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The Effect of Placental Laterality on Uterine Artery Doppler Velocimetry in Normal Pregnancy, PIH & IUGR

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Summary

This prospective controlled study was conducted to examine the effect of placental laterality in uterine artery flow velocity waveform in normal pregnancy, pregnancy induced hypertension (PIH) and IUGR at Department of Obstetrics and Gynaecology, Kasturba Medical College, Manipal. A total of 85 singleton pregnant women were included in the study, of which 50 had PIH (Study group), remaining 35 had no maternal complication (control group). Uterine artery Doppler velocimetry was performed between 24 and 28 weeks. The location of the placenta was determined by real time ultrasonography. The placentae were classified as central and unilateral. S/D ratio and Resistance Index (RI) of both the uterine arteries were calculated.

The relationship between mean uterine artery resistance index, S/D ratio and laterality of placenta in study and control group were noted. Out of 85 pregnant women 50 had unilateral placenta and 35 had central placenta. When the placenta was central there was no statistically significant difference either in S/D ratio or in RI between the left and right arteries and that between PIH and control group. But when the placenta was unilateral, in study group the mean S/D ratio (3.0 ± 1.1) and RI (0.62 ± 0.116) of contralateral uterine artery were more than those of ipsilateral artery (2.1 ± 0.54 and 0.52 ± 0.105 respectively). This difference was statistically highly significant ($p \leq 0.001$ for both S/D ratio and RI). The incidence of abnormal waveform in either of the arteries as well as mean of both the arteries was more when the placenta was unilateral. Abnormal S/D ratio was seen in 64% of unilateral placenta cases versus 14.20% in central placenta cases (p=0.001) and abnormal RI in 44% of unilateral placenta cases versus 2.85% of central placenta cases (p=0.002) Both these findings were statistically highly significant. Hence it was concluded that Doppler velocity waveforms show abnormal indices in PIH and IUGR.

Introduction

The development of proper uteroplacental circulation is essential for achievement of a normal pregnancy outcome. In pregnancy induced hypertension (PIH) underlying problem appears to be uteroplacental arterial insufficiency causing placental ischaemia and hypoxia. The uteroplacental circulation can be studied non-invasively by means of Doppler ultrasound. Study of uterine vessels gives more predictive information about impaired uteroplacental perfusion. The abnormal waveform indicating high resistance is characterized by low or absent diastolic flow, persistent diastolic notch and high indices. The study of uterine artery is important because they are reproducible and give overall picture of placental bed.

A number of studies have shown (Kofinas et al, 1988, Ito et al 1990) that there is significant association between placental location and uterine artery resistance. Doppler indices of arteries on ipsilateral placental side were low compared to contralateral side. It is possible that placental location may influence the uterine blood flow distribution and predispose pregnancy to adverse

outcome like PIH and IUGR. This study was conducted to examine whether the placentation, either central or unilateral, has any effect on uterine artery resistance.

Materials and Methods

This prospective study was done in Department of Obstetrics and Gynecology Kasturba Medical College, Manipal between January 1997 and December 1998. A total of 85 singleton pregnant women were included in the study, of which 50 had PIH (study group) 35 had no maternal complication (control group). Diagnosis of PIH was according to the criteria of American College of Obstetrician and Gynaecologist. IUGR was diagnosed when the birth weight was less than 10th percentile of the gestational age. The age and parity indices between the two groups were matched.

Uterine artery Doppler velocimetry was performed between 24 and 28 weeks. The flow velocity waveform was obtained with the mother lying comfortably in slight left lateral tilt. Doppler equipment consisted of color duplex system of ATL Ultramark 9 with carrier frequency of 3.5 MHz with special analyzer. The signal was obtained by placing the transducer 2.3cm medial to the anterior superior iliac spine. The landmark permitted regional consistency and reproducibility of flow velocity waveform produced by uterine artery.

The location of the placenta was determined by real time ultrasonography. The entire cavity was scanned and placental location was determined. The placenta was classified central when it was equally distributed between the right and left side irrespective of anterior, posterior or fundal position. When 75% or more mass was on one side of the midline it was classified as unilateral placenta irrespective of anterior, posterior or fundal position. Measurements were obtained on both sides and reported as right uterine flow velocity waveform from right and left uterine artery waveform from left respectively, in cases with central placenta. In cases with unilateral placenta the measurements obtained were reported as ipsilateral and contralateral flow velocity waveform depending on the artery at the placental site or opposite site respectively. The average of both sides was reported as mean uterine flow velocity waveform.

