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Evaluation Of Intrauterine Growth Retardation, It's Correlation With Various Risk Factors Using USG Fetal Parameters, Doppler Indices And Its Implementation In Perinatal Outcome Among The Rural Population Of Puducherry

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Abstract

Background:

Intrauterine growth restriction (IUGR) is a condition in which a growing foetus cannot grow to its genetically determined maximum size. The risk of perinatal mortality and morbidity is four to eight times higher in women who have IUGR. Half of the IUGR children that survive have severe morbidity.

Various risk factors like maternal hypertension, Diabetes, Oligohydramnios, Advanced age, placental grade and gravida has been linked with IUGR. To some extent, accurate and prompt diagnosis of IUGR helps reduce negative pregnancy outcomes.

Doppler studies are used to evaluate IUGR fetuses by looking at Uterine artery Doppler spectral waveforms and fetal arterial spectral waveforms.

Methods:

My study was a cross-sectional prospective study comprised of 100 pregnant women referred from the Department of Obstetrics and Gynecology, Sri Lakshmi Narayana Institute of Medical Sciences, 50 pregnant females had suspected IUGR and rest 50 were taken as control

Results:

The gold standard for determining fetal size is fetal biometry. Other associated factors such as high HC/AC ratio, elevated FL/AC ratio, and presence of oligohydramnios without ruptured membranes and placental grading are used for better results.

Interpretation & Conclusion:

Pulsatility index, resistance index, systolic/diastolic, persistence of uterine artery diastolic notch, absence & reverse diastolic flow in umbilical artery are all associated with utero-placental insufficiency found with IUGR. The Brain–Sparing Reflex, which is indicated by a reduction in Pulsatility index, resistance index, systolic/diastolic ratio of MCA, Cerebroplacental and Cerebro-umbilical ratio occurs in the context of fetal hypoxaemia.

Keywords: Fetal biometry, Fetal Doppler, Ultrasonography, Intrauterine Growth Retardation

Introduction

Fetal intrauterine growth restriction (IUGR) is described as a small for gestational age (SGA) foetus with an estimated foetal weight (EFW) less than the 10th percentile for gestational age1. This is used clinically since perinatal death and morbidity are considerably higher in this group2. The prevalence of

LBW is estimated to be 26% in India, while the proportion of IUGR is estimated to be 54%.3. The inability of a fetus to reach its anticipated development rate has been caused by a variety of factors, the most frequent of which is utero-placental insufficiency. Insufficiency of the placenta causes compensatory alterations in the fetal circulation. IUGR is linked to an elevated risk of perinatal death and morbidity by eight times. Half of the IUGR children that survive have severe morbidity4.

Doppler studies are used to evaluate IUGR babies by looking at uterine artery Doppler spectral waveforms and foetal arterial spectral waveforms. The evidence of utero-placental insufficiency is shown by deranged uterine artery Doppler parameters5. Within the myometrium, uterine arteries split into separate arteries. Later in the first trimester, extra villous trophoblast infiltrate the spiral arteries, converting them from high to low resistance vessels and generating vasodilator peptides that act locally in the decidua and myometrium.

Uterine blood flow is 50 ml per minute in non-pregnant women, but it can exceed 700 ml per minute during the third trimester of pregnancy6. By 18-22 weeks in normal pregnancies, the uterine artery's Doppler waveform shows a modest peak flow velocity and no diastolic notch. MCA Doppler investigations reveal the hemodynamic alterations that occur when a foetus is hypoxic. Blood flow is shifted centrally in the presence of foetal hypoxaemia, with increased cranial flow and reduced peripheral and placental flow7. The brain-sparing reflex is a sort of blood flow redistribution that assists in foetal hypoxaemia response.

When placental insufficiency develops, the fetus' essential organs lose their ability to operate, resulting in severe compromise, acid base problems, and even death[7]. Reduced S/D ratio, decreased resistance index, and reduced PI in the MCA show the brain sparing phenomenon that the fetus adopts in the case of IUGR[8].

This study used USG fetal biometry and Doppler spectral waveform analysis to evaluate IUGR fetuses. This thesis work was done in the Department of Radio-Diagnosis of SLIMS in conjunction with the Department of Obstetrics and Gynecology.

Material And Methods

This is a cross-sectional prospective study conducted in the department of Radio-diagnosis, SLIMS, in conjunction with the department of Obstetrics and Gynecology. The study comprised of 100 pregnant women referred from the Department of Obstetrics and Gynecology, Sri Lakshmi Narayana Institute of Medical Sciences, 50 pregnant females had suspected IUGR and rest 50 were taken as control.

