

## **CPR is Better Predictor of Intrauterine Growth Restriction as Compare to Individual Artery Examination**

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### **Abstract**

**Purpose:** In clinically suspected cases of intrauterine foetal growth restriction, the study set out to see how well doppler indices measured in the uterine artery, umbilical artery, and middle cerebral artery and which artery is better predictor of IUGR and might better predict perinatal outcome or neonatal growth.

**Material and Methods:** Doppler ultrasonography of the uterine artery, umbilical artery, and middle cerebral artery was performed on 96 pregnant women who were beyond the 26-weeks' gestation and suspected of carrying a baby with intrauterine growth restriction.

**Results:** Approximately 96 pregnancies were analyzed when IUGR was suspected based on clinical criteria. The average birth weight was  $2.3 \pm 0.519$  kg. Nearly half of all newborns (n=46) weighed less than 2.5 kilogram at delivery. Of the fetuses studied, 64.58 percent (n=62) had at least one undesirable outcome. The remaining 35.41% (n=34) of the pregnancies were successful. Out of a total of 89 births, 7 women passed away from complications within the womb. There were 89 live births, and 41 of the newborns were hospitalized to a neonatal intensive care unit. At 5 minutes, 42 of the newborns had an APGAR score of less than 7, and 16 of the births were deemed urgent enough to need caesarean section. An examination of the pulsatility index in the uterine artery had a sensitivity of 54.83 percent for predicting a negative perinatal outcome.

The sensitivity of umbilical artery Doppler ultrasonography with PI for predicting neonatal outcome was 64.51 percent. Doppler tests of the umbilical and uterine arteries together were more sensitive than studies of either arterial alone. The CPR / cerebro placental ratio (93.54 percent) is a more reliable predictor of intrauterine growth restriction and worse perinatal outcome than either the middle cerebral artery or the umbilical artery alone.

**Conclusion:** The cerebro umbilical ratio (MCA/UA PI) is more indicative of a bad delivery outcome when IUGR is suspected than either an abnormal MCA PI or Umb A PI alone (93.54 percent vs. 64.51 percent, 70.91 percent respectively). However, the MCA/UA PI Ratio generally provides more insightful results than just comparing the two PIs. Diastolic flow in the umbilical artery is connected with a decreased risk of mortality. Monitoring of high-risk

pregnancies with intrauterine growth restriction using Doppler ultrasound imaging is beneficial since it has been found to enhance pregnancy outcomes and may provide indirect confirmation of foetal impairment.

**Keywords:** PI - pulsatility index, RI -Resistive index, MCA - Middle cerebral artery, UA - Uterine artery, Umb A - Umbilical artery , US -Ultra sound, IUGR - Intrauterine growth restriction, PIH - Pregnancy induced hypertension , CP ratio - Cerebroplacental ratio.

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## Introduction

Intrauterine growth restriction describes a foetus whose development or size is below normal throughout pregnancy (IUGR). When a foetus' estimated foetal weight (EFW) falls below the 10th percentile for its gestational age, it is said to be experiencing growth restriction" which is the definition of intrauterine growth restriction (IUGR) [1]. Some forms of IUGR are symmetric, whereas others are asymmetric. Both symmetric and asymmetric IUGR may occur, although symmetric IUGR is caused by complications early in pregnancy.

Just 2% of infants whose birth weight was in the third to tenth percentile had a negative perinatal outcome during the Prospective Observational Trial to Optimise Paediatric Health(PORTO). For Third percentile EFW 6.2% adverse outcomes were there, which included of intraventricular haemorrhage, hypoxic ischemic encephalopathy, periventricular leukomalacia, necrotizing entero-colitis, sepsis, broncho pulmonary dysplasia, sepsis, and death. an estimated percentage of 3-5% IUGR is noted in healthy and well-nourished mothers. Women who have previously had a growth-restricted foetus or hypertension have a higher risk (15-20%) of having a baby who is born with [2].

