



Original Research Article

# Estimation of various color doppler indices in low and high risk preterm pregnancies

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**How to cite this article** Himanshu Singla, Srajan Dashore, Ajay Kumar Dubey, Shreedevi B Patel. Estimation of various color doppler indices in low and high risk preterm pregnancies. IAIM, 2015; 2(6): 40-46.

Available online at [www.iaimjournal.com](http://www.iaimjournal.com)

Received on: 19-05-2015

Accepted on: 31-05-2015

## Abstract

**Background:** Fetal arterial and venous doppler studies help in identification of the foetuses at risk for perinatal complications and may help in prediction of the fetal acid base status or neonatal complications.

**Aim:** To estimate various color doppler indices in low and high risk preterm pregnancies.

**Material and methods:** Study comprised of 60 patients which was an observational, descriptive hospital based study. The study was divided into 2 groups: High risk group (n=30) and Low risk group (n=30). Color doppler scanners (Philips envisor HD7, HD9 and GE logic P5 ultrasound machine), was used with 3.5 Mhz curvilinear array and following Doppler Velocimetry were assessed - Uterine artery, Umbilical artery, Middle cerebral artery, Umbilical vein, Uterine vein and Ductus Venosus.

**Results:** Gestational age (in weeks) at examination was (31.89±2.69) in low risk group as compared to (29.25±1.96) in high risk group. Gestational age (in weeks) at delivery was (36.2±1.78) in low risk group as compared to (29.83±1.86) in high risk group. In low risk group uterine artery doppler show decrease in PI, RI and S/D ratio with increasing gestation as compared to increasing PI, RI and S/D ratio in the high risk group. Significant differences for the mean for PI, RI and S/D ratio were seen (p<0.001).

**Conclusion:** Doppler investigation of the fetal circulation play an important role in monitoring high risk pregnancies and thereby help to determine optimal time for delivery. Hence, the use of doppler provides information that is not readily obtained from more conventional test for fetal wellbeing. Therefore it has a role to play in management of high risk pregnancies.

## Key words

Low risk preterm pregnancies, High risk preterm pregnancies, Fetal doppler, Uterine artery, Uterine Vein, Umbilical artery, Umbilical vein, Ductus venosus.

## Introduction

The uteroplacental circulation is assessed by Doppler velocimetry of the uterine arteries [1]. In normal pregnancy the resistance in the uterine artery flow decreases with advancing gestational age [2].

Elevated impedance to blood flow in the placenta is reflected by abnormal umbilical artery velocimetry [3]. Absence or reversal of end-diastolic flow in the umbilical artery (UA) is suggestive of poor fetal condition, whereas normal or slightly decreased umbilical Doppler flow is rarely associated with significant morbidity and provides strong evidence of fetal well-being when delivery is delayed to achieve further fetal maturity [4].

Fetuses that are intrauterine growth-restricted (IUGR), secondary to placental insufficiency, redistribute their blood flow from the periphery to the brain [5], and Doppler ultrasound of the umbilical artery (UA) and fetal brain arteries can be used to determine these changes [6, 7].

The growth restricted fetus seems to be at highest risk of death when Doppler abnormalities are observed in the venous circulation (ductus venosus {DV} and umbilical vein) [8].

Recently, more attention has been paid to the venous system. Umbilical vein pulsations and reversed flow in the ductus venosus have been reported as ominous signs of perinatal mortality and ventricular failure. It has been suggested that umbilical vein pulsations are a consequence of reversed flow in the ductus venosus, with the ductus venosus considered as the only direct link

between the inferior vena cava and the umbilical vein.

## Materials and methods

The study was carried out in the Department of Radiodiagnosis, S.B.K.S. Medical Institute and Research Centre, Waghodia, Vadodara.

### Study design

Type of the study: An observational, descriptive hospital based study.

Sample size: 60 patients.

### Selection of subject

#### Inclusion criteria

The pregnant women were divided into two groups, low risk (n=30) and high risk (n=30) group.

#### Low risk

- No history of pre-eclampsia, gestational hypertension, stillbirth or abruption.
- Delivered a live born fetus with weight >5th percentile in one or more previous pregnancies.
- No known medical disease.
- Had a booking blood pressure <140/90 mmHg without anti-hypertensive medication.

#### High risk

- Previous h/o or present pre-eclampsia.
- Chronic hypertension.
- Previous babies with birth weight <5<sup>th</sup> centile.
- Previous spontaneous premature delivery.
- Previous abruption.
- Previous stillbirth/early neonatal death.
- Diabetes.
- Renal disease.

- Other medical diseases.