Following patient's consent, a comprehensive history was gathered from each patient by questionnaire method. Diabetes, Hypertension, asthma, kidney illness, heart conditions, and other medical conditions were also identified. The last menstrual cycle and/or an early ultrasound examination were used to determine gestational age. A physical examination followed by taking patient's history, Ultrasound examinations were performed on all of the patients using an Ultrasonography equipment SONIX SPQ+. The carrier frequencies utilized were 3.5 MHz and 7.5 MHz

The Hadlock equations, which employs FL, AC, and BPD, were used to calculate the foetal weight. Small for gestational age (SGA) newborns were categorized as those weighing less than the 10th percentile, while those weighing in 10th and 90th percentiles were classed as appropriate for gestational age (AGA) babies.

A pulse wave Doppler ultrasound was performed after that. Once the placental position was confirmed, the uterine artery (Ut.A) was explored. The mean of the bilateral uterine arteries was estimated if the placenta was central. A sample spot was chosen at the cervico-uterine junction, where the uterine artery intersected the external iliac artery. The internal carotid artery was used to sample MCA near its origin in between 1/3rd and 2/3rd distance.

The waveforms gathered from these vessels were estimated by the USG machine. For each cardiac cycle, the programme calculated peak systolic velocity, end diastolic velocity, mean velocity, Pulsatility index, resistance index and systolic/diastolic ratios.

Inclusion criteria:

1. Singleton pregnancy with disparity of USG fetal LMP parameters.
2. Gestational age from 28 weeks to term (3rd trimester).

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3. Oligohydramnios.
4. Early dating scan ultrasound reports in case of established wrong dates to calculate the Last Menstrual Period.
5. Fetus with no congenital anomalies

Exclusion criteria:

1. Multiple gestation.
2. Fetus having major congenital anomalies.
3. Less than 28 weeks pregnancy.
4. Macrosomic infants.
5. Intrauterine death (IUD).

The following characteristics are measured:

Pulsatility index, resistance index.

Systolic/diastolic ratio.

Uterine notch.

Absence or reversed end diastolic flow in UA.

Cerebroplacental index (CPI).

Cerebral-umbilical index (CU).

An Umbilical artery S/D of more than 3, An Uterine artery S/D of more than 2.6 and a Middle Cerebral Artery S/D of more than 4 is abnormal[9]. Preterm MCA PI of more than 1.45 and term MCA PI of 1 is typical. A CPI of 1 (MCA RI/UA RI) indicates that something is wrong[10]. CUI < 1.08 denotes brain-sparing effect[11].

The OBGY department provided information on pregnancy outcomes, delivery records including age at birth, mode of delivery, indication of Caesarean, birth weight, Apgar score, and Neonatal ICU hospitalization.

Results and Discussion:

A total of 100 cases were included in the study, Of 50 IUGR suspected cases, 35 cases (about 2/3rd) were actually small for gestational age (SGA) and 15 cases had fetuses appropriate for gestational age (AGA) and were included in the control group. The mean age of the pregnant women with SGA babies were significantly higher as compared to those women who had AGA babies.

Of these 100 cases, 62 were primigravidae and 38 were multigravidae. There was no significant statistical difference in the pregnancy outcome by Gravida of the patients.

Among the risk factors, those patients with hypertension were more likely to have SGA babies as compared with other risk factors like urinary tract infection, respiratory tract infection, asthma etc. The proportion of abnormal HC/AC ratio (>1) is higher among the SGA babies as compared to AGA babies and the difference was clinically significant. The sensitivity, specificity Positive predictive value, Negative predictive value of HC/AC ratio in detecting Short for gestational age are 84.8%, 92.3%, 84.8%and 89.5% respectively.

Abnormal FL/AC ratio was significantly higher among SGA babies as compared to AGA babies. The sensitivity, specificity, Positive predictive value , Negative predictive value of FL/AC ratio in detecting Short for gestational age are 57%, 92.3%, 80% and 80% respectively. SGA babies were significantly more likely to have oligohydramnios as compared to AGA babies. The proportion of Grade III placenta was higher among SGA babies as compared to AGA babies.

