Doppler ultrasound study of umbilical artery and middle cerebral arteries in pregnancies complicated by pregnancy induced hypertension (PIH) and/or intrauterine growth restriction (IUGR)

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ABSTRACT

Objectives: To evaluate the role of Umbilical artery’s and Middle Cerebral Artery’s Doppler indices as predictors of abnormal perinatal outcome.

Materials and Methods: This study was conducted in Department of Radiology, GMC Hospital, Ajman. Ongoing Study was conducted for a period of 6 Months and included 15 subjects till now.

Summary: In our method we have shown that among Middle Cerebral Artery MCA PI and Umbilical Artery UA PI pulsatility index (PI), “UAPI has the highest sensitivity and specificity. Of all the indices cerebroplacental Ratio (MCA/UA PI ratio) has more sensitivity and accuracy than others.

Conclusions: In conclusion among Umbilical Artery UA and Middle Cerebral Artery MCA PI, UA PI has the peak Sensitivity. Of all the indices Cerebro Placental Ratio has the Highest Diagnostic accuracy.

Cautious interpretation of these results in compromised pregnancies can help the clinician to intervene at the right time and thus reduce perinatal mortality and morbidity

Keywords: ultrasound, pregnancy, IUGR

INTRODUCTION

One of the foremost important causes of Intrauterine growth restriction (IUGR) is the placental insufficiency, whether primary or secondary to maternal factors such as hypertension, poor nutrition, etc. As it is associated with increased perinatal mortality and morbidity it causes an important obstetric problem. It is utmost essential to recognize placental insufficiency as early as possible to reduce its complications, if not prevented.

Hemodynamic changes occur in fetus and placental circulations easily and better understand in Doppler USG in comparison to other modalities, by this it is considered one of the vital tools in high-risk pregnancies for surveillance of fetomaternal circulations. Through this there is drastic reduction in perinatal mortality and morbidity.

The main idea and goal of our ongoing study with review of literature is to “high light the importance and usefulness of the pulsatility index (PI) of the umbilical artery (UA) and that of the middle cerebral artery
(MCA), as well as the ratio of the MCA PI to the UA PI (C/U ratio), in the diagnosis of small-for-gestational-age (SGA) fetuses and the prediction of adverse perinatal outcome1.”

MATERIALS AND METHODS
This study was conducted in Department of Radiology, GMC Hospital, Ajman, UAE.
Prospective Study was conducted for a period of 6 Months and included 20 subjects
Study Population Inclusion criteria
Singleton pregnancy in 31 to 40 weeks of gestation complicated by development of PIH and/or IUGR. Gestational dating was done with US Scan before 20 weeks (in case when LMP was not known)

Exclusion criteria
1. Any pregnancy with a documented major congenital anomaly.
2. Multiple pregnancy
Doppler US Technique

- We used Philips IU 22 MACHINE with the frequency of transducers ranging from 3.5–5.0 MHZ with wall filter of Doppler was 50–100 Hz.
- Just one important method is to allow the patients to rest for 10 to 15mins in a semi-recumbent position and then do the ultrasound investigation.
- Fetal biometry was performed initially. The wave forms were obtained during fetal inactivity and apnea.
- Umbilical artery Doppler flow velocity waveforms were obtained from a free loop of cord, and measurements taken when a clear waveform was acquired in the absence of fetal breathing or body movement.
- For MCA Doppler US, a transverse image of the fetal head was obtained at the level of the sphenoid bones.

- The UA Pulsatility index ratios were considered abnormal if the value was above the 95th percentile of previously published values for gestational age.
- The MCA Pulsatility index was considered abnormal if the value was below the 5th percentile.

Outcome Criteria
- Doppler US results were analyzed for prediction of perinatal outcome. Outcome variables included,
  - Birth Weight.
  - Perinatal death
  - Emergency CS for fetal distress
  - Low APGAR score
  - Admission to NICU for complications of LBW.
- The outcome for each pregnancy was obtained by examining the labor ward records and neonatal intensive care unit records wherever appropriate.

- The UA Pulsatility index ratios were considered abnormal if the value was above the 95th percentile of previously published values for gestational age.
- The MCA pulsatility index was considered abnormal if the value was below the 5th percentile.
- The MCA/UA PI ratio (cerebro-placental ratio) is usually constant during the last 10 weeks of gestation. Therefore, a single cutoff value (1.08) was used, above which velocimetry was considered normal and below which it was considered abnormal.

