

## Umbilical Artery Flow Velocity in Pregnancy Induced Hypertension at Third Trimester

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### ABSTRACT

**Background:** Doppler ultrasound of umbilical vessels is a technique for evaluating fetoplacental blood flow which is very important in high risk pregnancies like hypertensive pregnancies and can predict both fetal and maternal morbidity and mortality. Since the traditional methods are not good enough to assess uteroplacental and fetoplacental circulation, blood flow studies are used to assess fetal well-being in normal and hypertensive pregnancies.

**Aim:** To measure the blood flow indices of umbilical artery using Doppler ultrasound in patients with pregnancy induced hypertension (PIH) and healthy pregnant women.

**Methods:** This is a case control study at which 60 participants, 40 with PIH and 20 with normal pregnancy at the third trimester were studied in Al Najaf Governorate. Doppler ultrasound of umbilical artery was performed for both, the patient and the control groups in which Resistive Index (RI), Pulsatility Index (PI) and Systolic to Diastolic ratio (S/D ratio) were calculated.

**Results:** The mean  $\pm$ SD of RI, PI and S/D of the umbilical artery were  $0.63 \pm 0.11$ ,  $0.97 \pm 0.33$  and  $2.9 \pm 1.38$  respectively in the PIH group, they were higher than those of the control group ( $0.62 \pm 0.06$ ,  $0.91 \pm 0.17$  and  $2.72 \pm 0.41$  respectively) at 33-36 weeks. However, differences were found to be insignificant as well as they were higher at 37-40 weeks.

**Conclusion:** There are insignificant elevations of indices of the umbilical artery in PIH women with respect to those of normal pregnancy.

## Introduction

Gestational hypertension, also referred to as pregnancy induced hypertension (PIH), is a condition characterized by high blood pressure during pregnancy. Hypertension during pregnancy affects about 6-8% of pregnant women [1]. The umbilical artery, the very important vessel of the fetus, was the first vessel to be assessed and has since become the most widely investigated component of the fetal circulation. The unique umbilical artery waveform can easily be detected by real time ultrasound associated with pulse wave [2]. Flow velocity waveforms from the umbilical cord have a characteristic saw-tooth appearance of arterial flow in one direction and continuous umbilical venous blood flow in the other [3]. Resistance to blood flow in the umbilical arteries falls with advancing gestation due to continuing development of the placental vascular system throughout pregnancy [4].

The S/D ratio of umbilical artery falls continuously with the advancing of gestation owing to increase in arterial blood flow during the course of pregnancy. The consequence is a persistent flow throughout the cardiac cycle with a steady in the end diastolic volume, so umbilical arterial circulation is normally a low impedance

circulation [5], because of many causes. First, the branching of the stem villi and ensuing development of the non-branching placental microcirculation are responsible for a low vascular resistance [6]. Second, is the increase in fetal cardiac output Third, the changing compliance & the resistant of the vessels wall & rise of fetal blood pressure [7]. A reduction of the branching of the stem villi and a reduction in the development of the non-branching placental microcirculation result in fewer small arterioles in the tertiary stem villi, along with a thickened fetal-maternal placental interface. This will result in progressive decrease in the end diastolic flow in the umbilical arterial Doppler waveform until absent & then reverse flow during diastole is noted [8]. Clearly, the end-diastolic component of the Doppler waveform was very important in fetal prognostication. Absent or reversed end-diastolic flow velocity is associated with a remarkably adverse perinatal outcomes, fetal death and chromosome abnormality [2].

## Methods

Sixty pregnant women were participated as volunteers after obtaining their signed consent and formal approval of the Ethical Committee of the Faculty of Medicine, University of Kufa. The study was conducted

between January 2013 and August 2013 at AL-Ameer Diagnostic Center. Pregnant women have to meet the inclusion criteria (Pregnant women at 33-40 gestational weeks, including normal pregnancy (as control) and PIH (without complications). They were without extensive history and physical examination. Ultrasound examinations were performed by a single investigator, using ultrasound machine GE Vivid 3 with color Doppler facilities. The transducer frequency was 3.5-5.0 MHz. The Doppler sample volume was 2 mm, and the wall filter was 50–100 Hz. The spatial temporal average intensity was below 100 mW/cm<sup>2</sup>, according to the manufacturing specification. The participants were divided into two groups, group one represents the pregnancy induced hypertension (PIH), group two represents normal pregnancy as a control, both groups were pregnant at 33-40 weeks. The gestational age was estimated from the last normal menstrual period and confirmed by the first or second trimester ultrasound reports according to crown-rump length, femoral length & biparietal diameter records.