Of 100 cases studied, 29 cases had abnormal Doppler studies and SGA fetuses were significantly more likely to give abnormal Doppler readings. The mean (SD) of Uterine Artery Pulsatility index and Resistive Index were higher in SGA babies than AGA babies and the difference was statistically significant. Mean Systolic/Diastolic ratio of uterine Artery was higher in SGA babies compared to AGA babies. Sensitivity, Specificity, Positive predictive value & Negative predictive value of Uterine artery S/D Ratio in detecting SGA are 60%, 87.7%, 72.4% and 80% respectively.

Uterine artery diastolic notching was seen in 11 SGA fetuses, 8 of them had unilateral notching and 3 had bilateral notching, 8 of them had maternal hypertension. The mean (SD) of Uterine Artery Pulsatility Index and resistive index were higher in SGA babies than AGA babies. Mean S/D ratio of umbilical Artery was higher in SGA babies compared to AGA babies. Sensitivity, specificity, Positive predictive value and Negative predictive value of Umbilical artery S/D in detecting SGA are 48.5%, 93.8%, 80.9% and 77.2% respectively.

There was one neonatal death which was associated with absent diastolic flow in the umbilical artery and bilateral uterine notching at 36 weeks, the mother also had pre-eclampsia. The mean (SD) of MCA PI

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and RI were lower in SGA babies than AGA babies. Abnormal MCA S/D ratio was significantly more in the SGA fetuses.

Sensitivity, Specificity, Positive predictive value and Negative predictive value of MCA S/D in detecting SGA fetuses were 71.4%, 75.9%, 62.5% and 83.3% respectively. The proportion of CPI ≤ 1 indicative of brain sparing effect were significantly higher in the SGA fetuses. Sensitivity, specificity, positive predictive value and negative predictive value of CPI in detecting brain sparing were 48.5%, 93.8%, 80.9% and 77.2% respectively. The proportion CU index ≤ 1.08 indicative of brain sparing effect were significantly higher in the SGA fetuses. Sensitivity, specificity, positive predictive value and negative predictive value of CU index in detecting brain sparing were 45.7%, 100%, 100% and 77.3% respectively.

Overall there were only 4 preterm cases of which 3 were in the SGA group. Most of the SGA fetuses were of term size. There was no significant difference in the gestational outcome by maturity of the babies. Out of 100 cases, 61 cases delivered vaginally of whom 3 cases required instrumental delivery. Caesarean sections were performed in 39 cases(significantly higher in SGA fetus group). In case of SGA babies acute fetal distress (AFD) was the indication for Caesarean section in majority of cases.

The mean gestational age at the time of delivery of the AGA babies (39.15 W)were significantly higher as compared to the mean gestational age at delivery of the SGA babies(38.17 W). SGA fetuses had lower birth weight (2.103 Kg) as compared to AGA fetuses(3.174 kg) and the finding was statistically significant. SGA babies were significantly more likely to have Apgar score <7 as compared to AGA babies. SGA babies were more likely to be admitted in the NICU as compared to the AGA babies.

Sensitivity, Specificity, Positive predictive value and Negative predictive value of various fetal parameters and Doppler spectral parameters

	HC/AC	FL/AC	UTERINE ARTERY S/D	UMBILICAL ARTERY S/D	MCA S/D	CEREBRO-PLACENTAL INDEX	CEREBRO-UMBILICAL INDEX
Sensitivity	84.8%	57.1%	60%	58.5%	71.4%	48.5%	45.7%
Specificity	92.3%	92.3%	87.6%	93.8%	75.9%	93.8%	100%

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PPV	84.8%	80%	72.4%	80.9%	62.5%	80.9%	100%
NPV	89.5%	80%	80.2%	77.2%	83.3%	77.2%	77.3%

Conclusion:

Out of 100 patients in our research, 50 were suspected IUGR cases and the other 50 were controls. 35 (70%) of the 50 suspected cases were SGA newborns, whereas 15 (30%) were AGA babies. Doppler abnormalities were seen in 23 of 35 SGA infants(66%). SGA mothers had a greater average age as compared to mother of AGA infants. SGA infants had a high Head Circumference /Abdominal Circumference ratio, a lower Femur Length /Abdominal Circumference ratio. They also had a higher placental grade. Among the many risk factors for IUGR in our study, hypertension was most important risk factor that was also acknowledged by other researchers. The Brain–Sparing phenomenon, which is indicated by reduction in PI, RI, S/D ratio of Middle Cerebral Artery occurs in the context of foetal hypoxaemia.