RESULTS
- Mean birth weight was 2.45 kg ( <10th ct)
- The incidence of adverse outcome was 20%.
- There were totally 20 live births.
Table 1: Comparison of diagnostic accuracy of UA PI, MCA PI, MCA/UA PI

<table>
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<tr>
<th></th>
<th>UA PI</th>
<th>MCA PI</th>
<th>MCA/UA PI</th>
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<tbody>
<tr>
<td>Present study</td>
<td>94%</td>
<td>80%</td>
<td>98%</td>
</tr>
<tr>
<td>Gramellini et al [1992]</td>
<td>84%</td>
<td>72%</td>
<td>92%</td>
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- The sensitivity, specificity, and diagnostic accuracy of UA PI, MCA PI, MCA/UA PI

DISCUSSION

“Intrauterine Growth Restriction (IUGR) is an adverse perinatal problem strongly related to the development and function of the uteroplacental and fetoplacental circulations. For the normal growth of the fetus, the adequate development of fetal circulation in appropriate time is a must and foremost important. During pregnancy many changes occur in maternal, placental and fetal vasculatures for development and nourishment of the fetus”.

The Hemodynamic changes occurring in the fetoplacental circulation is close correlation with Umbilical Artery velocimetry. As the gestational age advances the changes in UA are more obvious. As the GA progresses there is increase in diastolic flow of UA. As early as 15 wks of gestation diastolic component of umbilical artery UA started appearing and around 28-30 wks we can appreciate the mature flow. Low PI, high diastolic flow with low impedance is the typical features of normal UA waveform. In contrast normal middle cerebral artery MCA shows high pulsatile index PI, with high RI, relatively low diastolic flow.

According to one of the studies by Gramellini et al., the ratio of PI of MCA/UA “i.e. the C/U ratio will remain constant in the last 10 weeks of pregnancy”. So in our ongoing study, we used a single cut-off value of 1.08 for all cases of 30–41 weeks of gestation.

The umbilical arterial blood flow is directly correlated with the placental vascular resistance; If any changes occurs in the placental vascular resistance then it directly causes changes in umbilical blood flow. “In one of the studies by Fleischer and Schulman, they stated that in complicated IUGR with PIH, there will be an increase in UA PI due to inadequate trophoblastic invasion of the spiral arteries, leading to increased resistance in the arteries and decreased blood flow in the placental vascular bed indirectly UA”. This is termed as uteroplacental insufficiency. [Figure 1]

Figure 1: Abnormal umbilical artery waveform patterns showing markedly reduced diastolic flow and increased pulsatility index

Reduction of diastolic flow in UA with increase in PI, then absent end-diastolic volume (AEDV) and at last reverse end-diastolic volume (REDV) occur in patients with PIH as severity progresses. The prognosis of patients having absent end-
diastolic volume (AEDV), reverse end-diastolic volume (REDV) are very poor. “The Fetuses having AEDV and REDV require close monitoring and intensive surveillance as these are having poor perinatal outcome”.

As the resistance increases in placental vascular bed the oxygen supply to the fetus is compromised, in order to supply oxygen, there is relatively vasodilatation in vital organs like heart, brain with vasoconstriction in non vital organs. This brain sparing effect causes relative less PI in MCA, with abnormal C/U ratio. [Figure 2]

Figure 2: Abnormal middle cerebral artery waveform pattern shows low resistance and high diastolic flow due to cerebral vasodilatation (the brain-sparing effect)

So in overall, we came to find that with review of literature the ratio of C/U was the most important and the best predictor of SGA newborns and to analyze adverse perinatal outcome than either the MCA PI or UA PI alone. “The importance of C/U ratio demonstrated 100% specificity with high positive predictive value in diagnosing IUGR and in predicting adverse perinatal outcome”. Although the negative predictive value and sensitivity of the C/U ratio were comparable to those of UA PI, but more than those of MCA PI.

Apart from Doppler test for diagnosing and predicting the perinatal outcome in SGA there are other tests like biophysical tests available to assess fetal well-being, “the most common methods are Amniotic Fluid Volume (AFV), biophysical profile scoring (BPS) and non-stress test (NST)”, but results are inferior to Doppler tests in risk assessment.

In diagnosing the SGA fetuses Doppler tests are inferior to other modalities, it’s because uteroplacental insufficiency is just one of the causes of IUGR on contrast Doppler is very pivotal in predicting IUGR fetuses at risk for their abnormal perinatal outcomes.

CONCLUSION
In conclusion, UA and MCA PI UA PI have the Highest Sensitivity. Of all the indices Cerebro/ Placental Ratio has the Highest Diagnostic accuracy. Cautious interpretation of these results in compromised pregnancies can help the clinician to intervene at the right time and thus reduce perinatal mortality and morbidity.

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REFERENCES