# Pattern of Fetal Arterial Blood Flow in Selected Vessels in Patients With Pregnancy Induced Hypertension in Aminu Kano Teaching Hospital Kano, Nigeria

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## ABSTRACT

**Background:** Doppler velocimetry of fetal arterial blood flow in pregnancy induced hypertension (PIH) determines fetal hemodynamic adjustment. **Objective:** This study was aimed to determine the pattern of fetal arterial blood flow of selected vessels in patients with PIH. **Materials and Methods:** A total of 34 pregnant women with PIH at a gestational age of 24-37 weeks were prospectively examined with Doppler ultrasound of the fetal middle cerebral artery (MCA), umbilical artery and placental blood flow (uterine artery). **Results:** The mean peak systolic velocity (PSV) of the fetal MCA was 8.23±3.96, resistance index (RI) was 0.763±0.07 and systolic diastolic (S/D) ratio was 4.558±1.36. The mean PSV of umbilical artery was 72.28±26.585, RI was 0.62±0.19 and S/D was 2.63±0.75. The mean placental blood flow (uterine artery) PSV was 141.34±70.58, RI was 0.59 and S/D was 2.42±1.07. Uterine artery PSV was normal in only six patients. Uterine artery was also not sonographically demonstrated in two patients. **Conclusion:** Doppler velocimetry of arterial blood vessels in pregnancy complicated with PIH reveals abnormal pattern; its application in PIH would be useful for further management.

**Key words:** Doppler velocimetry; fetal arterial blood flow; pregnancy induced hypertension; Nigeria

## Introduction

Pregnancy induced hypertension (PIH) is a condition of elevated blood pressure without proteinuria, which occurs after the 20th week of gestation in a woman who has been previously normotensive.[1]

This condition and other hypertensive disorders of pregnancy contribute up to 9.1% of the maternal deaths in Africa, 16.1% in developed countries, 9.1% in Asia and 25.7% in Latin America and the Caribbean.[2]

Impaired trophoblastic invasion of maternal spiral arteries associated with increased vascular resistance of the uterine artery and hence a decreased perfusion of the placenta has been implicated in the pathogenesis of (PIH) with poor pregnancy outcome.[3]

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| Quick Response Code: | Website: www.wajradiology.org |
| | DOI: 10.4103/1115-1474.117902 |

The use of ultrasound to non-invasively investigate the fetal circulation dates back to about 5 decades.[4] Advances in duplex Doppler ultrasound technology have made it possible to reliably identify and safely insonate fetal vessels that were previously inaccessible. Doppler sonography has been used for antenatal fetal surveillance in high risk pregnancies like PIH for the determination of hemodynamic adjustments[5] such as in differentiating PIH with poor outcome from PIH with normal outcome; thus, supporting the concept of heterogenous causes of PIH.[6] Doppler velocimetric study is a valuable tool for evaluation of high risk pregnancies. In this regard, Gupta *et al*.[7] found abnormal uterine and umbilical Doppler indices are more frequent among hypertensive patients. Though they found some normotensive cases also show abnormal umbilical Doppler, they concluded that detecting decreased uteroplacental and fetoplacental blood flow suggest a hypoxic fetus.[7] Similarly, Khalid *et al*.[8] demonstrated increased resistance in spiral uterine arteries; which leads to increased impedance of blood flow in uterine artery. This is reflected in higher values of S/D PI

and resistance index (RI) of the uterine artery. The abnormal waveforms were characterized by a higher systole, lower diastole and the persistence of diastolic notch which helps in predicting PIH and its adverse consequences.[8]

The aim of this study was to determine the pattern of fetal arterial blood flow in middle cerebral artery (MCA), umbilical artery (UA) and placental blood flow (uterine artery) in patients with PIH at Aminu Kano Teaching Hospital, Kano (AKTH), Nigeria.

## Materials and Methods

A total of 34 patients with PIH were recruited from the antenatal clinic of AKTH from May to December, 2011.

Their socio-demographic characteristics were documented.

Detailed obstetric history including their gestational age, parity, order of marriage, previous history of PIH, history of chronic hypertension, outcome of previous pregnancy complicated with PIH were collected. Their blood pressure at booking and at the onset of PIH was determined. Urine was tested for proteins with dipstick to confirm the diagnosis. Fetal heart rate was also checked following examination and the findings were documented on a structured data check list. They were sent to the radiology department for further evaluation.