The uterine and umbilical arteries' Pulsatility Index, Resistive Index and Systolic/Diastolic ratios were substantially higher in SGA babies than in AGA babies, whereas the MCA Pulsatility Index, Resistive Index and Systolic/Diastolic ratios were less in Short for gestational age infants than in Appropriate for gestational age infants. The early Notching of the Ut. artery was found in 11 cases , and all of them gave birth to SGA infants. In 8 out of 11 cases, hypertension was the risk factor. Two examples of absent diastolic flow and reversed diastolic flow each were found, and the fetuses died in-utero.

SGA newborns had a higher CS rate than AGA fetus, as well as a low age, low weight, less Apgar score, and NICU hospitalization. Acute Fetal Distress (AFD) was the most common reason for CS in women with SGA infants . In earlier studies the main vessels used for IUGR detection was MCA and Umbilical artery, however our study also utilized Uterine artery for more accurate interpretation of IUGR. The outcomes of this study back up the conclusions made by majority of the researchers. The study's flaws were the small sample size and the absence of venous Doppler. To conclude, In all suspected IUGR cases, foetal biometry and Doppler studies are indicated because alterations in umbilical, uterine, and MCA arteries Doppler parameters significantly correspond with pregnancy outcome in growth restricted babies.

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ILLUSTRATIONS:

Normal fetal Biometry:

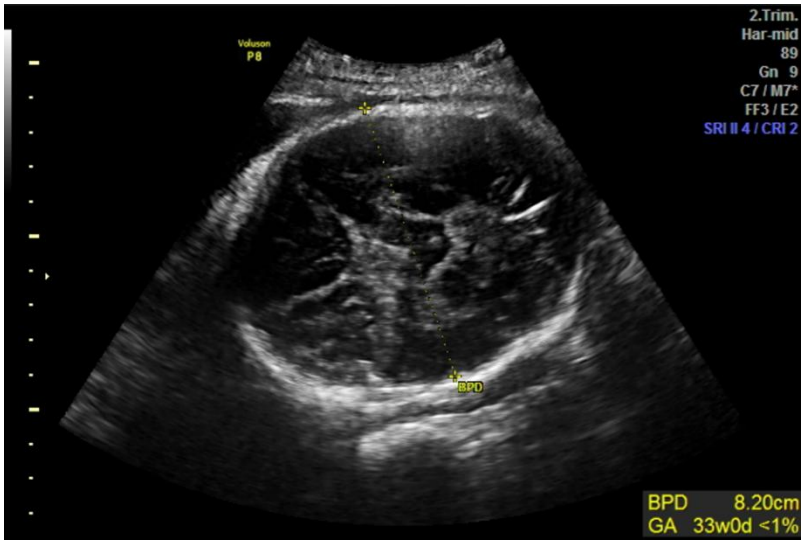

Figure: 1

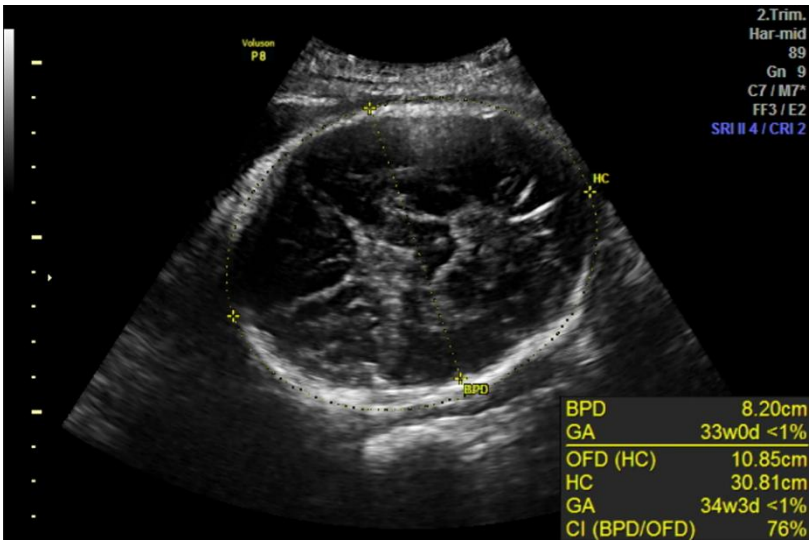

Figure: 2

Figure 1 and 2: Normal Bi-parietal diameter and head circumference of a 34W3D fetus with no risk factors and abnormal fetal Arterial Doppler parameters. Postnatal outcome is good without any complications.

