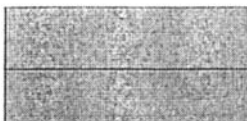

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Original Article

Divergent systolic diastolic ratio of the uterine arteries and its significance

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Abstract

Objectives: To determine whether difference in the S/D ratio of both sides of uterine arteries was significantly associated with the development of IUGR *Methods:* One hundred and ten women attending the antenatal clinic of our hospital were included in the study. At the time of anomaly scan at 20 weeks doppler assessment of both uterine arteries was done. Systolic diastolic ratio of both sides was calculated. Clinical outcome was recorded at the time of birth. Statistical analysis was performed using chi-square test, regression curve, and Fischer test, using SPSS software. *Results:* The correlation coefficient between the average S/D ratio and the difference between the right and left s/d ratio (δ) was 0.67 which was highly significant (p<.001). Abnormal S/D ratio difference defined as more than1 was significantly associated with IUGR. (p<.001). The placenta on histopathology examination showed significantly lesser number of vessels per tertiary villus in those with abnormal S/D ratio difference (p=.045). *Conclusion:* Abnormal S/D ratio difference in uterine arteries is a significant pathophysiological event which results in decreased placental perfusion and it appears that it is the resultant placental ischemia which is responsible for intrauterine growth retardation and low birth weight at delivery.

Key words: uterine arteries, divergent flows, pre-eclampsia, IUGR, placental perfusion.

Introduction

Intrauterine growth retardation and preeclampsia are both conditions strongly related to proper placental development and function. It has been shown that poor trophoblastic conversion of the spiral arterioles leads to the development of IUGR and preeclampsia or both (Khong et al[1]. Poor trophoblastic conversion results in increased uteroplacental artery resistance. This is turn can lead to reduced uteroplacental bed perfusion.

Doppler flow velocity waveform analysis in the uterine arteries performed by a continuous wave doppler analysis in considered a useful method, for evaluation of high risk pregnancy. Schulman et al[2] have shown that both the uterine arteries do not respond to the pregnancy with same degree of compliance and that the difference in the resistance (change in S/D ratio) correlated well with pregnancy outcome.

A rise is the S/D ratio of both uterine arteries precedes clinical preeclampsia and IUGR. There are a number of literatures that studied the role of second trimester

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doppler flow velocity waveforms and the prediction of preeclampsia and IUGR2. Most of the studies based on the role of second trimester doppler as a screening test for adverse perinatal outcome used mean S/D ratio of both the uterine arteries. Others considered the worst value for analysis of IUGR and preeclampsia Campbell et al[3], Arduini et al[4] and Hanretty[5] however considered the best value for analysis; divergent uterine artery flow is a result of one artery being the dominant supplier of the placenta. There was a significant difference in the systolic diastolic ratio of both the sides of the uterine arteries in some cases of IUGR. So this study was designed to analyze the normal and abnormal divergence of the uterine artery systolic diastolic ratio and the associated consequences of such an event.

Material and Methods

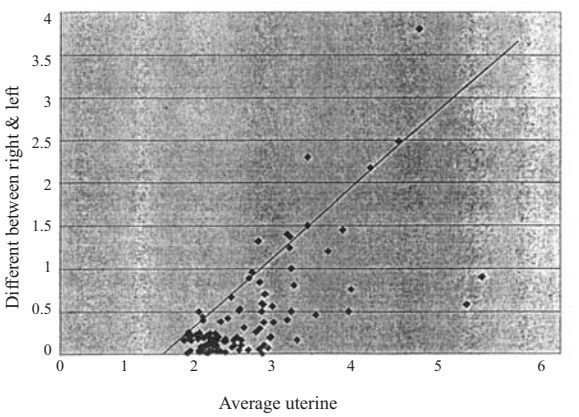
One hundred and ten women attending the antenatal OPD of our hospital during the period of August 2001-March 2003 for a routine anomaly scan between 20-22 weeks gestation were studied.

At the time of anomaly scan doppler assessment of maternal uterine arteries was carried out with a 3.5-5 MHZ pulsed wave 3S probe at 20 weeks. Vivid 7 GE ECHO and doppler system was used. Both the uterine arteries were studied near its origin from the anterior division of internal iliac artery. A systolic diastolic ratio was calculated for both the sides. An average of these values was also obtained. Umbilical artery velocimetry was also calculated at the same time. Clinical outcome was recorded at the time of birth. The various maternal outcomes at the time of birth were antenatal complications which occurred during pregnancy like preeclampsia and antepartum hemorrhage, gestational age at delivery and type of delivery. Fetal parameters recorded were birth weight and Apgar score, baby with mother or in NICU.