In India, the incidence of IUGR is 25-30%.[3] Recent studies conducted by UNICEF have shown that hypertension, renal illness, collagen vascular disease, substance misuse, and inadequate nutrition

leading to placental insufficiency are among the leading causes of IUGR in mothers. Also leading to IUGR include foetal illnesses such toxoplasmosis and CMV, as well as chromosomal abnormalities including triploidy and trisomies 13 and 18.[4] One of the most frequent causes of IUGR is a condition known as primary placental insufficiency, which occurs when the mother is not the source of the problem. A growth-retarded foetus has an 8- to 10-fold higher perinatal mortality and 50-75 percent higher morbidity than a normally-sized foetus [5]. Stillbirth, Perinatal asphyxia, Intrapartum foetal acidosis, Meconium aspiration syndrome, Hypocalcemia, Hypoglycemia, Hypoxic ischemic encephalopathy, and Hypothermia were all more common in IUGR-affected foetuses.

Identifying tiny foetuses at high risk of perinatal death and morbidity has been made easier with the advent of ultrasonography doppler examination, which evaluates compromised uteroplacental and fetoplacental circulations. In terms of foetal health assessments, umbilical arterial (Umb A) Doppler velocimetry has undergone the most thorough testing. [6] The pulsatility index of the middle cerebral artery (MCA) is much lower in IUGR foetuses compared to normal foetuses, as determined by Doppler ultrasonography.[7]

End-diastolic flow in the umbilical artery of a foetus with severe growth restriction decreases before alterations are seen in the

middle cerebral artery (MCA). And then, following those changes to the veins' blood flow. The hemodynamic state of a foetus with growth restriction may be determined with Doppler ultrasonography examination of the ductus venosus and MCA [8]. Artery of the umbilical cord Doppler velocimetry is the major surveillance method for monitoring foetuses with growth limitation because it measures the resistance of blood perfusion in the foetoplacental unit. Uterine artery function normally Doppler US pictures had a reduced perinatal mortality and a lower risk of overall unfavourable outcomes compared to those who did not [9]. In foetal growth restriction, the PSV has outperformed the PI in predicting neonatal death [10].

In the context of foetal growth limitation, the cerebroplacental ratio (CPR) has been investigated as a potential predictor of negative pregnancy outcomes [11]. If a fetus's ratio is below the fifth percentile for its gestational age, it is said to have foetal brain sparing [12]. At term, CPR demonstrated that aberrant CPR was a predictor of slowed foetal development and the necessity for an emergency C-section due to foetal compromise [13]. The ductus venosus 'A' waveform is missing or inverted, which is a late discovery indicative of acidemia and likely death within 7 days [14].

A high umbilical artery Doppler PI (>95th percentile) in a growth-restricted foetus may be used to determine when to deliver the baby. Doppler velocimetry surveillance in suspected foetal growth restriction, and discuss the techniques used to acquire such images; however, no immediate neonatal benefit was established from waiting to deliver until the ductus venosus monitoring showed substantial abnormalities (absent or retrograde flow). neonates with birth weights below the 10th percentile but above the 90th percentile (5 to 30 times higher,

respectively) The rates were 70-100 times higher in individuals weighing less than 1500 g [15].

### Material and Methods

This study was approved by the Ethical Committee of our institution. The study was conducted for a period of 21 months from February 2021 to October 2022. Data for the study was collected from patients attending the department of Radio-diagnosis, referred by Department of Obstetrics and Gynecology at our hospital. The study included 96 antenatal women who were diagnosed as having a fetus with intra uterine growth restriction inclusion criteria were met:

#### Subject Inclusion Criteria:

Antenatal women referred to department of radio-diagnosis and modern imaging

Patients who gave consent for study.

#### Subject Exclusion Criteria:

Patients who are not giving consent for relevant investigation.

All subjects with h/o rupture of membranes, or who are in active labour.

Multiple pregnancy.

The uterine artery RI > 0.58 and presence of diastolic notch were considered abnormal. The UmA Pulsatility index ratios were considered abnormal if the value was above the 95<sup>th</sup> percentile for the gestational age. The MCA pulsatility index was considered abnormal if the value was below the 5th percentile for the gestational age, according to reference values of D Gramellini *et al* [16]. Of the various Doppler indices, pulsatility index has the smallest measurement error and narrower reference limits. The MCA/Umb A PI ratio (cerebro-umbilical ratio) is usually constant during the last 10 weeks of gestation. It is possible to use a single cut off value after 30<sup>th</sup> week

because cerebral umbilical Doppler ratio does not vary significantly between 30<sup>th</sup> and 40<sup>th</sup> weeks as reported by Wladimiroff *et al* [17] who observed a significant differences in cerebro-umbilical ratio only between weeks 26-38. After 26<sup>th</sup> week, the statistical comparison showed no significant differences between the intervals considered. The MCA PI/ Umb A PI ratio was calculated. In our study a single cutoff value of 1.3 for MCA/Umb A PI ratio (cerebral-umbilical ratio < 5 percentile) was used, above which velocimetry was considered normal and below which it was considered abnormal, according to reference values of D Gramellini *et al* [16].

