ORIGINAL ARTICLE

EFFECTS OF VARIATION IN UMBILICAL ARTERY FLOW ON FOETAL MIDDLE CEREBRAL ARTERY FLOW IN HYPERTENSIVE PREGNANCIES

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Introduction: Cerebral vasodilation occurs in conditions of hypovolemia and cerebral hypoxia in adults. This effect is also found in foetuses. In gestational hypertension, blood flow to the foetus is compromised creating a situation somewhat similar to hypovolemia and cerebral hypoxia. Doppler ultrasound indices namely Resistive Index (RI) Pulsatility Index (PI) and Systolic-Diastolic Ratio (S/D)are useful tools in picking these changes in blood flow. The aim of this study was to see the effects of alterations in umbilical artery flow on foetal middle cerebral arterial flow with Doppler ultrasound parameter. **Material and Methods:** Ninety pregnant women with pregnancy-induced hypertension were selected with gestational age >35 weeks. Doppler ultrasound examination were carried out to record Pulsatility Index (PI), Resistive Index (RI), and Systolic-Diastolic Ratio (S/D) of Umbilical artery (UA) and Foetal Middle Cerebral Artery (MCA). Pearson's correlation was determined between UA and MCA PI, RI and SD. **Results:** A non-significant (p=0.067) negligible negative correlation (r= -0.194) was seen between UA PI and MCA PI. A significant (p=0.000) very strong negative correlation (r= -0.754) was present between the UA RI and MCA RI. A significant (p=0.002) moderate negative correlation (r= -0.328) was observed between UA SD and MCA SD. **Conclusion:** A significant negative correlation was observed between the resistive indices and SD ratios of umbilical and middle cerebral arteries. No significant correlation was found between the pulsatility indices of the two arteries.

Keywords: PIH, Doppler, Resistive Index, Pulsatility Index, SD Ratio, Correlation

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INTRODUCTION

Cerebral vasodilation in response to volume depletion is a proven phenomenon in adults. Each time there is decrease in blood volume due to whatever cause, there is redistribution of remaining blood to the vital organs, especially the brain.[1] Hypovolemia causes sympathetic stimulation which leads to peripheral vasoconstriction. Due to this, blood is shunted away from the skin, muscles, gut, and many other organs towards the brain.[2]Similarly, studies using foetal middle cerebral artery simultaneously with intrapartum pulse-oxymetry have shown that when the foetus is exposed to hypoxia due to hypovolemia it also tries to preserve its vital organs by redistribution of blood to them.[3]

Pregnancy induced hypertension (PIH) produces a condition similar to hypovolemia in foetuses.[4] Normally, the trophoblast invades the uterine wall in two phases known as first phase trophoblast invasion which occurs at about the 12th week of gestation and second phase trophoblast invasion which occurs at around the 18th week. In both of these processes, the trophoblast invades the medium sized muscular arteries, depriving them of the smooth muscle present in their tunica media. This results in loss of vasoconstrictive ability of these arteries hence, maintaining a constant and continuous blood flow throughout the cardiac cycle, thus rendering a low resistant high flow system which maintains a constant blood supply to the developing foetus.[4,5]

Defect in either of the two phases will results in a high resistance low flow system, thus leading to decreased blood flow to the foetus. The foetus then reacts to this decreased blood flow by redistributing its blood volume to preserve vital organs.[6–8]

Doppler Ultrasound is a good tool to pick up alterations in foeto-placental circulation.[9] Research has proven umbilical artery Doppler waveforms as an important predictor of pregnancy outcome.[10–12] Foetal middle cerebral artery and foetal aortic Doppler indices namely Pulsatility Index, Resistive Index and Systolic-Diastolic Ratio have also been used as predictors of foetal outcome and wellbeing.[13] Pulsatility Index is the measure of variability of flow in a blood vessel. It is measured as the difference between maximum velocity of blood during systole and the minimum velocity of blood during diastole divided by the mean velocity during the cardiac cycle in an artery. Resistive index indicates the resistance flowing blood comes across while passing through an artery. Systolic-Diastolic (S/D) ratio is the measure of difference of blood flow during systole and diastole in an artery.[14,15]

The objectives of this study were to study the correlation between Pulsatility Index (PI), Resistive Index (RI) and S/D Ratio of UA and MCA, and to determine the most significant Doppler Index for correlation between UA and MCA.