The examinations were performed in semirecumbent position to avoid pressure effect upon the inferior vena cava which may lead to hypotension [9]. The umbilical artery was insonated; It was identified first by

color Doppler imaging and the pulse wave Doppler recorded at its portion close to the placenta [10,11]. When 3 to 5 similar waveforms were imaged on the screen, the required measurements were taken in the form of the peak systolic velocity, end diastolic velocity and mean velocity.

The calculation of indices were carried out from the measurements of the arterial waveforms which consisted of systolic velocity/diastolic velocity (S/D), resistive index:  $\text{resistive index} = \frac{\text{systolic velocity} - \text{diastolic velocity}}{\text{systolic velocity}}$  (RI= S–D/S) and pulsatility index:  $\text{pulsatility index} = \frac{\text{systolic velocity} - \text{diastolic velocity}}{\text{mean value}}$  (PI= S-D/mean value) over one cardiac cycle, where, S= maximal Systolic Doppler shift frequency and D= minimum Doppler shift frequency.

Statistical analysis of data was done using SPSS version 20. Results at P<0.05 was considered to be statistically significant [12].

## Results

### **Umbilical (Um) artery Doppler waveform parameters related to gestational age 33-36 weeks in pregnancy induced hypertension:**

The mean and SD values of RI for Um artery at 33-36 weeks gestation was found to be  $0.63 \pm 0.11$  and the 95% confidence interval of the mean for four weeks was obtained to be 0.56-0.65. The

mean and SD values of PI for Um artery at 33-36 weeks gestation was  $0.97 \pm 0.33$  and the 95% confidence interval of the mean for five weeks was 0.84-1.10. The mean and SD values of S/D for Um artery at 33-36 weeks of gestation was  $2.9 \pm 1.38$  and the 95% confidence interval of the mean for four weeks was 2.36-3.45 (Table 1).

**Table 1:**

Doppler waveform parameters for umbilical artery in PIH group (33-36 weeks)

	Mean $\pm$ SD	95% CI
Um RI	$0.63 \pm 0.11$	0.56-0.65
Um PI	$0.97 \pm 0.33$	0.84-1.10
Um S/D	$2.90 \pm 1.38$	2.36-3.45

**Umbilical artery Doppler waveform parameters in pregnancy induced hypertension related to gestational age 37-40 weeks:** The RI was  $0.62 \pm 0.08$  and the 95% confidence interval of the mean for Four weeks was 0.50- 0.81. The PI was  $0.95 \pm 0.70$  and the 95% confidence interval of the mean for four weeks was 0.56 -1.41. The S/D was  $2.54 \pm 0.50$  and the 95% confidence interval of the mean for four weeks was 2.03-2.64 (Table 2).

**Table 2:**

Doppler waveform parameters of umbilical artery for pregnancy induce hypertension group (37-40 weeks)

	Mean $\pm$ SD	95% CI
Um. RI	$0.62 \pm 0.08$	0.50-0.60
Um. PI	$0.95 \pm 0.70$	0.56-1.41
UM S/D	$2.54 \pm 0.50$	2.03-2.64

**Umbilical artery Doppler waveform parameters related to gestational age 33-36 weeks in the control group:**

The mean and SD values of RI for umbilical artery at 33- 36 weeks gestation were  $0.61 \pm 0.06$  and the 95% confidence interval of the mean for four weeks 0.55- 0.70. The mean and SD values of PI for umbilical artery at 33-36 weeks gestation were  $0.91 \pm 0.17$  and the 95% confidence interval of the mean for four weeks 0.69- 1.13. The mean and SD values of S/D for umbilical artery at 33-36 weeks gestation were  $2.72 \pm 0.41$  and the 95% confidence interval of the mean for four weeks 2.20- 3.24

**Umbilical artery Doppler waveform parameters in control group related to Gestational Age 37-40 weeks:**

The mean and SD values of RI of the umbilical artery at 37- 40 weeks gestation was found to be  $0.58 \pm 0.06$  and the 95% confidence interval of the mean of four weeks was 0.54-0.62. The mean and SD values of PI for the umbilical artery was obtained to be  $0.89 \pm 0.23$  and the 95% confidence interval of the mean was

0.79-1.05. The mean and SD values of S/D for the umbilical artery was  $2.50 \pm 0.64$  and the 95% confidence interval was 2.22-2.94 (Table 4).