Analysis comprised of ROC (receiver operator curve), regression curve, correlation coefficient and chi square test and Fischer exact test. The SPSS software was used for these calculations.

Results

One hundred and ten women who were attending the antenatal clinic of SGRH from August 2001-March 2003 were included in the study. Of these 110 women, 12 had S/D difference between the right and the left uterine artery of more than 1. ($\delta>1$). The rest 98 women had $\delta<1$. Fig.1 depicts the regression curve analysis of left-right difference in S/D ratio and the average S/D ratio. Here the difference δ between the two S/D ratios is taken on the 'y' coordinate and the average uterine artery has been taken on the 'x' coordinate. The average S/D difference of the two uterine arteries was taken as 0.3 with a standard deviation of 0.3 (Schulman et al)[2] hence abnormal was defined as mean +2 standard deviation which included values more than 1. The correlation coefficient between the average S/D ratio and the difference between the right and left S/D ratio (δ) was 0.67 which was highly significant ($p<.001$). From the receiver operator curve analysis the average S/D ratio associated with abnormal perinatal outcome was found to be 2.6 at 20 weeks gestation. Fig. 2 shows the receiver operator curve for S/D ratio and IUGR.



Regression curve analysis

Pregnancy outcome was noted in those females who had abnormal S/D ratio difference of more than 1, with those who had normal S/D ratio difference.

The incidence of PIH was not significantly more, in those who had S/D ratio difference between the two uterine arteries of more than 1 (Table 1). A total of 31 patients developed PIH. Only five of these had S/D ratio difference of more than one, and this was not statistically significant ($p=0.27$)

When the S/D ratio difference between the two uterine arteries was >1, it was very significantly associated with the development of IUGR ($p=0.001$) (Table 2). Of the 21 patients who had IUGR babies, seven had S/D ratio difference of more than 1.

Table 1:
Discordant flow and development of PIH

PIH	Difference between the two uterine arteries		Total	Significance
	<1	>1		P= 0.271
Absent	72	7	79	K= 0.089
Present	26	5	31	

P =p value, p<.05 significant,
K = Kappa value

Table 2:
Discordant flow and development of IUGR

PIH	Difference between the two uterine arteries		Total	Significance
	<1	>1		P= 0.001
Absent	82	5	87	K= 0.300
Present	16	7	23	

P =p value, p<.05 significant, very significant,p<0.001 highly significant
K = Kappa value

Table 3:
The various pregnancy parameters in association with S/D ratio difference of more than 1

	No of females (N)	<l (n =88)	> l (n =12)	P value
PIH	31	26	5	P = 0.271
IUGR	23	16	7	P= 0.001***
Mean birth weight in kg	110	2.56	2.00	P= 0.007**
Preterm delivery	32	26	6	P= .091
AVG UT S/D ratio > 2.6	21	10	11	P<0.001***
Umbilical S/D ratio >4	13	11	2	P= 0.281
Apgar<7 at 1 minute	10	8	2	P= 0.333
LSCS	57	50	7	P= 0.632

*P<0.05 Significant
**P<0.01 Very significant
***P<0.001 Highly significant

Table 4:
Discordant uterine flows and no vessels per tertiary villus

No of vessels per tertiary villus	δ<1	δ>1	Total
<4	37	9	46
4.1 – 5	43	1	44
5.1 – 6	11	2	13
>6.1	7	0	7
Total	98	12	110

**P<0.01 Very significant

Table 5:
Incident of PIH when δ>1

Authors	PIH present	PIH absent	Significance
Schulman (1987)	16/28	12/28	P<.05
Our study	5/12	7/12	NS

P<.05 significant
NS not significant

Table 6:
Incident of IUGR when δ>1

Authors	IUGR present	IUGR absent	Significance
Schulman (1987)	9/28	19/28	P<0.05
Kofinas (1992)	17/40	13/40	P<0.03
Our study	7/12	5/12	P<0.001

*P<.05 significant
**P<0.01 very significant
***P<0.001 highly significant

The birth weight at delivery was very significantly lower in those who had (δ >1) 2.56 kg vs 2.00 kg. (Table 3). The other parameters like the incidence of PIH, preterm deliveries and LSCS was not significantly different between the two groups. On histopathological examination the number of vessels per tertiary villus was significantly lower in those women who had discordant flows (Table 4). None of the 12 women who had discordant flows had six or more number of vessels per tertiary villus.