#### Exclusion criteria

- Pregnancies with a prenatal diagnosis of a chromosomal or structural abnormality.
- Women with multiple pregnancies.

#### Study tools

All the grey scale and color doppler analysis of the vessels were obtained using Philips envisorHD7, HD9 and GE P500 ultrasound machine, with a 3.5/5-MHz curvilinear array.

#### Study protocol

- Group – pregnant women divided into two groups, low risk and high risk group.
- Prior to Doppler assessment, initially all pregnant women underwent gray scale ultrasonography to evaluate biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL). Estimated fetal weight was calculated according to the Shepard and Hadlock formulas.

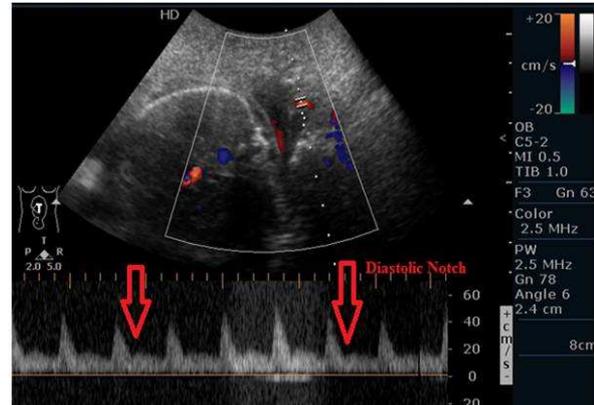
The following vessels were evaluated on color doppler and the indices were correlated with fetal outcome.

**Uterine artery** - RI, PI, diastolic notch and S/D ratio was measured and the presence of early diastolic uterine artery notches was noted. An abnormal Doppler pattern was defined as a mean PI >95th percentile and/or the presence of a diastolic notch. (**Figure - 1**)

**Uterine veins** - Three types of Uterine vein flow velocity patterns were identified: Type I, continuous non-pulsatile flow; Type II, pulsatile flow with a 'notch' down to the zero line; Type III, pulsatile pattern with absent flow during part of the heart cycle.

After localization of the MCA by color doppler flow, PSV and PI was measured from proximal portion of MCA.

**Figure – 1:** Left uterine artery trace showing increase diastolic flow, and diastolic notch in 29 weeks of gestation.



**Umbilical artery** blood velocity was also recorded from a free-floating central part of the cord. Multiple waveforms recording such as RI, PI and S/D ratio was calculated.

**Umbilical venous** blood flow was recorded for any pulsation and reversal flow. Umbilical venous pulsations were defined as a diastolic decrease in blood velocity exceeding 15% of the baseline maximum.

The **Ductus Venosus (DV)** Velocities was measured as mean values of at least four heart cycles and PVIV was calculated automatically according to the formula  $(S-A)/D$ , where S is the peak velocity during ventricular systole, A is the lowest forward velocity during atrial contraction in late diastole and D is the peak velocity during early diastole. Also flow reversal a wave if any recorded.

Perinatal outcome variables in high-risk pregnancies included were mode of delivery, metabolic complication, birth weight, Apgar score at 5 min, Fetal distress, admission in NICU, need for artificial intubation, perinatal and



neonatal mortality. SGA was defined as fetal weight less than 10 percentile of gestational age.

## Results

In the present study, majority of pregnant patient with risk factor were those who presented with clinical and sonographic finding of IUGR (73%). Next in frequency were patient with Preeclampsia which constituted 70% of the total. Both IUGR and preeclampsia contributed 60% predisposition in high risk group. 2 patients (6%) had history of chronic hypertension without any proteinuria. None of the patient gave history of alcohol /smoking intake. In present study, it was observed that majority of patients with low risk group were of  $\leq 25$  years (80%) and in high risk group  $\geq 25$  years (73%). None of the patients were below 19 or  $> 35$  years. Most of the pregnant women in both high and low risk group were primigravida (60% each).

Gestational age (in weeks) at examination was  $(31.89 \pm 2.69)$  in low risk group as compared to  $(29.25 \pm 1.96)$  in high risk group. Gestational age at delivery in low risk group was  $(36.2 \pm 1.78)$  as compared to  $(29.83 \pm 1.86)$  high risk group. Majority of patients (24/30) in low risk group underwent spontaneous delivery as compared to high risk group (4/30). Elective caesarean section was done in 16% of cases in low risk group and 56.6% of cases in high risk group of which 30% were on emergency.