At radiology department, each study participant was examined in the supine position on the ultrasound examination couch using 3.5 MHz convex transducer of the mindray digital ultrasound imaging system (Model DC-6; Shenzhen Mindray Biomed Electronics, China.); following application of water soluble coupling gel over the lower abdomen.

Each uterine artery was interrogated with color Doppler mode using external iliac artery as a land mark. The uterine arteries were insonated on the lower uterine segments on the right and left sides, angling the transducer on either side of the uterus toward the cervix [Figure 1]. The UA was identified by placing the transducer over the lower abdomen and by randomly directing it toward the uterine cavity to identify the umbilical cord using amniotic fluid acoustic window [Figure 2].

Fetal MCA was identified with color Doppler mode on the axial scan of the fetal head at the level of the thalami and cavum septum pellucidum, the same reference points for measuring biparietal diameter.

Spectral waveforms were examined by placing the pulsed-Doppler range gate within the vessel at an angle of 55-56°. The Doppler scale was adjusted such that the velocity measurement would be recorded without aliasing. The peak systolic velocity (PSV) and end diastolic velocity were

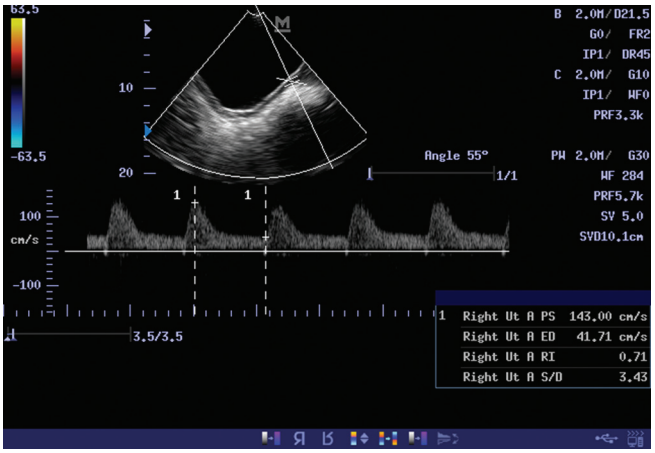


**Figure 1:** Duplex Doppler sonogram of the right uterine artery of one of the hypertensive patient, showing the peak systolic velocity of 143.0 cm/s and resistance index of 0.71

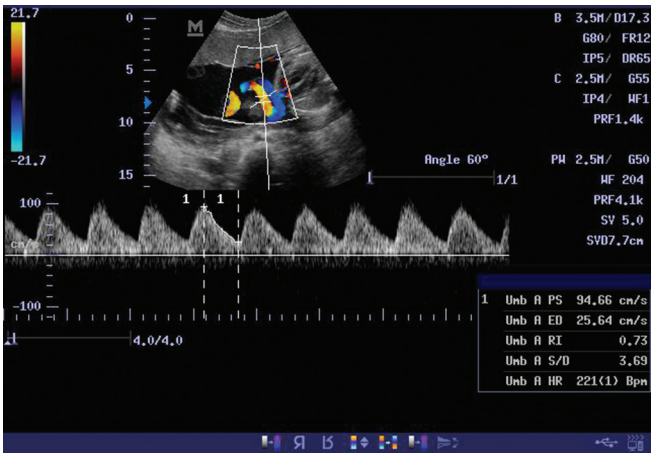


**Figure 2:** Duplex Doppler sonogram of the umbilical artery in one of the hypertensive patient at an angle of 60°, showing uniform uni-directional blood flow and peak systolic velocity of 94.66 cm/s and resistance index of 0.73

measured in cm/s. Furthermore, the resistive indices and systolic diastolic (S/D) ratio were also recorded.

Other routine obstetric ultrasound parameters were also recorded to determine the fetal weight, gestation age, the state of amniotic fluid and placental localization.

## Results

Table 1 showed the socio-demographic characteristics of patients.

The age range was 24-37 years with the mean age±SD of 31.0±4.848.

Among the respondents, up to 4 (11.8%) pregnant women attended primary level of education, 8 (23.5%) attended secondary level of education and 22 (64.7%) had tertiary level of education. None of the respondents attended qur'anic school and none with any form of education.