Discussion

There have been a number of studies which have demonstrated the relationship between the abnormal uterine artery velocity waveforms and maternal hypertensive syndromes[6]. Campbell et al[3] examined and classified the two uterine arteries as placental or antiplacental based on the location of placenta. This however appears incorrect as the placenta in most cases is located anterolaterally or posterolaterally rather than right lateral or left lateral. Little[7] could not demonstrate the significance between placental location and pregnancy outcome.

The blood supply of the uterus comes from the two uterine and the two ovarian arteries. These vessels anastomose at the cornua of the uterus and give rise to arcuate

arteries that run circumferentially around the uterus. The radial arteries arise from the arcuate vessels and penetrate into the outer third of the myometrium. These vessels then become the spiral arteries which nourish the endometrium and the intervillous space of placenta during pregnancy. Physiological modification of the spiral arteries is required to permit the ten fold increase in uterine blood flow that is necessary to meet the respiratory and the nutritional requirements of the fetus and the placenta.

Trophoblastic invasion of the spiral arteries occurs in the two waves. The first wave of trophoblastic invasion occurs upto the decidual segment and the second wave upto the myometrial segment of the spiral arteries. These arteries dilate progressively proximally apparently due to the loss of musculoelastic layer. These alterations have been described as "physiological changes". These vascular changes are found to be restricted to the decidual segments of these spiral arteries or to be totally absent in pregnancy complicated by preeclampsia and a proportion of those with a small for gestational age fetus, thus leaving the segments with intact musculoelastic wall responsive to vasoactive peptides.

Khong et al[8] in their study of placental bed biopsies showed that as many as half of the abnormal pregnancies showed this absence of physiological change throughout the entire length of some spiral arteries, clearly indicating that they had not been colonized by trophoblast at any stage of gestation. Shulman et al[2] similarly showed that both the uterine arteries do not respond to the pregnancy with the same degree of compliance and the difference between the two uterine arteries correlated well with poor pregnancy outcome. Divergent uterine flow is the result of one artery being the dominant supplier of placenta[9]. Placental location can influence uterine artery resistance. Unilateral placentas are associated with elevated uterine artery resistance and the development of preeclampsia and impaired fetal growth according to Kofinas et al[10]. He suggested that uterine artery discordance (left – right uterine artery systolic/diastolic) ratio was mostly the result of an abnormal non placental uterine artery. It was Campbell et al[3] who classified the two uterine vessels as placental and antiplacental depending on the location of the placenta. Schulman et al[2], however thought it incorrect to classify the uterine as such because the development of collaterals is unpredictable and a large number of placentas are situated anterolaterally or posterolaterally and hence cannot be classified as lateral placentas. However both Schulman et al and Kofinas et al have shown a difference in waveforms on either side of the uterus and suggested that this might be associated with abnormal placentation and IUGR although the basis of this hypothesis is not clear. It is interesting to note that when abnormal difference between the right and the left vessels exist they appear to have an adverse impact on pregnancy outcome. In our study we have evaluated the clinical significance of abnormal uterine artery S/D ratio difference in relation to PIH and IUGR.

While Schulman et al found a significant increase in the incidence of PIH we could not find a significant increase in the incidence of PIH (Table 5), with discordant uterine artery flow. The study conducted by Kofinas et al11 used hypertensive pregnant women as the study group and they could not find a significant increase in the incidence of proteinuria in these women.

Our study in accordance with the previous studies showed a significant increase in the incidence of IUGR when there was a significant discordance in flow ($\delta > 1$) (Table 6). Ito et al[11] analyzed the utero placental flows in babies with IUGR and found a similar discordance in flow.

The incidence of preterm deliveries was significantly increased in the studies by Kofinas et al. and Schulman et al. It has not been mentioned whether they were induced or spontaneous. No corresponding significant increase in preterm deliveries was found in our study which could be due to the lesser induction and more conservative approach.

There was no significant increase in the incidence of cesarean section and Apgar scores in our study in keeping with the study by Schulman et al[2] and Kofinas et al[10]. A significant proportion of women with divergent flows meant S/D ratio above 2.6 ($p=<.001$). It appears that dissimilar uterine flow velocity may be significant pathophysiological event. It is the resultant placental ischemia, due to less perfusion, decreased uteroplacental flow and decreased number of vessels per tertiary villus which is responsible for intrauterine growth retardation and low birth weight at delivery.

Conclusion

A significant correlation coefficient was found between the average systolic diastolic ratio and the difference

between the systolic diastolic ratio of both sides. Significant difference in pregnancy outcome like birth of an IUGR baby and perinatal parameters like birth weight at delivery were noted. However the difference in the incidence of PIH was not significant. Interestingly two women developed accidental hemorrhage and both had discordant flows. Discordant uterine flow at 20 weeks was associated with IUGR and low birth weight babies.

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