Waveforms were measured by 2 different indices

1. Systolic to Diastolic ratio (S/D ratio)
2. Resistance Index (RI)

The waveforms were classified abnormal if

1. S/D value exceeded 95th percentile of normal value i.e., > 2.8 after 24 weeks.
2. RI was > 0.58 after 24 weeks.

The relationship between mean uterine artery resistance index, S/D ratio and laterality of placenta in each group were noted and discussed. Statistical significance of result was evaluated by x2 test; student t test used when comparison comprised of paired observations.

Results

Out of 85 women 50 had unilateral placenta and 35 had central placenta. When the placenta was central the indices (S/D ratio or RI) on right and left uterine arteries showed no statistically significant difference either in PIH and control group (Table I). When the placenta was unilateral the difference in S/D ratio and RI between contralateral and ipsilateral arteries in PIH group was statistically highly significant, p=<.0001. Even the difference in S/D ratio and RI between PIH and control groups in ipsilateral category was statistically significant, p=.028 and 0.54 respectively (Table II). Abnormal waveform of either of the arteries and mean of the arteries were more with unilateral placenta, in comparison to central placenta. These differences were statistically highly significant (Table III).

Discussion

Doppler ultrasonography has an advantage of

Table I: Comparison of indices in central placenta n=35

Indices	Case	Total	Right Ut Artery Mean + SD	Left Ut Artery Mean + SD	p value
	Control	23	1.92 ± .32	1.9 ± .55	.56
S/D Ratio	PIH	12	1.80 ± .35	1.7 ± .36	.069
	P value		.399	.119	
	Control	23	.46 ± .095	.48± .105	.303
RI	PIH	12	.45 ± .100	.41± .119	.028
	P value		.303	.092	

Table II: Comparison of indices in unilateral placenta n=50

Indices	Case	Total	Contralateral artery Mean + SD	Ipsilateral artery Mean + SD	p value
S/D Ratio	Control	12	2.70 ± 1.1	1.8 ± .39	.032
	IH	38	3.0 ± 1.1	2.1 ± .54	<.0001
	P value		.367	.028	
RI	Control	12	.57 ± .133	.44± .112	.024
	PIH	38	.62 ± .116	.52± .105	<.0001
	P value		.253	.054	

Table III: Placental laterality and abnormal uterine artery waveform n=85

Indices	Placental Location	Either of the arteries Abnormal	Normal	Mean of both arteries Abnormal	Normal	Total
S/D ratio	Central	5	30	4	31	35
	Unilateral	32	18	24	26	50
x2 rest		p=.0001		p=.0004		
RI	Central	1	34	1	34	35
	Unilateral	22	28	15	35	50
x2 test		p=.0002		p=.001		

being technically fast, reproducible and safe if performed on a daily basis. It is a vital measurement because it reassures if normal and suggests potentiality of problems if abnormal. It offers the potential of identifying the fetuses at risk and also has resulted in improvement in management of hypertension.

A number of studies have shown that there is significant association between placental location and uterine artery resistance. Doppler indices of arteries on ipsilateral placental side were low compared to contralateral side. It is possible that placental location may influence the uterine blood flow distribution. Study on normal pregnancy and complicated pregnancy by Kofinas et al (1988) found that the patient with unilateral placenta more associated with abnormal uterine artery flow velocity waveform was against those with central placenta. Another study by Perales (1986) in 84 control and 28 hypertensive women found that with unilateral placenta the S/D ratio of the ipsilateral artery was significantly lower than the contralateral artery ratio and unilateral placenta was found more often in hypertensive pregnancy.

Schulman (1986, 1987) & Schulman et al (1986 & 1987) studied S/D ratio difference between two uterine arteries in 71 pregnant women. He concluded that divergent uterine artery ratio findings are as a result of one artery being dominant supplier to placenta. The women found to have elevated S/D ratio seem to have divergent uterine blood supply to uterus and placenta and suggest error in placentation site which contribute to development of PIH and IUGR.

