Validity of Umbilical Artery Doppler Ultrasound in Diagnosis of Intrauterine Growth Restricted Fetuses.

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Abstract
Background: To determine the validity of the umbilical artery doppler ultrasound in the diagnosis of intrauterine growth restricted fetuses between 24 – 36 weeks using fetal birth weight as gold standard.
Methods: In this cross sectional study a total of 108 pregnant women with growth restricted fetuses were studied. Doppler sonological assessment was done on abnormal umbilical artery waveform like decreased diastolic flow, absent and reversed diastolic flow, peak systolic / diastolic ratio> 3, pulsatility index ≥ 0.98, resistive index ≥0.64. The results of umbilical artery Doppler ultrasound were compared with perinatal birth weight (gold standard). 2X2 table was used to find out true positive, true negative, false positive and false negative .Sensitivity, specificity,positive predictive value, negative predictive value and accuracy were determined to validate the results.
Results: The age range of patients was from 18 years to 40 years(27.7 years ± 3.9 SD). Majority (53.7%) were true positives, 26.9% were true negatives, 10.1% were false positives and 9.3% were false negatives . Umbilical artery Doppler ultrasound had sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of 85.3%, 72.5%, 84.1%, 74.4% and 80.1% respectively. Doppler waveform (Absent or reversed) sensitivity ( 85.3%), specificity (72.5%),positive predictive value (84.1%),negative predictive value ( 74.4%) and over all accuracy (80.1%) validate the study results.
Conclusion: Umbilical artery Doppler ultrasound is an effective tool in early detection of IUGR fetuses.

Key Words: Intrauterine growth restriction, Umbilical artery Doppler waveform.

Introduction
The estimated fetal weight after second trimester during pregnancy being at or below 10th percentile for gestational age, as determined through an ultrasound, is intrauterine growth restriction (IUGR). It carries an increased risk of perinatal morbidity and mortality. Intrauterine growth restriction (IUGR) is a term used to describe a condition in which the fetus is smaller than expected for the number of weeks of Pregnancy. Newborn babies with IUGR often appear thin, pale, and have loose, dry skin. The umbilical cord is often thin and dull-looking rather than shiny and fat. IUGR can begin at any time in pregnancy. Early-onset IUGR is often due to chromosomal abnormalities, maternal disease, or severe problems with the placenta. Late-onset growth restriction (after 32 weeks) is usually related to other problems. With IUGR, the growth of the baby's overall body and organs are limited, and tissue and organ cells may not grow as large or as numerous. When there is not enough blood flow through the placenta, the fetus may only receive low amounts of oxygen. This can cause the fetal heart rate to decrease placing the baby at great risk.

The umbilical artery Doppler is a non invasive ultrasonic medical test to examine the umbilical cord of a fetus. The procedure is able to measure the amount of resistance that fetal blood meets as it travel through the placenta. This is an important measurement for pregnancy well being.

Umbilical artery Doppler ultrasound shows the ratio of peak systolic to end diastolic blood flow velocities in the umbilical artery. Abnormal umbilical artery waveform is defined by peak systolic/ diastolic ratio greater than or equal to 3 in 24 -36 weeks of pregnancy. Decreased end diastolic flow and raised Doppler indices are thought to reflect increased placental resistance caused by damage to placental tertiary villi. In more severe cases end diastolic flow may be absent or even reversed. Reversed end diastolic flow is an indication for termination of pregnancy.

High perinatal mortality has been reported in association with the finding of absent end diastolic flow velocities in the umbilical arteries. Umbilical artery Doppler study is used for prediction of adverse perinatal outcome in suspected Intrauterine Growth Restricted fetuses. The perinatal mortality rate for these infants is greater than that for normally
grown population. This can be lowered by timely identification and management of growth restricted fetuses.

**Patients and Methods**

In this cross sectional study, performed in department of Radiology, Capital Development Hospital, pregnant women (n=108) with growth restricted fetuses were studied. All pregnant women referred from gynae & obs department, for the assessment of small for gestational age fetuses were examined with umbilical artery Doppler ultrasound. Sonological diagnosis was made based on abnormal umbilical artery waveform like decreased diastolic flow, absent and reversed diastolic flow, peak systolic/diastolic ratio $\geq$3, pulsatility index $\geq$0.98, resistive index $\geq$0.64. The results of umbilical artery Doppler ultrasound were compared with perinatal birth weight (gold standard). 2X2 table was used to find out true positive, true negative, false positive and false negative (Table 1). Sensitivity, specificity, positive predictive value, negative predictive value and accuracy were determined to validate the results (Table 2).

