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Full Length Research Paper

Additional of Umbilical and Cerebral Arteries Color Doppler Ultrasound to Foetal Biometry in Diagnosis of IUGR

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Abstract
Duplex Doppler Sonography is a reliable, non- invasive and rapid diagnostic technique in IUGR patients. Ultrasound biometry is the gold standard for assessment of foetal size. Various criteria are used to label a feotus growth restricted; foetal weight less than 10th percentile for gestational age is mostly widely accepted criterion and presence of oligohydramnios without ruptured membranes, presence of advanced placental grade can alsobe used for improving the accuracy of diagnosis. After establishing the diagnosis of IUGR, Umbilical artery Doppler waveforms reflect the status of the fetoplacental circulation and any underlying placental insufficiency. To assess the fetoplacental circulation (umbilical artery) and foetal circulation (middle cerebral artery) in the evaluation of biometrically suspected IUGR pregnancies. Descriptive and analytic study of fifty pregnancies with biometrically diagnosed IUGR. UA, MCA Doppler and Cerebro-placental ratio (CPR): had done and fetoplacental and foetal circulation was assessed.Thirteen cases showed absent umbilical artery end diastolic flow and three showed reversal of end diastolic flow. Twenty three patients (67.6%) of the thirty four cases with positive diastolic flow showed elevated PI. Adverse perinatal outcome was observed in all patients with absent and reversal of end diastolic flow. Thirty three cases 66% showed low MCA PI and six showed a pseudonormalization. A cerebro -placental ratio of < 1.08 was observed in eighteen patients, (53%) it was calculated in only those pregnancies that showed forward diastolic flow in umbilical artery (n= 34). Doppler imaging is of value for monitoring pregnancies complicated with IUGR because it can provide indirect evidence of foetal compromise. The use of foetal biometry & Doppler examination are recommended in all cases of suspected IUGR cases.

Keywords: *IUGR, Umbilical artery, Middle cerebral artery (MCA), Pulsatility Index (PI), Resistive Index (RI), Systolic to Diastolic Ratio (S/D)*

Introduction

The condition intrauterine growth restriction (IUGR) is implied to those foetuses who do not achieve their genetically determined potential size. IUGR being a major complication of pregnancy may result in significant morbidity and mortality, hence timely diagnosis is of utmost importance. The widely accepted definition of IUGR is a foetus whose estimated foetal weight is below the 10th percentile for its gestational age (1). It is generally prevalent in 3-10% of the neonates. Causes of fetus growth retardation include: 1) Maternal factors such as poor nutrition which is the most common causes of IUGR but have the least risks. Mother's hypertension is the most prevalent maternal factors associated with IUGR. 2) Factors related to placenta: In many cases of IUGR, the placenta is small and doesn't provide sufficient nutrition to the growing baby. In IUGR pregnancies, blood flow to the placenta decreases as pregnancy progresses, compared with normal pregnancy when blood flow to the placenta increases throughout pregnancy to meet the growing baby's demand for oxygen and nutrition. Cell death (apoptosis); in pregnancies complicated by IUGR, the placenta contains a relatively high proportion of cells that have a shorter life than normal. This means the placenta functions less well, thereby transferring fewer nutrients and less oxygen both to and from the baby and pre-eclampsia. 3) Factors related to fetus including major congenital anomalies (2, 3). Placenta-based intrauterine growth restriction (IUGR) is predominantly a vascular disorder. It starts with abnormal tertiary villous vessels and ends with characteristic fetal multi-vessel cardiovascular manifestations (4). These effects can be documented with Doppler ultrasound examination of a number of vessels: maternal uterine arteries and the fetal umbilical arteries for the placenta; middle cerebral artery (MCA) for preferential brain perfusion; and precordial veins for the cardiac effects of placental dysfunction. As IUGR worsens, Doppler abnormalities in these vascular territories also deteriorate (5), suggesting a sequential pattern of disease progression. This presumed sequence and the anticipation of fetal deterioration form the basis for Doppler surveillance in IUGR. Deterioration in Doppler findings typically leads to several changes in clinical IUGR management: increased monitoring frequency, administration of antenatal steroids and delivery (6).

Materials and methods

Study area

In a descriptive-analytical study fifty cases with symmetrical growth retardation pregnancies were studied in Al Zahraa university hospital and private clinic between the period of November 2012 and December 2013. Biometric parameters suggestive of IUGR are foetal weight, head circumference, Biparietal Diameter, Abdominal circumference, Femur length, Amniotic fluid index and Placental grading. Informed consent from all the patients, a detailed history was obtained from the patient focusing on risk factors

of IUGR, previous obstetric history, any associated history of pregnancy induced hypertension (PIH), Diabetes Mellitus (DM) and infections.