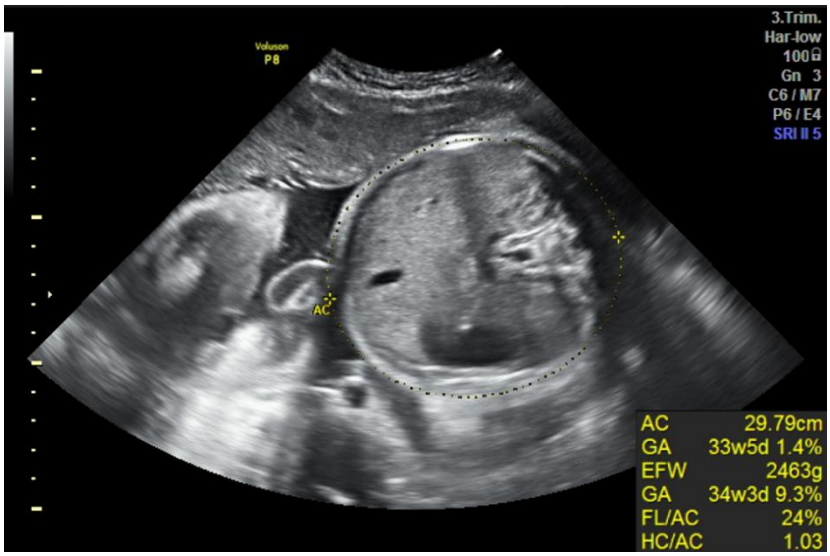

Figure: 3

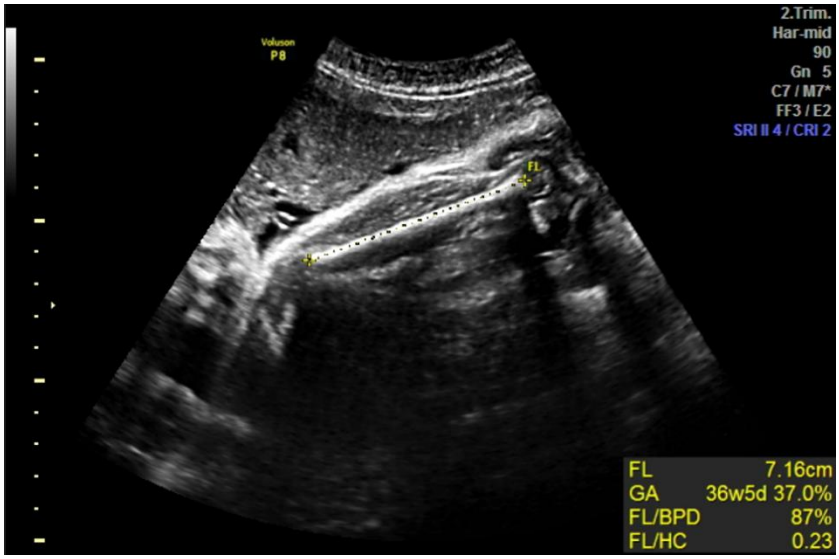

Figure: 4

Figure 3 and 4: Normal Abdominal circumference and femur length of a 36W5D fetus with no biometric and Doppler parameters abnormality, no associated maternal risk factors and complications.

Normal fetal arterial spectral waveform:

1) Umbilical Artery

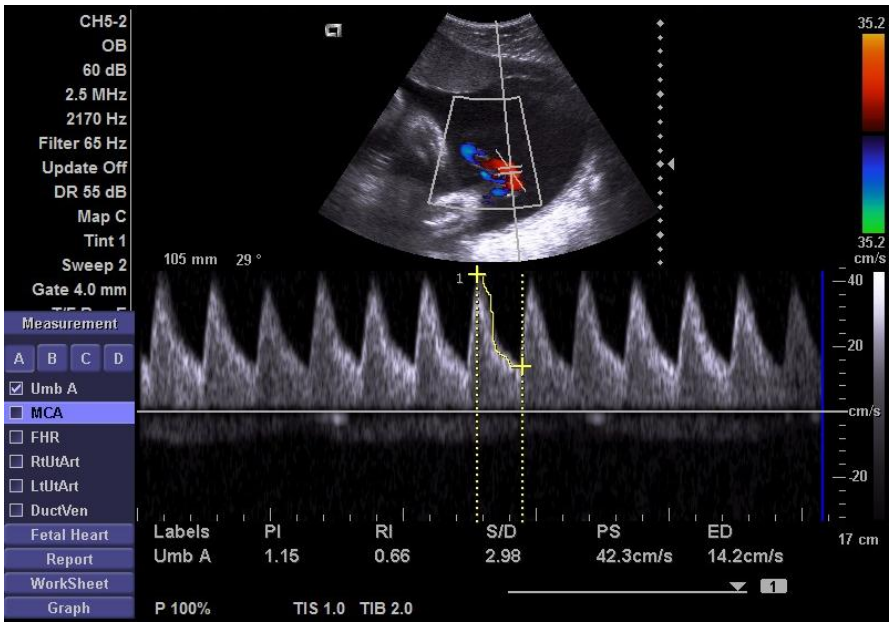

Figure: 5

Gestational age - 31 w 1 day.