MATERIAL AND METHODS

This was a cross-sectional study. After taking written consent from the subjects for participation in the study, 90 pregnant ladies with singleton pregnancy and diagnose PIH were serially selected. Pregnancy induced hypertension was defined as a reading of 140/90 mmHg or above or an increase of 30/15 mmHg or more above the baseline reading on 3 separate occasions at least 2 weeks apart.

Inclusion Criteria

- Diagnosed case of PIH
- Para 1 to 3
- Women with accurate gestational age (with known LMP and also confirmed by 1st trimester ultrasound)
- Women registered at Ziauddin Hospital, and Habib Medical Centre before 18th week of gestation
- Normotensive up to the 20th week of gestation.

Exclusion Criteria

- Essential Hypertension
- Multiple Pregnancies
- Previous Caesarean Section or any uterine surgery
- Placenta Praevia
- Fibroids
- Abnormal uterine anatomy
- Abnormal vaginal discharge or bleeding
- Autoimmune disorders
- Vascular disorders
- Gestational diabetes
- Diabetes mellitus
- Congenital anomalies in foetus
- History of preterm delivery
- PCOS
- History of Nicotine use, alcoholism or any other street drug use

Doppler ultrasound examinations were carried out by the same operator in which the Pulsatility Index (PI), Resistive Index (RI) and Systolic-Diastolic Ratio (RI) in Umbilical Artery (UA) and Foetal Middle Cerebral Arteries (MCA) were noted down. Three readings were taken and mean values were recorded.

The study was approved by the Ethical Review Committee and Board of Advanced Studies and Research of Ziauddin University, Karachi.

Statistical analysis

The data feeding and analysis were done on the computer package SPSS-17. Pearson's correlation was used to correlate the parameters of UA and MCA. Scatter plots were used for diagrammatic representation of the correlation.

In all statistical analysis, only p-value <0.05 has been considered significant.

RESULTS

Table-1 shows a statistically non-significant (p=0.067) negligible negative correlation (-0.194) between the pulsatility indices of umbilical and foetal middle cerebral arteries.

Table-1: Correlation between umbilical artery and foetal middle cerebral artery pulsatility indices (n=90)

		UA PI	MCA PI
UA PI	Pearson Correlation	1	-0.194
	p		0.067
MCA PI	Pearson Correlation	-0.194	1
	p	0.067	

Figure-1 gives a diagrammatic representation of the correlation between the pulsatility indices of umbilical and foetal middle cerebral arteries.

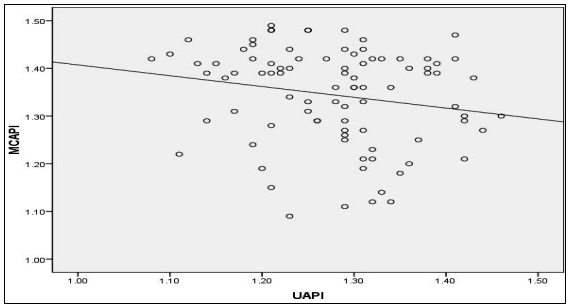

Figure-1: Correlation between umbilical artery and foetal middle cerebral artery pulsatility indices

Table-2 shows the existence of a significant (p=0.000) and very strong negative correlation (-0.754) between the resistive indices of umbilical and foetal middle cerebral arteries.