Fig 1: Philips IU22 colour duplex unit operating at a frequency of 1 to 5 MHz (curvilinear PureWave transducer) with pulsed and colour Doppler capability. All biometrically suspected IUGR pregnancies were enrolled in this study and Duplex Doppler ultrasound findings of foetal circulation was assessed.

Inclusion criteria: Pregnancy between 32-40 weeks shows sonographic manifestation of IUGR.

Exclusion criteria: Were pregnancy with delivery problems including pelvic inadaptability, long delivery, and pre rupture of membrane (PROM), multiple gestations and also, pregnancies with congenital abnormality.

Statistical analysis
SPSSTM, version 16 is the used statistical software program. Chi-square test was used to evaluate mean comparisons and Mann-Whitney-U test was applied to study the relationship between rank and qualitative variables. The resulted outcomes stated as frequency percentage, mean along with standard deviation and $p<0.05$ was regarded as the meaningful level.

Assessment of umbilical artery
The umbilical arteries take their origin from the two internal iliac arteries and join together to enter the umbilical cord. Maternal or placental conditions that obliterate small muscular arteries in the placental tertiary stem villi result in a progressive decrease in end-diastolic flow in the umbilical artery Doppler waveform until absent and then reversed flow during diastole are evident. (7) Reversed end-diastolic flow in the umbilical arterial circulation represents an advanced stage of placental compromise and has been associated with obliteration of 70% of arteries in placental tertiary villi.(8). There are other quantitative assessments of umbilical artery Doppler as resistance index, the systolic to diastolic (S/D) ratio and pulsatility index (PI) are commonly used to manage most cases of suspected IUGR. When end-diastolic flow is absent, the S/D ratio is immeasurable and PI may be used. Waveforms obtained near the placental end of the cord reflect downstream resistance and show higher end-diastolic flow velocity than waveforms obtained near the abdominal cord insertion. To optimize reproducibility, we suggest interrogating the umbilical artery at the abdominal cord insertion. (9)

Doppler indices: Systolic flow (A) and the diastolic flow (B) for the above mentioned arteries were obtained. Doppler indices were calculated.
· Systolic/Diastolic(S/D) ratio= A/B
· Resistance index (RI)= A-B/A
· Pulsatility index (PI)= A-B/mean

The UA pulsatility index were considered abnormal when the values were >2SD,the MCA pulsatility index was considered abnormal when the values were <5th percentile. MCA/UA PI<1 was considered abnormal (10). The reference values are according to Gramellini et al

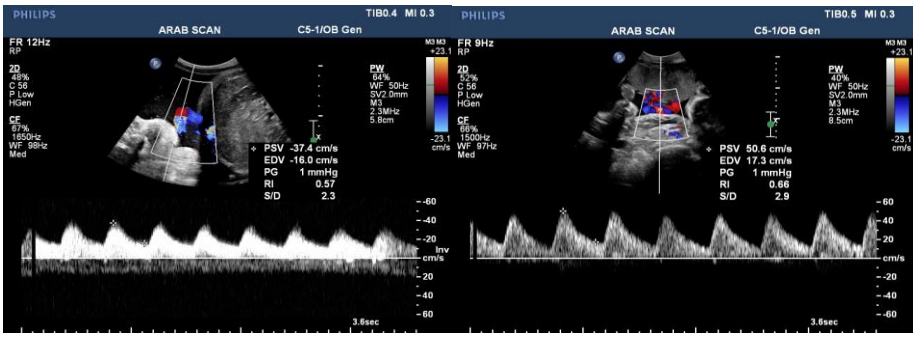


Fig 3: Showing a free floating loop of the umbilical cord and subsequently Doppler indices are obtained including RI and S/D ration

Assessment of middle cerebral artery
The middle cerebral arteries, which carry >80% of the cerebral circulation, represent major branches of the circle of Willis and are the most accessible cerebral vessels for ultrasound imaging in the fetus.The middle cerebral artery can be imaged with color Doppler ultrasound in a transverse plane of the fetal head obtained at the base of the skull. In this transverse plane, the proximal and distal middle cerebral arteries are seen in their longitudinal view, with their course almost parallel to the ultrasound beam. Middle cerebral artery Doppler waveforms, obtained from the proximal portion of the vessel immediately near the circle of Willis, have shown the best reproducibility (11). A transaxial view of the foetal head is obtained; section chosen is a plane that is slightly more caudal to the plane used for BPD measurements, which include the cerebral peduncles. Proximal part of the MCA is chosen

to place the Doppler sample volume. The angle of insonation is kept close to zero for this vessel. After obtaining a good waveform Peak systolic velocities are measured (Figure 4).