Resistive index - < 0.8

Pulsatility index - < 1.24

Systolic/Diastolic ratio - ~ 3.9 - 2.1 (Decreases towards term)

The umbilical arterial waveform usually has a "Saw-tooth" pattern with Rapid systolic upstroke and continuous forward diastolic flow suggestive of Low resistance flow.

2) Middle Cerebral Artery

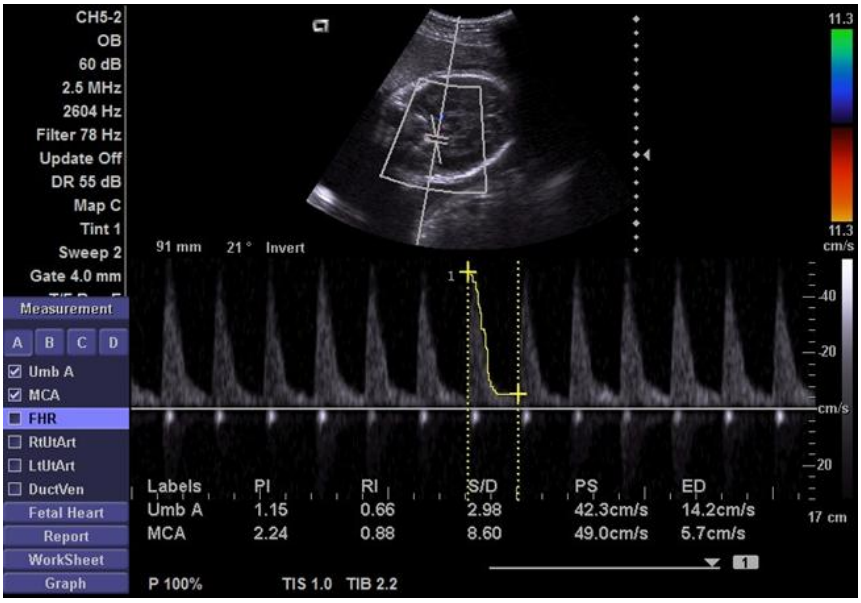

Figure: 6

Gestational age - 31 w 1 day.

Resistive index - > 0.8

Pulsatility index - > 1.4

Systolic/Diastolic ratio - Always be higher than umbilical A.S/D ratio

The Middle cerebral arterial waveform usually has a High systolic velocity and minimal diastolic velocity suggestive of high resistance flow.

3) *Uterine Artery*

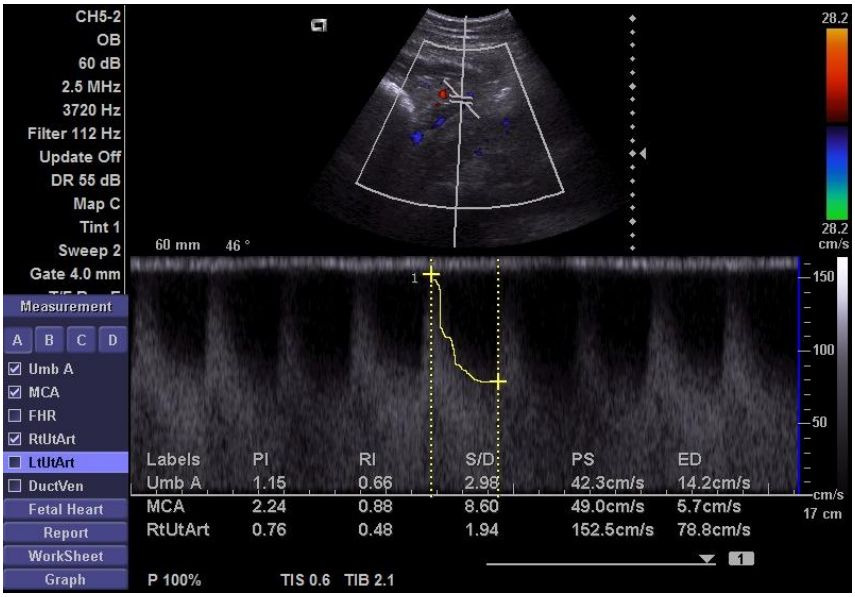

Figure: 7

Gestational age - 31 w 1 day.