Table-2: Correlation between umbilical artery and foetal middle cerebral artery resistive indices (n=90)

		UARI	MCARI
UARI	Pearson Correlation	1	-0.754*
	p		0.000
MCARI	Pearson Correlation	-0.754*	1
	p	0.000	

*Correlation is significant at p<0.01 (2-tailed)

Figure-2 diagrammatically represents the very strong negative correlation between the resistive indices of umbilical and foetal middle cerebral arteries.

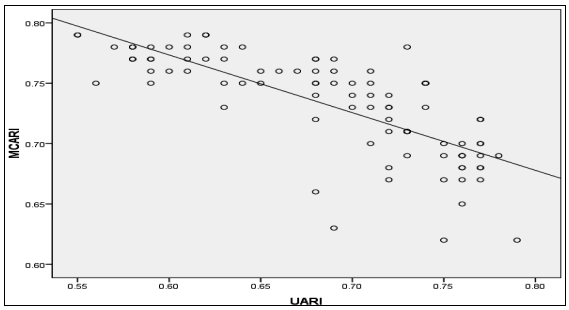

Figure-2: Correlation between umbilical artery and foetal middle cerebral artery resistive indices

Table-3 shows a statistically significant (p=0.002) moderate negative correlation (-0.328) between the SD ratios of umbilical artery and foetal middle cerebral arteries.

Table-3: Correlation between umbilical artery and foetal middle cerebral artery SD ratios (n=90)

		UASD	MCASD
UASD	Pearson Correlation	1	-0.328*
	p		0.002
MCASD	Pearson Correlation	-0.328*	1
	p	0.002	

*Correlation is significant at the 0.01 level (2-tailed)

Figure-3 diagrammatically represents the moderate negative correlation present between the SD ratios of umbilical artery and foetal middle cerebral arteries.

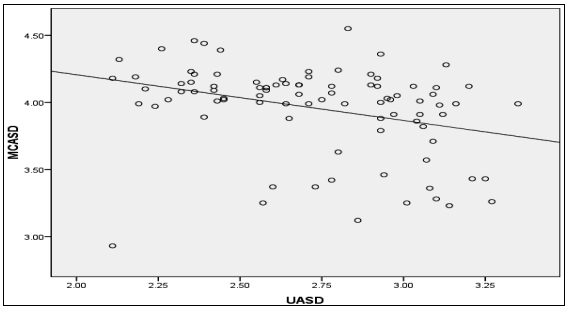

Figure-3: Correlation between umbilical artery and foetal middle cerebral artery SD ratios

DISCUSSION

In the present study no significant correlation could be determined between the PI of UA and MCA. Although no study carried out previously to the knowledge of the authors have tried to show a correlation between these two, in previous studies it has been seen that the ratio between UA PI and MCA PI could not significantly be of much use in prediction of foetal outcomes.[16,17]

When UA RI and MCA RI were correlated with each other, it was seen that a significant and very strong negative correlation exists between the two. This means that as the RI in the UA increases resulting in decreased foeto-placental blood flow; the resistance in the MCA decreases resulting in increased blood flow to the brain, thus exhibiting brain sparing effect. Studies have been carried out showing the value of the ratio between UA RI and MCA RI,[18,19] but none have tried to show a correlation between the two.

When the UA SD and MCA SD were correlated, it was seen that a significant and moderate correlation exists between the two. An increasing UA SD indicates a greater difference in the peak systolic and peak diastolic flows. This occurs in conditions that cause increased vasoconstriction, such as PIH. In response, the foetal MCA starts dilating in order to preserve the brain, thus exhibiting low SD. Studies done previously are directed towards the ratio between UA SD and MCA SD. None, however, have tried to show a correlation between the two.[20]

CONCLUSION

Umbilical artery and foetal middle cerebral artery Doppler indices are inversely related to each other. The most significant correlation is seen in the RI of the two arteries in which rise in UA RI causes a marked decrease in MCA RI. Increases in UA SD causes moderate amount of fall in MCA SD. No significant correlation could be found between the PI of the two arteries.

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