**Table 1: Socio-demographic characteristics of the patients**

| Feature | Frequency | Percentage |
|---|---|---|
| Age | | |
| 18-24 | 6 | 17.6 |
| 25-29 | 4 | 11.8 |
| 30-34 | 16 | 47.1 |
| 35-39 | 8 | 23.5 |
| Total | 34 | 100.0 |
| Educational status | | |
| None | 0 | 0.0 |
| Primary | 4 | 11.8 |
| Secondary | 8 | 23.5 |
| Tertiary | 22 | 64.7 |
| Quranic | 0 | 0.0 |
| Total | 34 | 100.0 |
| Occupation | | |
| House wife | 16 | 47.0 |
| Business | 4 | 11.8 |
| Professional | 2 | 5.9 |
| Artisans | 0 | 0.0 |
| Students | 0 | 0.0 |
| Others | 12 | 35.3 |
| None | 0 | 0.0 |
| Total | 34 | 100.0 |

Of the respondents, 16 (47.1%) were housewives, 4 (11.8%) were business women, 2 (5.9%) were professionals and 12 (35.3%) had other occupations, which included fish-farming, cattle rearing, poultry and handcrafts.

Table 2 depicted fetal outcome in previous pregnancies complicated with PIH. Fourteen (41.2%) patients had uncomplicated pregnancies. Eighteen (52.9%) had live babies while two patients had preterm labor.

Up to 32 (94.1%) of the respondents were in the first order of pregnancy while two patients (5.9%) were in the second order of their pregnancy.

Up to 20 (58.8%) of the respondents had PIH in their previous pregnancies.

Ten patients (29.4%) were primiparas and eight (23.5%) delivered four times.

Table 3 above depicts the PSV, RI and S/D of MCA, UA and uterine artery.

The mean fetal MCA PSV was 8.23±3.96, RI was 0.763±0.07, and S/D ratio was 4.558±1.36.

Only eight patients had MCA PSV within 55-75 cm/s. Others had abnormal results. Fourteen patients had RI of more than 0.7 which was normal. S/D ratio was normal in only four patients (5.2).

**Table 2: Obstetric clinical parameters of the subjects**

| Feature | Frequency | Percentage |
|---|---|---|
| Gestational age (weeks) | | |
| 24 | 2 | 5.9 |
| 28 | 2 | 5.9 |
| 30 | 4 | 11.8 |
| 31 | 4 | 11.8 |
| 32 | 2 | 5.9 |
| 33 | 4 | 11.8 |
| 34 | 4 | 11.8 |
| 36 | 8 | 23.5 |
| 37 | 4 | 11.8 |
| Total | 34 | 100.0 |
| Fetal outcome in previous complicated pregnancy | | |
| Uncomplicated/1st pregnancy | 14 | 41.2 |
| Alive | 18 | 52.9 |
| Preterm labor | 2 | 5.9 |
| Total | 34 | 100.0 |
| Order of marriage | | |
| First | 32 | 94.1 |
| Second | 2 | 5.9 |
| Total | 34 | 100.0 |
| Previous history of hypertension | | |
| No | 22 | 64.7 |
| Yes | 12 | 35.3 |
| Total | 34 | 100.0 |
| Previous history of PIH | | |
| No | 14 | 41.2 |
| Yes | 20 | 58.8 |
| Total | 34 | 100.0 |
| Parity | | |
| 0 | 4 | 11.8 |
| 1 | 10 | 29.4 |
| 2 | 6 | 17.6 |
| 3 | 8 | 23.5 |
| 4 | 2 | 5.9 |
| 6 | 2 | 5.9 |
| 7 | 2 | 5.9 |
| Total | 34 | 100.0 |

PIH – Pregnancy induced hypertension

**Table 3: Summary of the results of PSV, RI, and S/D of the selected vessels**

| Parameter | Middle cerebral artery | Umbilical artery | Uterine artery |
|---|---|---|---|
| PSV | 8.23±3.96 | 72.28±26.585 | 141.34±70.58 |
| RI | 0.763±0.07 | 0.62±0.19 | 0.58±00 |
| S/D | 4.55±1.36 | 2.63±0.75 | 2.42±1.07 |

PSV – Peak systolic velocity; RI – Resistance index; S/D – Systolic diastolic

The mean umbilical PSV was 72.28±26.585, RI was 0.62±0.19 and S/D was 2.63±0.75.

Six patients had abnormal UA PSV of more than 88 cm/s, (Normal was 40-88 cm/s). RI was also more than

0.7 in those six patients (normal was 0.5-0.7). Four patients had RI of <0.5. S/D ratio was more than three among eight patients (normal was <3).