<table>
<thead>
<tr>
<th>Ultrasound findings</th>
<th>IUGR at birth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
</tr>
<tr>
<td>Positive</td>
<td>True Positive</td>
</tr>
<tr>
<td>Negative</td>
<td>False Negative</td>
</tr>
</tbody>
</table>

**Table 2: Validation of results**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>Sensitivity = $\frac{\text{True Positive}}{\text{True Positives+False Negatives}} \times 100$</td>
</tr>
<tr>
<td>Specificity</td>
<td>Specificity = $\frac{\text{True Negative}}{\text{True Negatives+False Positives}} \times 100$</td>
</tr>
<tr>
<td>Positive Predictive Value</td>
<td>Positive Predictive Value = $\frac{\text{True Positive}}{\text{True Positives+False Positives}} \times 100$</td>
</tr>
<tr>
<td>Negative Predictive Value</td>
<td>Negative Predictive Value = $\frac{\text{True Negative}}{\text{False Negatives+True Negatives}} \times 100$</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Accuracy = $\frac{\text{True Positives+True Negatives}}{\text{True Positives+True Negatives+False Positives+False Negatives}} \times 100$</td>
</tr>
</tbody>
</table>

**Results**

A total of 108 pregnant women with growth restricted fetuses have been studied. The age range of patients was from 18 years to 40 years (27.7 years ± 3.9 SD). Majority (53.7%) were true positives, 26.9% were true negatives, 10.1% were false positives and 9.3% were false negatives (Table 3). Umbilical artery Doppler ultrasound had sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of 85.3%, 72.5%, 84.1%, 74.4% and 80.1% respectively (Table 3). Present study found a strong relationship between pregnancy outcome in IUGR babies and abnormal umbilical artery Doppler waveform (Absent or reversed) (Fig 1 and 2). Sensitivity (85.3%), specificity (72.5%), positive predictive value (84.1%), negative predictive value (74.4%) and overall accuracy (80.1%) validate the study results.

**Table 3: Cross-tabulation of ultrasound and IUGR at birth**

<table>
<thead>
<tr>
<th>Ultrasound</th>
<th>IUGR at birth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Positive</td>
<td>58 (True Positives)</td>
</tr>
<tr>
<td>Negative</td>
<td>10 (False Negatives)</td>
</tr>
<tr>
<td>Total</td>
<td>68</td>
</tr>
</tbody>
</table>

**Fig 1 - Absent diastolic flow of umbilical artery.**

**Fig 2 - Reversed diastolic flow of Umbilical artery.**

**Discussion**

Intrauterine growth restriction is associated with an increased risk of perinatal mortality, morbidity and impaired neurodevelopment. The correct detection of the compromised IUGR fetus to allow for timely intervention is a main objective of antenatal care. Intrauterine growth restriction is a common clinical sign of chronic fetal hypoxemia. It has been shown by various workers that perinatal morbidity and
mortality were significantly greater in small for gestational age babies with abnormal umbilical artery Doppler studies than in those with normal studies. Some fetuses have decreased diastolic velocity that remains constant with advancing gestation and never becomes absent or reversed which may be due to a milder form of placental insufficiency.

Doppler studies also allow more precise targeted prenatal monitoring and obstetric interventions, as pathological Doppler findings may be detected several hours to days before any abnormality, in cardiotocographic tracing. We studied 108 patients and compared our results with multiple studies. The mean age of the women selected for study was 27.7 years ± 3.9 SD. Our study results showed that in overall study population 53.7% (n=58) were true positives, 26.9% (n=29) were true negatives, 10.1% (n=11) were false positives and 9.3% (n=10) were false negatives (table 2).

Our study results showed that sensitivity, specificity, positive predictive value, negative predictive value and accuracy of 85.3%, 72.5%, 84.1%, 74.4% and 80.1% respectively. The validity of umbilical artery Doppler ultrasound has been assessed by several investigators. A study conducted by Hazra SK et al showed that the umbilical artery Doppler ultrasound has sensitivity of 86.1% and specificity of 92.8%.

A study conducted by Smitha K, Sowmya K, Malathi T showed that absent end diastolic flow waveform in umbilical artery is associated with mortality of 27.78% and reversed end diastolic waveform with mortality of 100%.

Conclusion

1. There is a strong relationship between pregnancy outcome in IUGR babies and abnormal UA Doppler waveform (Absent or reversed).
2. Surveillance of high-risk fetuses with umbilical artery Doppler ultrasound results in a marked decrease in fetal death and morbidity when compared to traditional surveillance (non-stress test).
3. All fetuses with suspected intrauterine growth restriction should undergo umbilical artery Doppler evaluation.
4. If end diastolic flow is normal, wait and then to repeat Doppler regularly along with other methods of fetal surveillance like NST and BPP, is a better approach.

References

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