Present study was conducted to examine whether the placentation, either central or unilateral, has any effect on uterine artery resistance. It was found that when the placneta was central there was no statistically significant difference either in S/D ratio or in RI between the left and right arteries and that between PIH and control group. But when the placenta was unilateral, in study group the mean S/D ratio (3.0 ± 1.1) and RI (0.62 ± 0.116) of contralateral uterine artery were more than those of ipsilateral artery (2.1 ± 0.54 and 0.52 ± 0.105 respectively). This difference was statistically highly significant (p=<0.001 for both S/D ratio and RI). These findings were comparable to those of Perales (1986) and Ito et al (1990).

The incidence of abnormal waveform in either of the arteries as well as mean of both the arteries was more when the placenta was unilateral. Abnormal S/D ratio was seen in 64% of unilateral placental cases versus in 14.20% of central placenta cases (p=0.001). These findings were statistically highly significant and comparable to the findings of Kofinas et al (1988, 1992) (Table IV).

Study done by Kofinas et al (1988) showed that the incidence of abnormal S/D ratio was more in contralateral uterine artery when compared to ipsilateral uterine artery in both PIH and control group. These findings were statistically highly significant. The present study also showed similar findings (Table V). The incidence of abnormal RI was more when the placenta was unilateral (44%) as compared to that when the placenta was central (2.85%). These findings were similar to those made by Ito et al (1990).

Table IV: Abnormal S/D ratio according to placental laterality

Placental Location	Kofinas et al (1988)				Present study			
	Either of artery		Mean of the arteries		Either of artery		Mean of the arteries	
	Abnormal wave	Normal wave	Abnormal wave	Normal wave	Abnormal wave	Normal wave	Abnormal wave	Normal wave
Central	20 (27%)	118 (52%)	16 (30%)	122 (49%)	5 (14%)	30 (62%)	4 (14%)	31 (54%)
Unilateral	55 (73%)	107 (48%)	37 (70%)	125 (51%)	32 (86%)	18 (38%)	24 (86%)	26 (46%)
X2 test	<.001		<.02		.0001		.0004	

Table V: Abnormal S/D ratio in Unilateral placenta

Uterine Artery	Kofinas et al (1988)					Present study				
	Normal		Hypertension			Normal		Hypertension		
	Mean + SD	No.	Mean + SD	No.	p	Mean + SD	No.	Mean + SD	No.	p
Contralateral	2.46 ± .73	48	4.04 ± 1.77	19	.001	2.7 ± 1.1	12	3.0 ± 1.1	38	.36
Ipsilateral	1.73 + .35	48	2.38 + 1.01	19	.19	1.8 + .39	12	2.1 + .54	38	.28
p value	p<0.0001		p=0.001			p=.032		p=<.0001		

Table VI: Comparison of abnormal RI in central placenta

Indices	Iso et al		Present study	
	RtUt A Mean + SD	Left UA Mean + SD	Rt Ut A Mean + SD	Left UA Mean + SD
RI	.48 + .08	0.47 + 0.03	.46 + 0.95	.48 + .105
P value	NS		NS	

Table VII: Comparison of abnormal RI in unilateral placenta

Indices	Iso et al		Present study	
	Ipsilateral Mean + SD	Contralateral Mean + SD	Ipsilateral Mean + SD	Contralateral Mean + SD
RI	.39 + .04	0.62 + .03	.44 + .112	.57 + .133
p value	p<.01		p<.02	

Ito et al (1990) found the difference in RI between right and left artery when the placenta was central was statistically not significant as seen also in the present study (Table VI). They also showed that the incidence of abnormal RI was more on contralateral side when the placenta was unilateral. This finding was statistically significant as was found in the present study (Table VI). The incidences of PIH (76%) and IUGR (48%) were more in unilateral placenta when compared to that in central placenta (34% and 11.42% respectively). These findings were statistically highly significant (p=.0001 for PIH and 0.009 for IUGR). Similar observations were made by Kofinas et al. (1988, 1992).

Above observations lead to the following conclusion: in cases of unilateral placenta the absence or insufficient trophoblastic invasion of arteries on contralateral side would make them retain their sensitivity to vaso-active substances during pregnancy hence the Doppler velocity waveforms show abnormal indices. The finding of unilateral placenta by real time ultrasonography may herald the development of PIH and IUGR and hence it may be used as predictive screening test.

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