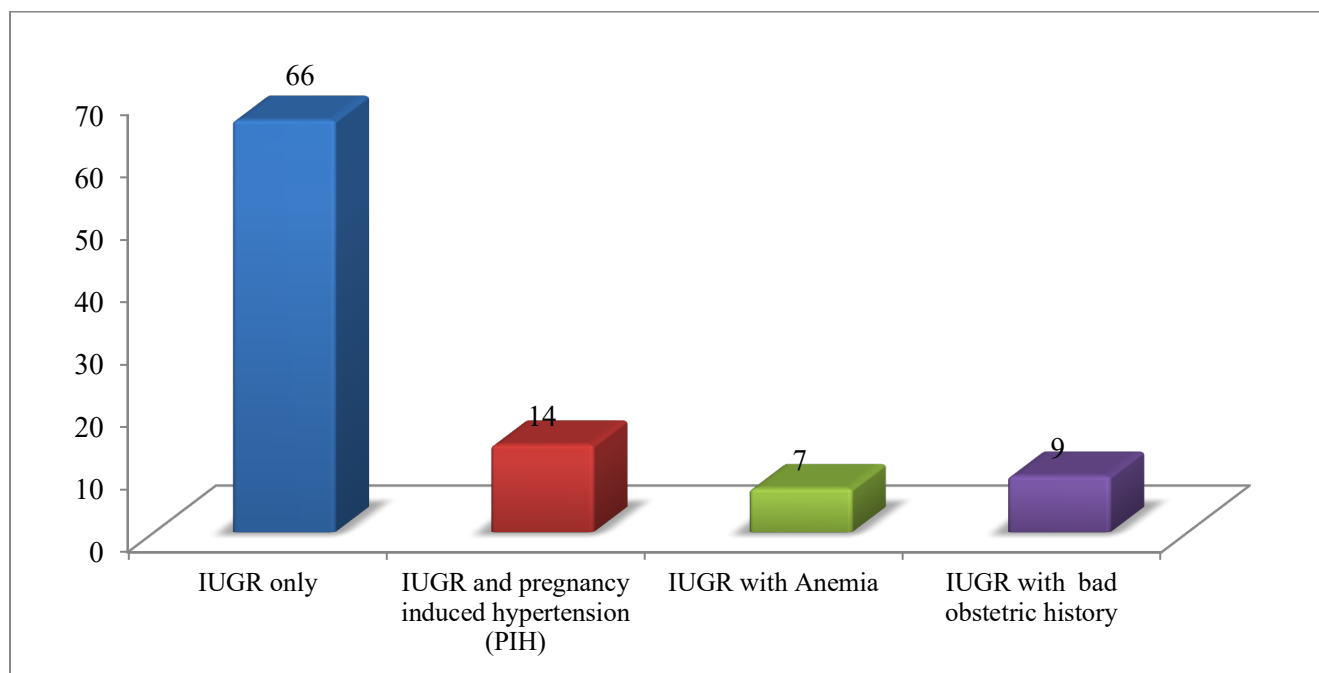
## Results

A prospective study of 96 prenatal patients was conducted after careful consideration of the inclusion and exclusion criteria. Doppler

flow velocity waveforms. Everyone in our patient population was between the ages of 19 and 37. Patients aged 21–25 made up the bulk of the sample (n=38) and accounted for 39.29 percent of the total.

The average age of the cases was 27.3 ± 4.29 years. In the under-20 age bracket, we saw the fewest patients. In our research group of 96 pregnant moms were recruited and the gestational age at the time of Doppler assessment varied from 26 to 39 weeks.

Thirteen (13.54%) of the pregnant women whose pregnancies were checked were between 26 and 30 weeks along, fifty-four (56.25%) were between 26 and 30 weeks along, and twenty-nine (30.20%) were between 36 and 40 weeks along. Before 26 weeks of pregnancy, none of the expecting moms were seen for a prenatal checkup.