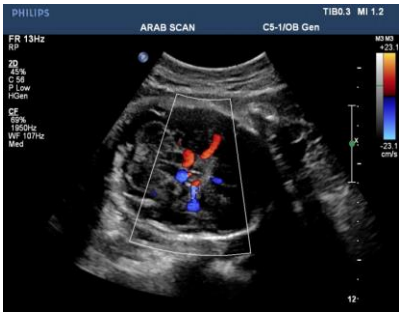
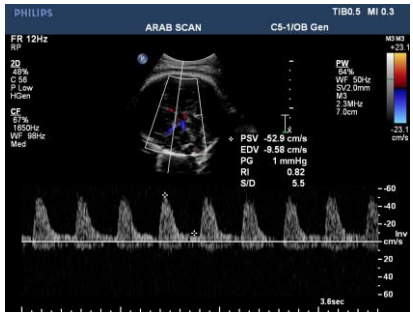
A  B 

Fig 4: Showing identification of circle of Willis including Middle Cerebral Arteries and Doppler indices

Results

Doppler study for foetal Umbilical and Middle cerebral arteries was performed on the 50 patients suspected to have intrauterine growth restricted babies on biometric parameters.

Age distribution

In our study the mean maternal age of pregnant women with IUGR babies (n=50), was in range of 18- 35 years. Higher incidence was noted in women in the 20-30 years age group (n=44). This was followed by patients that constituted the < 20 age group or >30 years age group.

Table 1: Age distribution of cases.

APAG Age in GAGEEAG	Number	Percentage
<= 20	5	10%
21-25	22	44%
26-30	22	44%
>30	1	2%
Total	50	100%

Parity distribution: Primipara (n=28) constituted 58% and multipara (n= 22) constituted 42 %. In this study multiparous patients were marginally less than the primi group. Percentage

Table 2: Parity distribution.

P Parity y	Number of cases NNNNNNIIUCJB	P Percentage
Primi	28	56%
Multi	22	44%

Placental grading*:* The proportion of Grade III placenta was higher among growth restricted babies as compared to Grade II.

Table 3: Distribution of placental grade of cases

Placental grade	Number of cases	Percentage
Grade II	15	30 %
Grade III	35	70 %

Placental Grade Number (n=) Percentage

Distribution of gestational age at Doppler examination

In the study group of 50 pregnant mothers, the gestational age at the time of Doppler examination ranged between 30 to 39 weeks.

Table 4: Distribution of gestational age at Doppler examination.

Gestational age	Number of cases	Percentage
30-34 weeks	11	22%
35-37 weeks	15	30%
>37 weeks	24	48%
Total	50	100%

Gestational age Number (N= 50) Percentage

Amniotic fluid index

Growth restricted babies showed a high association with oligohydroamnios. Thirty percent of pregnancies had a normal amniotic fluid index and seventy percent of pregnancies had Oligohydromanios.

Table 5: Showing Distribution of AFI in cases.

Amniotic fluid index	Number	Percentage
Normal	**15**	30 %
Oligohydromanios	**35**	70 %
Polyhydramnios	**0**	**0**

Amniotic fluid index Percentage

Umbilical artery Doppler parameters: End diastolic velocity flow patterns of foetal umbilical artery**:** In our study thirteen growth restricted foetuses showed absence of diastolic flow (26%) and three showed reversal of flow (6%).

Table 6: Distribution of end diastolic flow of umbilical artery. End diastolic

End diastolic flow pattern	Number (50)	Percentage
Positive diastolic flow	34	68%
Absent	13	26%
Reversal	3	6%

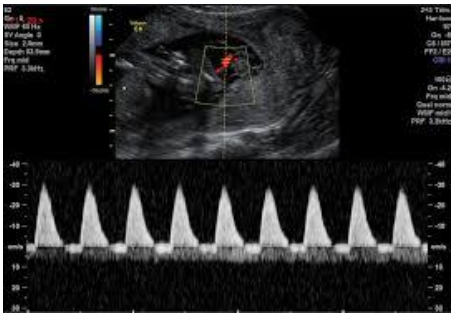
A)  **B)** 

Fig 5: Umbilical artery duplex with A) absent end diastolic flow B) Reversed flow

Table 7: Umbilical artery Resistive Index (RI)

Out of the 32 cases with forward diastolic flow, twenty `five showed elevated RI.