In two patients, umbilical arteries were not visualized.

The mean placental blood flow (uterine artery) PSV was 141.34±70.58, RI was 0.59 and S/D was 2.42±1.07.

Only six (17.65%) of the patients had normal PSV of the uterine artery (normal was 44-78 cm/s).

Uterine artery was also not sonographically demonstrated in two patients.

## Discussion

Pregnancies complicated with hypertensive disorders are associated with substantial morbidity and mortality. Despite significant improvements in obstetric care, hypertensive disorders are still the second leading cause of maternal mortality.[9] Perinatal mortality is also high due to subsequent placental insufficiency, pre-term delivery and placental abruption.[10]

Poor maternal vascular response to placentation is implicated in the etiology of pregnancy-induced hypertension. Several studies of Doppler on pregnant women have revealed increased RI or the presence of early diastolic notch in those with high possibility of developing pregnancy-induced hypertension.[11-13] It was looked for in this study, but not found.

In this study, pregnant women that booked for antenatal care and developed pregnancy-induced hypertension were recruited. Eighteen of the respondents had PIH in their previous pregnancies, but only two had preterm labor as a complication. This could be due to smaller sample size. Previous pregnancy complicated by severe PIH is a documented risk factor for PIH in a subsequent pregnancy.[13] Several studies have shown first order of marriage is strongly related to nulliparity, which is implicated as a risk factor for PIH.[14] Chronic hypertension and low parity[15,16] are also known factors associated with PIH; however, no statistical measures of association were used in this study. This may be due to selection challenges as the majority of patients coming to AKTH for ante natal care were of relatively high socio-economic class compared to the general population. As part of the limitation of this study is smaller sampling size a, larger scale community based study may be needed to sort out this relationship.

The mean fetal MCA PSV was 8.23 cm/s±3.96, in our study. This was below the normal range of 55-75 cm/s reported by Hershkovitz *et al*.[17] among healthy fetuses with single umbilical arteries. PIH could have implicated the PSV in the MCA.

The RI of the fetal MCA in the study was 0.763 cm/s±0.07, which was within the normal limits of >0.7 reported in other studies.[17,18] However, the S/D ratio of the MCA was also 4.558±1.36. Tarzamni *et al*.[18] reported a figure of 5.2 as the normal value.

On individual analysis, only four patients had MCA PSV within 55-75 cm/s. others had abnormal results. Seven patients had RI of more than 0.7, which was normal. S/D ratio was normal in only two patients (5.2).

The mean PSV of umbilical was 72.28±26.585. This agrees with the findings of Taslimi[19] on fetal Doppler ultrasonography, which reported a range of 40-88 cm/s. The RI was 0.62±0.19 and S/D was 2.63±0.75. These were within the normal range of 0.5-0.7 for RI and S/D of <3.[19]

Three patients had abnormal UA PSV of more than 88 cm/s. RI was also more than 0.7 in those three patients. Two patients had RI of <0.5. S/D ratio was more than three among four patients.

In one patient, UA was not visualized.

The mean placental blood flow (uterine artery) PSV was 141.34 cm/s±70.58. This was higher than the normal ranges of 44-78 cm/s reported by Lakhkar and Ahamed.[20]

The mean RI of uterine artery was 0.59. Lakhkar and Ahamed[20] reported RI findings that drop from 0.84 to 0.56 and later to 0.33 in the late third trimester.[20] S/D was 2.42±1.07 which was considered normal when less than 2.6.

Uterine artery PSV was normal in only three patients (normal was 44-78 cm/s).[20] Only one patient had an abnormal RI in the second trimester. All others had normal RI (normal 0.84-0.56 and in late third trimester drops to 0.33).[20] Three patient had abnormal S/D ratio of >2.6[20]

Uterine artery was also not sonographically demarcated in one patient.

## Conclusion

Doppler velocimetry of arterial blood vessels in pregnancy complicated with PIH reveals the variety of abnormalities and its application in patients with PIH will certainly be useful for further management of these patients and their newborns.

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**How to cite this article:** Yakasai IA, Tabari MA, Rabiu A, Ismail AM. Pattern of fetal arterial blood flow in selected vessels in patients with pregnancy induced hypertension in Aminu Kano Teaching Hospital Kano, Nigeria. West Afr J Radiol 2013;20:9-13.

**Source of Support:** Nil, **Conflict of Interest:** None declared.