**Figure 1: Clinical presentation of the antenatal mothers**

In our dataset, PIH affected 14.58 percent of patients. Sixty-eight-point five percent of

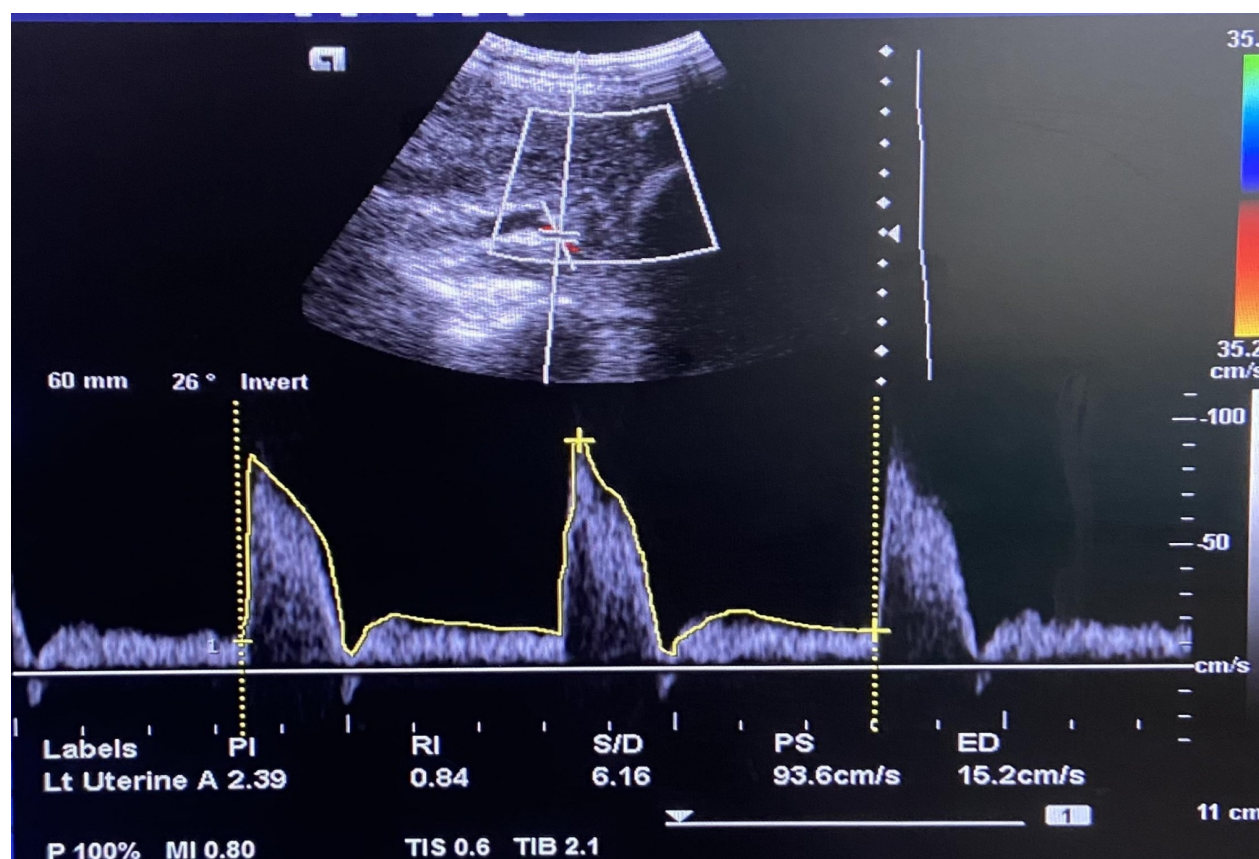
Doppler studies only found IUGR. In 7.29% of women who had IUGR during pregnancy,

anaemia was also a complication. About 9.37 percent of women had a problematic past with pregnancy.