RI	Number (32)	Percentage
Normal	7	21.8
Elevated	25	78.1
Total	32	

Table 8: Umbilical artery Systolic to Diastolic ratio (S/D)

Twenty one cases showed elevated S/D ratios and eleven showed normal values.

S/D	Number (34)	Percentage
Normal	12	35.3
Elevated	22	64.7
Total	34	100%

Umbilical artery Pulsatility Index (PI): The pulsatility index was calculated in all those patients who showed a forward positive end diastolic flow who recording thirty four cases. The pulsatility index was elevated in twenty three patients and normal in eleven patients.

Table 9: Distribution of PI of umbilical artery

PI	Number (34)	Percentage
Elevated	23	67.6%
Normal	11	32.4%
Total	34	100%

Middle cerebral artery Doppler study

Pulsatility index (PI) of Middle cerebral artery: Out of the 50 cases seventy two percent showed reduced PI and twelve percent showed pseudonormalization.

Table 10: Pulsatility index (PI) of middle cerebral artery

PI	Total (50)	Percentage
Normal	11	22%
Decrease	33	66%
Pseudodecrease	6	12%

PI Total (n= 50) Percentage

Resistive Index (RI) of Middle cerebral artery

Total of twenty seven patients showed reduced RI and six showed pseudonormalization.

Table 11: Resistive Index (RI) of Middle cerebral artery

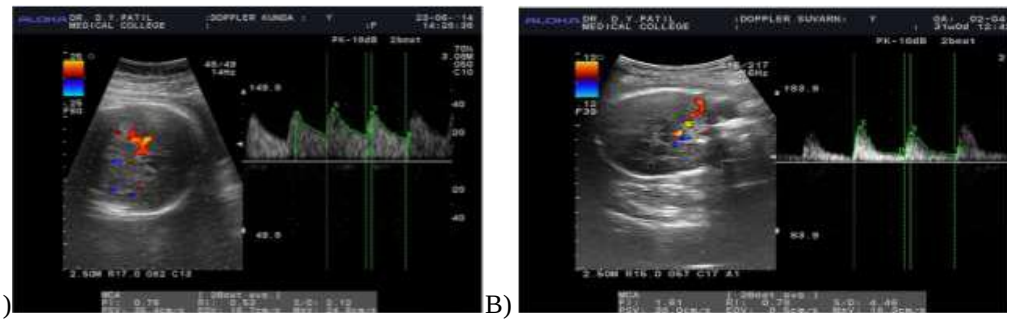
RI	Total (50)	Percentage
Normal	17	34%
Decrease	27	54%
Pseudonormmalization	6	12%

RI S/D ratio of middle cerebral artery: Twenty nine patients out of fifty showed reduced S/D ratios.

Table 12: S/D ratio of middle cerebral artery

RI	Total (50)	Percentage
Normal	15	30%
Decrease	29	58%
Pseudonormmalization	6	12%

A



) B)

Fig 6: A)Showing reduced Doppler indices reflecting "Brain sparing effect" in the MCA. B) Showing a pseudo-normalization of Doppler indices in the MCA due to underlying cerebral oedema (Reversal of Umb a diastolic flow was noted in the same patient).

Cerebro-placental ratio (CPR): Pulsatility index of MCA: Pulsatility index of Umbilical artery- Determinant of foetal blood flow redistribution. This ratio was calculated in those patients that showed a forward positive end diastolic flow in the umbilical artery. A ratio of less than 1.08 is an indicator of redistribution of blood to the foetal brain.

Table 13: (PI) of MCA: PI of umbilical artery

MCA/UMB A PI	Number (34)	Percentage
<1.08	18	53%
Normal	16	47%
Total	34	

Discussion

The pathophysiology of intrauterine growth restriction cannot be pinned down to one specific cause it results due to a series of events occurring along several possible pathways. Accurate antenatal diagnosis therefore distinguishes between the foetus which is constitutionally small for gestational age or a foetus which is growth restricted due to a consequence of impaired placental perfusion. Doppler flow velocity analysis aids in solving this problem. An assessment of umbilical arteries (Fetoplacental circulation) and middle cerebral artery (foetal circulation) can help in diagnosing at risk fetuses. Our study included 50 pregnant women, who were suspected to have foetuses with intrauterine growth restriction based on biometric parameters. Even after years of research and extensive study no definite universally accepted standard for defining abnormal Doppler flow velocity waveforms has been proposed, so the problem of conflicting observations might continue to emerge. But over the years literature has supported the use of certain standard cut offs which have improved the perinatal morbidity and mortality associated with at risk foetuses. In their study, Rhee et al stated that Doppler sonography in pregnant women play a significant role in evaluating fetus growth condition as well as studying IUGR pregnancies (12). In our study, abnormality rate of fetus middle cerebral, umbilical