Visualization of uterine arteries (100%) was possible in both low and high risk patients. Any value less than 5 percent ( $\pm 2SD$ ) of the mean from low risk group was considered as abnormal. The mean RI, PI and S/D ratios in low risk group were  $0.43 \pm 0.05$ ,  $0.78 \pm 0.21$  and  $1.79 \pm 1.54$  respectively in comparison with high risk group which showed values of  $0.54 \pm 0.13$ ,  $0.92 \pm 0.39$  and  $2.55 \pm 0.75$  respectively. The

difference between the values was clinically significant values were clinically significant (**Table - 1**).

Presence of diastolic notch was much commoner in high risk pregnancies as compared to the low risk (**Table - 2**).

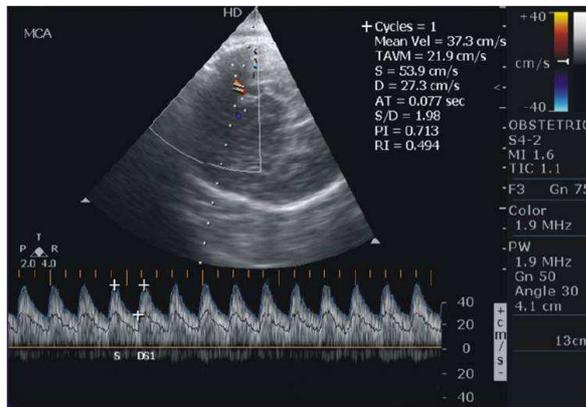
In low risk group decrease in PI RI and S/D ratio was seen with increasing gestation as compared to increasing PI, RI and S/D ratio in the high risk group.

All 30 patients in low risk group have type 1 waveform. Even in high risk group majority of patients 19 (63%) showed type 1 waveform. 11 patients in the high risk group showed type 2 and 3 waveform (**Table - 3**).

Visualization of MCA artery (100%) was possible in both low and high risk patients. Any value less than 5 percent ( $\pm 2SD$ ) of the mean from low risk group was considered as abnormal. The mean PSV and PI ratios in low risk group were  $43.73 \pm 5.91$  and  $1.836 \pm 0.379$  respectively. The values in high risk group were  $54.6 \pm 20.14$  and  $1.6 \pm 0.49$  respectively. The difference between the values was clinically significant. (**Table - 4**)

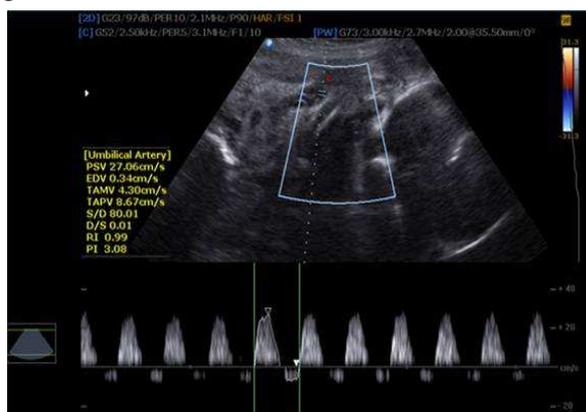
Of 30 patients in high risk group, 12 patients had abnormal MCA artery PI (40%). 60% patients (18/30) had normal PI. Similarly PSV was abnormal in 36.6 % Of patients (11/30). The average gestational age at examination and delivery in high risk group was 29 weeks and 29.8 weeks respectively. Significant difference of values for both birth weight ( $1832 \pm 4$  vs  $1601 \pm 5$ ) were seen in patient with normal and abnormal MCA artery parameters ( $p = 0.017$ ) and ( $p = 0.001$ ). Increase in diastolic flow with decreased pulsatility index shows the brain sparing taking place in compromised fetuses (**Figure - 2**)

**Figure – 2:** Middle cerebral artery trace showing increase diastolic flow with “Brain Sparing Effect” in 33 weeks of gestation.



Visualization of umbilical artery (100%) was possible in both low and high risk patients. Any value less than 5 percent ( $\pm 2SD$ ) of the mean from low risk group was considered as abnormal (**Figure - 3**). The mean RI, PI and S/D ratios in low risk group were  $0.61 \pm 0.06$ ,  $0.92 \pm 0.14$  and  $3.09 \pm 0.50$  respectively in comparison with high risk group. The values in high risk group were  $0.69 \pm 0.09$ ,  $1.25 \pm 0.42$  and  $3.78 \pm 1.24$  respectively. The difference between the values was clinically significant (**Table - 6**).

**Figure – 3:** Umbilical artery trace showing reverse end diastolic flow in 33 weeks of gestation.



In low risk group decrease in PI, RI and S/D ratio was seen with increasing gestation as compared to increasing S/D ratio in the high risk group. RI

and PI showed only subtle change with gestational age in high risk group.