All indices of the umbilical artery were higher in PIH group than those in the control group in both 33-36 and 37-40 weeks of gestation, although, the differences were insignificant (Tables 5 and 6).

**Table 3**

Doppler waveform parameters of umbilical artery of the control group (33-36 weeks)

Parameter	Mean $\pm$ SD	95% CI
Um. RI	$0.61 \pm 0.06$	0.55-0.70
Um. PI	$0.91 \pm 0.17$	0.69-1.13
UM S/D	$2.72 \pm 0.41$	2.20-3.24

**Table 4**

Doppler waveform parameters of umbilical artery of the control group (37-40 weeks)

Parameter	Mean $\pm$ SD	95% CI
Um. RI	$0.58 \pm 0.06$	0.54-0.62
Um. PI	$0.89 \pm 0.23$	0.79-1.05
UM S/D	$2.50 \pm 0.64$	2.22-2.94

## Discussion

In this study the umbilical artery indices were decreased with progression of pregnancy in normal and PIH and this is consistent with the findings of Pharuhas

Chanprapaph et al. [2], Gupta et al. [13] and Mohd Khalid1 et al. [14].

The mean values of umbilical artery Doppler velocimetry indices were higher in hypertensive than in normotensive group of the same gestational age. The mean values in the hypertensive group were higher than the normotensive group. The means of indices of RI, PI and S/D in the control of both groups (33-36 weeks and 37-40 weeks) decreased from 0.6, 0.91 and 2.72 respectively at 33-36 to 0.58, 0.89, 2.50 at 37-40 weeks respectively. The current results of indices of in the normotensive group were consistent with Paudel S et al [15], as well as the S/D ratio, it was close to the S/D in the study of Gupta Usha et al. [16].

The mean of indices of RI, PI and S/D in PIH in both groups (33-36 weeks and 37-40 weeks) were decreased from 0.63, 0.97 and 2.90 respectively at 33-36 weeks to 0.62, 0.95, and 2.54 respectively at 37-40 weeks. Our results were close to results of Um Gupta et al. [13] Pharuhas Chanprapaph et al [2]. However, these results were slightly higher than those obtained by Mohd Khalid1 et al. [14]. The slight difference is possible that their study concerned 40 week of gestation while the present result concerned the mean of the last four weeks.

The current results were consistent with those of Stuart and Drumm [17], they have found first a progressive fall in the values of Doppler indices of the Umbilical artery with progression of gestation.

**Table 5:**

A comparison of Doppler waveforms parameter of umbilical artery between control and pregnancy induced hypertension at 33-36 weeks gestation.

Parameter	Control (33-36 week) (Mean $\pm$ SD)	PIH(33-36 week) (Mean $\pm$ SD)	P value
Um. RI	0.61 $\pm$ 0.06	0.63 $\pm$ 0.11	0.77
Um. PI	0.91 $\pm$ 0.17	0.97 $\pm$ 0.33	0.70
UM S/D	2.72 $\pm$ 0.41	2.90 $\pm$ 1.38	0.77

**Table 6:**

A comparison of Doppler waveforms parameter of umbilical artery between control and pregnancy induced hypertension at 37-40 weeks gestation.

Parameter	Control (37-40 week) (Mean $\pm$ SD)	PIH (37-40 week) (Mean $\pm$ SD)	P value
Um. RI	0.58 $\pm$ 0.06	0.62 $\pm$ 0.08	0.23
Um. PI	0.89 $\pm$ 0.23	0.95 $\pm$ 0.70	0.74
UM S/D	2.50 $\pm$ 0.64	2.54 $\pm$ 0.50	0.28

The decrease in the values with advancing of gestation occurs due to decreased placental vascular resistance. This decrease does not occur in hypertensive pregnancies, who therefore have higher indices [18].

In conclusion, indices of the umbilical artery were higher in PIH group than those in the control group in both 33-36 and 37-40 weeks of gestation, although, the differences were insignificant.

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