Resistive index - < 0.8

Pulsatility index - < 1.2

Systolic/Diastolic ratio - ~ 1.8 - 1.9

The Uterine arterial waveform usually has a High systolic velocity and continuous diastolic flow suggestive of Low resistance flow.

Abnormal arterial spectral waveforms:

1) *Umbilical artery:*

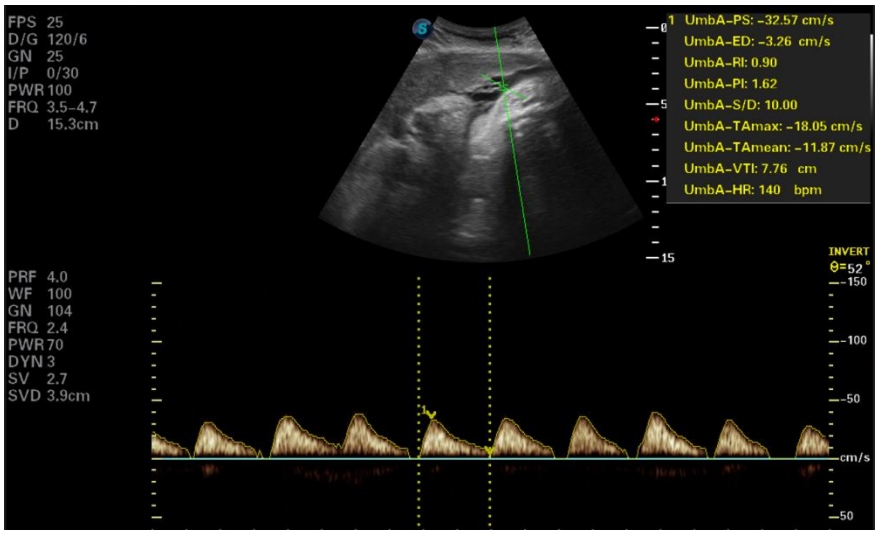

Figure: 8

Umbilical artery - Reduced diastolic flow.

- Gestational age - 31 w 2 days.
- Increased Resistive index.
- Increased Pulsatility index
- Associated deranged MCA Doppler parameter with reduced AC/HC ratio.
- Risk factor - Maternal hypertension
- Associated feature - Oligohydramnios.
- Outcome - Fetal distress

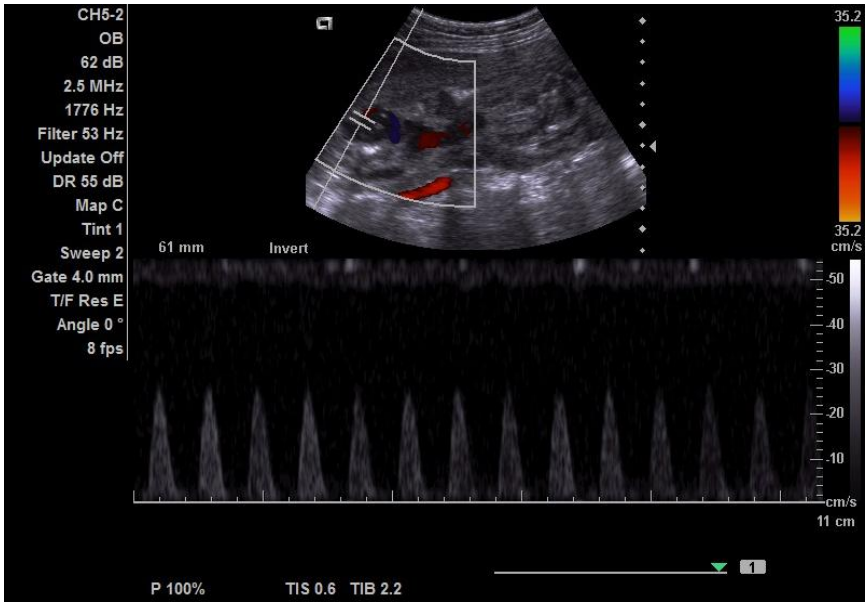

Figure: 9

Umbilical artery - Absent diastolic flow.