Of the 30 patient in low risk group 30 had normal flow and in high risk group 24 (80%) had normal flow, 6 (20%) had pulsation. P value was statistically significant for pulsatile flow (**Table - 6**)

PVIV in high risk group was  $(0.78 \pm 0.52)$  as compared to low risk group  $(0.49 \pm 0.18)$ . The difference in values was statically significant ( $P=0.011$ ) (**Table - 7**).

## Discussion

Doppler US provides a means of studying these circulatory beds and detecting abnormal vascular resistance patterns in the uterine and umbilical arteries non-invasively.

Present study showed that it is possible to record flow velocity signals from maternal UtVs. Of the 11 patient who showed pulsatility in high risk group significant difference in birth weight (1768/1639 g) was seen. 36% of the patients showed fetal distress and all of these foetuses had neonatal mortality.

With regard to fetal outcome for small for gestational age, high sensitivity was seen by Doppler parameters especially of the venous pulsation. However specificity was less. The arterial and venous parameters displayed high degree of specificity in uterine waveform and venous pulsation respectively.

## Conclusion

The introduction of Doppler technology has provided the first opportunity for repetitive non-invasive hemodynamic monitoring in human pregnancy. There is ample evidence that Doppler indices from the fetal circulation can reliably predict adverse perinatal outcome in an



obstetric patient population with a high prevalence of complications. Compared to other methods of fetal monitoring Doppler has proved to be more sensitive in detecting fetal compromises early.

Doppler investigation of the fetal circulation play an important role in monitoring high risk pregnancies and thereby help to determine the optimal time for delivery. Hence, the use of Doppler provides information that is not readily obtained from more conventional tests of fetal well being. It therefore has an important role to play in the management of high risk pregnancies.

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**Source of support:** Nil

**Conflict of interest:** None declared.

**Table - 1:** Comparison of Uterine artery indices between low and high risk group.

| Doppler parameter | Low risk (n=30) | High risk (n=30) | P value significance |
|-------------------|-----------------|------------------|----------------------|
| RI                | 0.438±0.05      | 0.54±0.13        | 0.098                |
| PI                | 0.78±0.21       | 92±0.39          | <0.001               |
| S/D               | 1.79±1.54       | 2.55±0.75        | <0.001               |

**Table - 2:** Comparison of uterine artery PI and diastolic notch with normal and adverse outcome.

| Doppler parameters | Low risk (n=30) | High risk (n=30) | P value significance |
|--------------------|-----------------|------------------|----------------------|
| PI                 | 0.92±0.14       | 1.25±0.42        | <0.001               |
| Notch index        | 1(3.3%)         | 11(36.7%)        | 0.001                |

**Table - 3:** Comparison of Uterine vein flow pattern between low and high risk group.

| Indices | Low risk (n=30) | High risk (n=30) | P value significance |
|---------|-----------------|------------------|----------------------|
| Type 1  | 30(100%)        | 19(63.3%)        | 0.001                |
| Type 2  | 0(0%)           | 7(23.3%)         |                      |
| Type 3  | 0(0%)           | 4(13.3%)         |                      |

**Table - 4:** Comparison of fetal MCA artery indices in low risk and high risk group.

| Doppler parameter | Low risk group (n=30) | High risk group (n=30) | Significance |
|-------------------|-----------------------|------------------------|--------------|
| PSV(cm/s)         | 43.73±5.919           | 54.64±20.149           | 0.006        |
| PI                | 1.83±0.379            | 1.6±0.498              | 0.046        |

**Table - 5:** Comparison of Umbilical artery indices in low and high risk group.

| Doppler parameter | Low risk group (n=30) | High risk group (n=30) | Significance |
|-------------------|-----------------------|------------------------|--------------|
| RI                | 0.61±0.06             | 0.69±0.09              | <0.001       |
| PI                | 0.92±0.14             | 1.25±0.42              | <0.001       |
| S/D               | 3.09±0.50             | 3.78±1.24              | 0.008        |

**Table - 6:** Comparison of umbilical vein flow pattern between low and high risk group.

| Indices   | Low risk (n=30) | High risk (n=30) | P value significance |
|-----------|-----------------|------------------|----------------------|
| Normal    | 30(100%)        | 24(80.0%)        | 0.024                |
| Pulsatile | 0(0%)           | 6(20.0%)         |                      |

**Table - 7:** Comparison of fetal Ductus Venosus indices in low and high risk group.

| Indices | Normal pregnancy | High risk pregnancy | P value significance |
|---------|------------------|---------------------|----------------------|
| PVIV    | 0.492±0.183      | 0.783±0.525         | 0.011                |