our study age, therefore, did not play a role as a risk factor for PET.

Preeclampsia is more common in primigravida's. In my study population, multiparawere 72 out of 100 since all patients in study group were multipara. Parity did not play as riskfactor in mystudy.

In study group(48) 13 developed HTNin which 9 had abnormal doppler and 10 patient hadFGR out of which 7 had abnormal doppler.

In control group(49) 3 patient had HTN in which 1 had abnormal doppler and 2 patient had FGR out of which none had had abnormal doppler.

Shear and colleagues [7] reported a relationship between pre-eclampsia and FGR. Their study showed critical maternal complications more frequently in pre-eclamptic patients with associated FGR.

Dahiana*et al*,[8] out of 1442 patients with mean PI > 95%414(28.7) developed preeclampsia and 171 developed FGR.

In the current study Pl values up to the 95^{th1} centile of the Pl chart was considered as normal. The following table was populated with data obtained from a study done by Gomez and coworkers(2000:130).

These values represent the 50thcentile for each of the trimesters of pregnancy at 12 weeks and 22 weeks of gestation and are also used as cut off values by the Fetal Medicine Unit at Chris Hani Baragwanath Hospital in,Johannesburg.

In velathar*et al* conducted a metaanalysis including 18 studies and more than 55000 pregnancies, use of uterine artery PI was able to identify 47% of PE cases and 39.2% of FGR with false positive rate of 7%.

Lee *et al* demonstrated that mean uterine artery PI above 95% measured at 23 weeks has a strong association with FGR, placental abruption, PE and fetal death.[9]

Yu *et al* evaluated > 30000 pregnancies in 2008 and found that uterine artery doppler was able to detect most of PE cases. Our study results compared with various others studies and found that results were more comparable with cnossen*et al*. Our study has comparable result with campbell*et al* in sensitivity and specificity of predicting HTN in control group is uterine artery PI.[10]

Conclusion

Our study showed uterine artery doppler screening was more beneficial in study group (high risk) than the control group (low risk) in predicting preeclampsia and other adverse outcome and early

first trimester screening better to initiate the prophylactic therapies and for increased surveillance.

References

1. Cunningham,Leveno, Bloom Hauth, Rouse,Spong.WilliamsObstetrics,McGraw Hill 2009, 25rd edition, Chapter 40,Hypertensive disorder. Page 729-779.
2. De wolf F, De wolf – peeters, brosens I, Robertson WB. The human placental bed: electron microscopic stusy of trophoblastic invasion of spiral arteries. Am J Obstetgynecol 1980; 137: 58 – 70
3. Meekins JW, Pijenborg R, Hanssens M, McFadyen IR, van Asshe A. A study of placental bed spiral arteries and trophoblast invasion in normal and severe pre-eclamptic pregnancies. Br J ObstetGynaecol 1994; 101: 669 – 674.
4. Campbell S, Diaz-Recasens J, Griffin DR, Cohen-Overbeek TE, Pearce JM, Willson K, Teague MJ. New Doppler technique for assessing uteroplacental blood flow. Lancet 1983; 1: 675 – 677.
5. Kaminopetros P, Higueras MT, Nicolaides KH. Doppler study of uterine artery blood flow: comparison of findings in the first and second trimesters of pregnancy. FetalDiagnTher 1991; 6: 58–64.
6. Papageorghiou AT, Yu CK, Nicolaides KH. The role of uterine artery Doppler in predicting adverse pregnancy outcome. Best Pract Res ClinObstetGynaecol 2004;18: 383 – 396.
7. S. AnanthKarumanchi, Sharon E. Maynard, Isaac E. Stillman, Franklin H. Epstein,
8. Vikas P. Sukhatme,Preeclampsia: A renal perspective, Kidney International,
9. Volume 67, Issue 6,2005,Pages 2101-2113,ISSN 0085-2538,
10. Dacaj R, Izetbegovic S, Stojkanovic G, Dreshaj S. Elevated Liver Enzymes in Cases of Preeclampsia and Intrauterine Growth Restriction. Med Arch. 2016;70(1):44-47. doi:10.5455/medarh.2016.70.44-47
11. Khong, T.Y., *et al*., 1986. Inadequate maternal vascular response to placentation in pregnancies complicated by pre-eclampsia and by small-for-gestational age infants. Br. J. Obstet. Gynaecol. 93, 1049–1059
12. Aris T. Papageorghious, Christian K H. Yu, II se E. Erasmur, Howard S. Cuckle.,Kypros H. Nicolaides, Br. J. ObstetGynaecol June 2005, vol.112 pp-707-709