- Gestational age - 30 w 5 days.
- Increased Resistive index.
- Increased Pulsatility index
- Associated deranged MCA Doppler parameter with increased FL/AC ratio and reduced HC/AC ratio.
- Risk factor - Maternal hypertension
- Associated feature - Oligohydramnios.
- Outcome - Caesarean delivery, NICU admission due to severe Fetal distress and finally Died after 7 days.

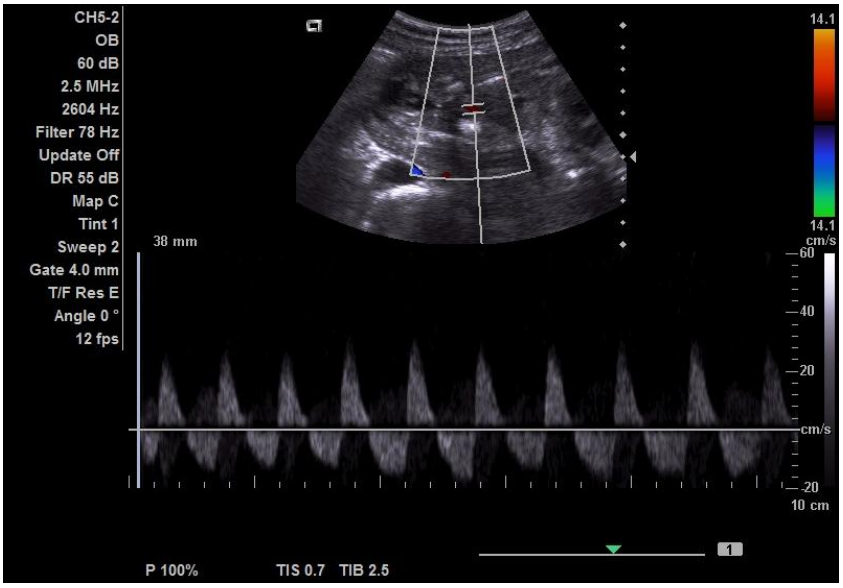

Figure: 10

Umbilical artery - Reversed diastolic flow.

- Gestational age - 31 w 4 days.
- Increased Resistive index.
- Increased Pulsatility index
- Deranged biophysical profile - 4/8.
- Risk factor - Maternal hypertension and urinary tract infection.
- Associated feature - Severe Oligohydramnios.
- Outcome - Intrauterine demise.

2) Uterine artery

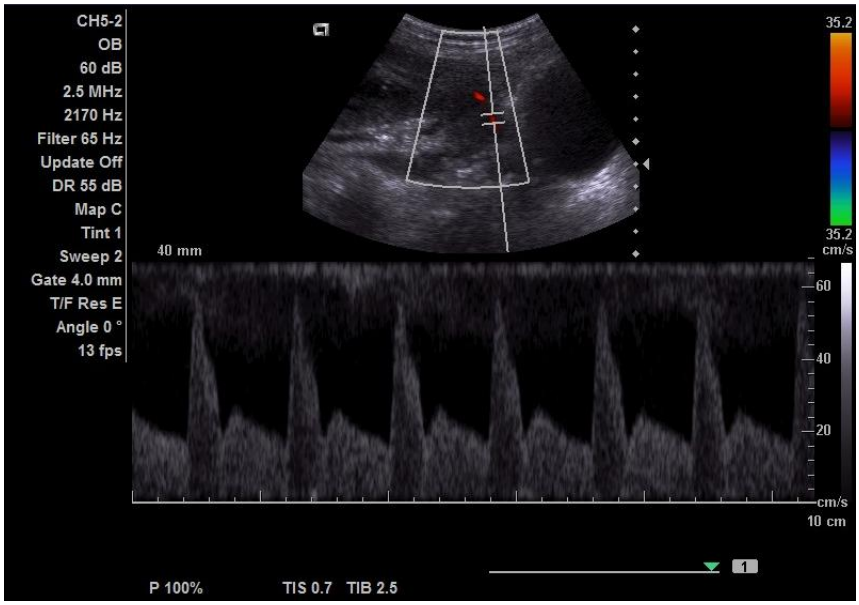

Figure: 11

Uterine artery - Diastolic notch.

- Gestational age - 31 w 5 days.
- Increased Resistive index.
- Increased Pulsatility index (>1.4)
- Apgar score 6
- Risk factor - Maternal hypertension
- Associated feature - Pre-eclampsia
- Outcome - Premature delivery (35w3d) - NICU admission due to fetal distress.

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