and Cerebro-placental ratio was observed in IUGR pregnancies. In agree with Sohn et al, In their study suggested that abnormal results of fetus Doppler sonography are effective factors in appearing abnormalities including IUGR (13). Among women where a cause for IUGR was identified, 42% had pregnancy induced hypertension (PIH). In a study by Bhatt et al, the association between PIH and IUGR was demonstrated. In this study detect a strong correlation between high placental grade (Grade III) and IUGR. Sixty six percent patients showed Grade III placenta and thirty four percent patients showed Grade II. This is further associated with adverse perinatal outcome due to its direct relation to the fetoplacental circulation that in turn is reflected in the foetal circulation. This has been highlighted in a study by K. H. Chen et al in 2010. All growth restricted pregnancies showed oligohydroamnios as another common association. Seventy six percent had a lower amniotic fluid index against twenty four percent who had a normal amniotic fluid index. In a study by Arora et al, they highlighted the increased risk of oligohydroamnios in growth restricted foetuses with abnormal Doppler indices, as an associated finding in their study group.

In our study sixty four percent (n=32) of the pregnancies showed a positive diastolic flow, whereas fourteen (28%) had absent diastolic flow and four (8%) had reverse diastolic flow Ghosh GS, et al studied 353growth restricted pregnancies and observed abnormal umbilical artery parameters in 102 patients. Shah Nehal et al and Yildrim et al emphasized the above observation in their studies, stating that absent and reverse diastolic flow are associated with a higher morbidity and mortality. The Doppler indices were calculated in the 32 pregnancies that showed forward diastolic flow. Out of the thirty two patients, 68.7% (n= 22) showed elevated PI values..7 Out of the patients showing elevated PI (n=22) and absent/ reversal of diastolic flow (n=18). In a study by Wladimiroff et al, he stated that there is a linear decline in PI and RI values according to advancing gestational age, whereas elevated PI and RI values are observed in IUGR. Middle cerebral artery as an adaptation to hypoxemia there is redistribution of blood flow during early stages; this is called the brain sparing reflex. Reflected as a decrease in PI and RI due to increased end diastolic flow. In our study we found low MCA PI in 72 % (36 cases). 66% (33 cases) cases were associated adverse perinatal outcome. The fall in Doppler indices was the foetus's adaptive mechanism to hypoxemia mentioned in literature as "brain sparing effect". Mari et al stated that evaluating fetus middle cerebral artery provide us useful information required for assessing IUGR fetuses conditions.

Shahina Bano et al also stressed on the above mentioned observation that if hypoxia persisted diastolic flow in the MCA returns to normal. In our study of fifty pregnancies thirty two cases showed positive umbilical diastolic flow (including those with high resistance; high PI) cerebroplacental ratio was calculated. Fifty percent (n=16) cases showed a ratio of less than 1.08 and was considered abnormal. Out of them 46.8 % (n= 15) cases showed adverse outcome. Considering Doppler parameters of umbilical artery and middle cerebral artery separately, 68.7% showed elevated umbilical artery PI and 56.2% cases showed low MCA PI values. Thus, highlighting that CPR is a better indicator of predicting adverse perinatal outcome than either umbilical artery PI or MCA PI alone.

Conclusion

Fifty patients with biometrically suspected Intrauterine Growth Restricted Foetuses were included in this study. Ultrasound evaluation followed by Duplex Doppler evaluation of the Fetoplacental and Foetal circulation was conducted. Observations from our study are as follows: Majority of the patients forming our study was in the age group of 20 to 30 years and most of them were Primi Gravida. Associated risk factors were PIH, DM and anaemia, PIH was the most common risk factor. Pathologically Growth restricted Foetuses showed abnormal Trends in the Doppler Indices-Elevated Indices in Umbilical artery and low Indices in MCA. Fourteen cases showed absent umbilical artery end diastolic flow and four patients showed reversal of end diastolic flow. Twenty two patients showed elevated PI. A cerebro -placental ratio of < 1.08 was observed in 16 patients, it was calculated in only those pregnancies that showed forward diastolic flow in umbilical artery (n=22). Results of the above-mentioned study make it clear that evaluating Doppler sonography of middle cerebral, umbilical and left and right uterine arteries in pregnant women provide us useful information.

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