### **Uterine Artery Doppler Studies And Early Diastolic Notch**

Uterine artery PI was increased in 57 moms (59.37%) and normal in 39 patients (40.62%). In our research, 48 patients (50%) had a high PI in only one uterine artery, whereas 9 patients (9.37%) had elevated PI in both arteries. Of those analysed, only 39 (40.62%) had normal pulsatility indices. The

uterine artery flow waveform was abnormal in 37 (38.54%) of pregnant women, whereas it was normal in 59 (61.45%) of the patients. Twenty-nine patients, or 30.20 percent, had a notch on just one side during early diastole, whereas eight, or 8.33 percent, had notches on both sides. When both characteristics (presence of PI and presence of persistent early diastolic notch) were taken into account, 63 of the 96 pregnant moms (65.62%) with IUGR had an aberrant uterine artery flow velocity profile.

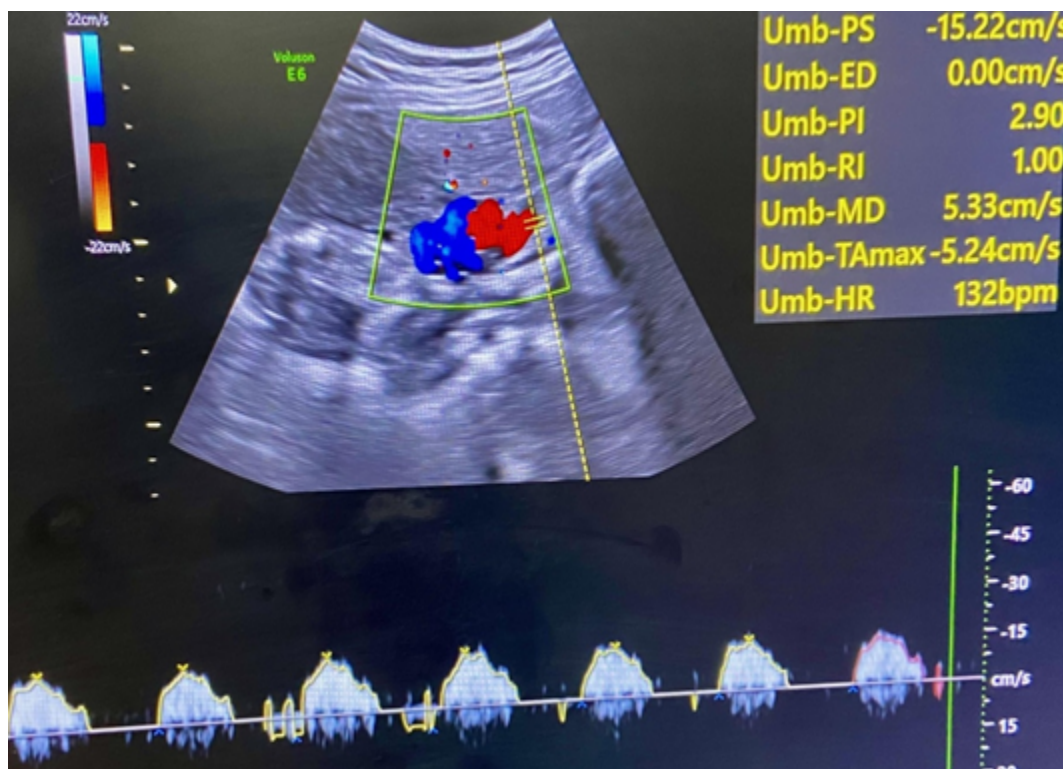


**Uterine artery Doppler showing early diastolic notch, with high S/D ratio and elevated PI and RI**

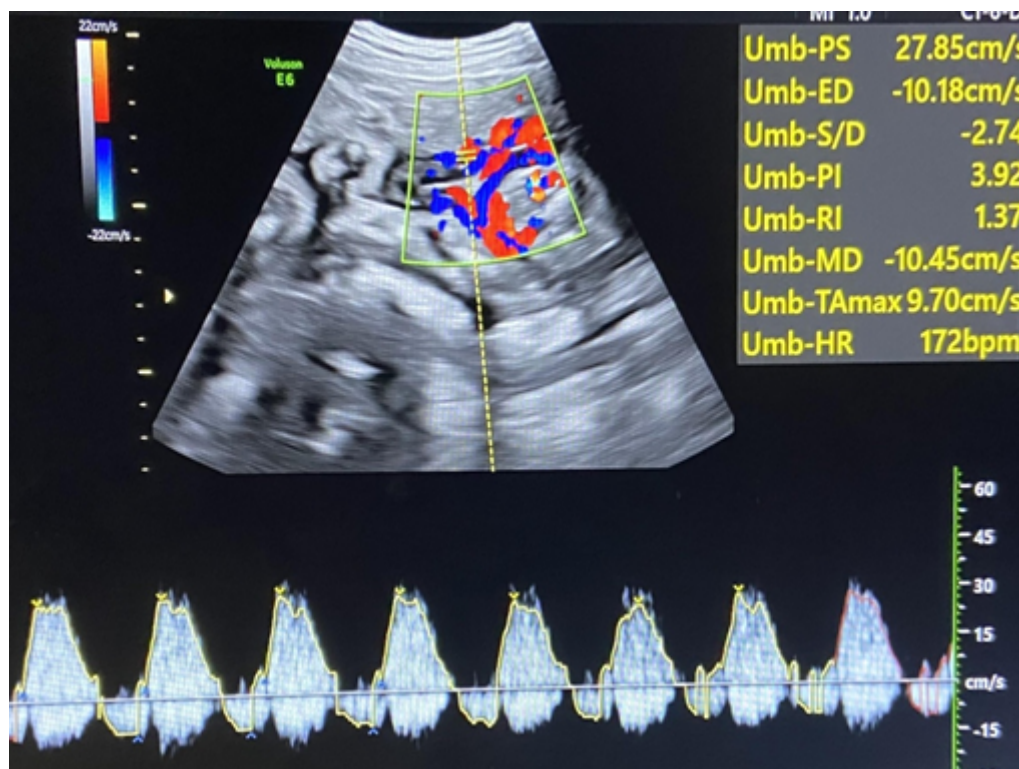
### **Doppler Studies Of Umbilical Artery**

Umbilical artery PI was elevated in 40 patients (41.66%) and was normal in 56 (58.33%) patients. A total of 10.41% of fetuses exhibited aberrant waveforms; this included 7 fetuses (7.39%) with absence and 3 fetuses (3.1%) with reversal of end diastolic flow in the umbilical artery.





**Umbilical artery showing absent end diastolic flow**



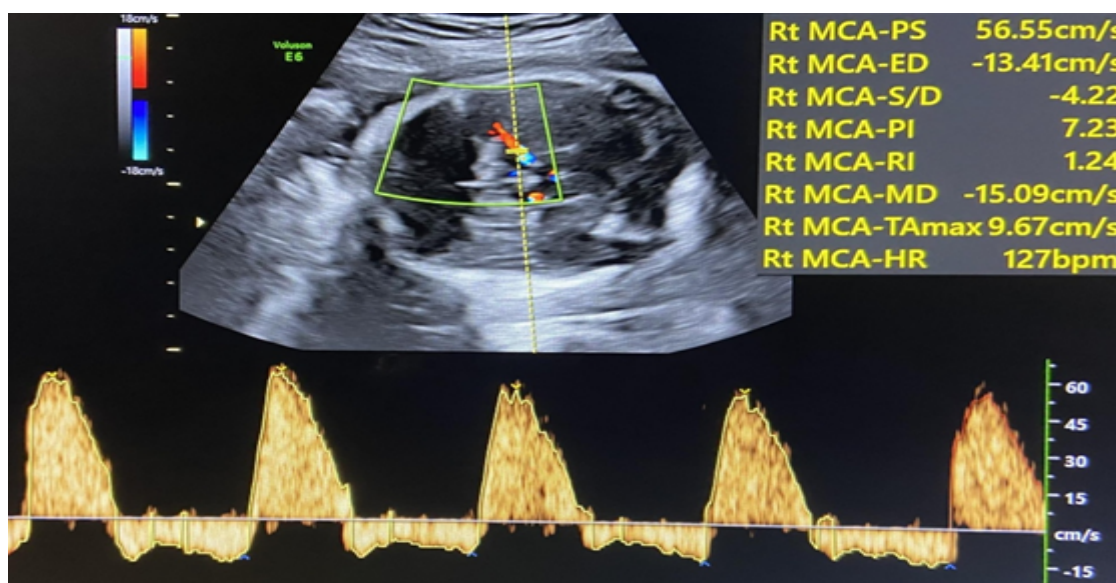
**Umbilical artery showing reverse end diastolic flow**

### Analysis Of Both Uterine And Umbilical Arteries

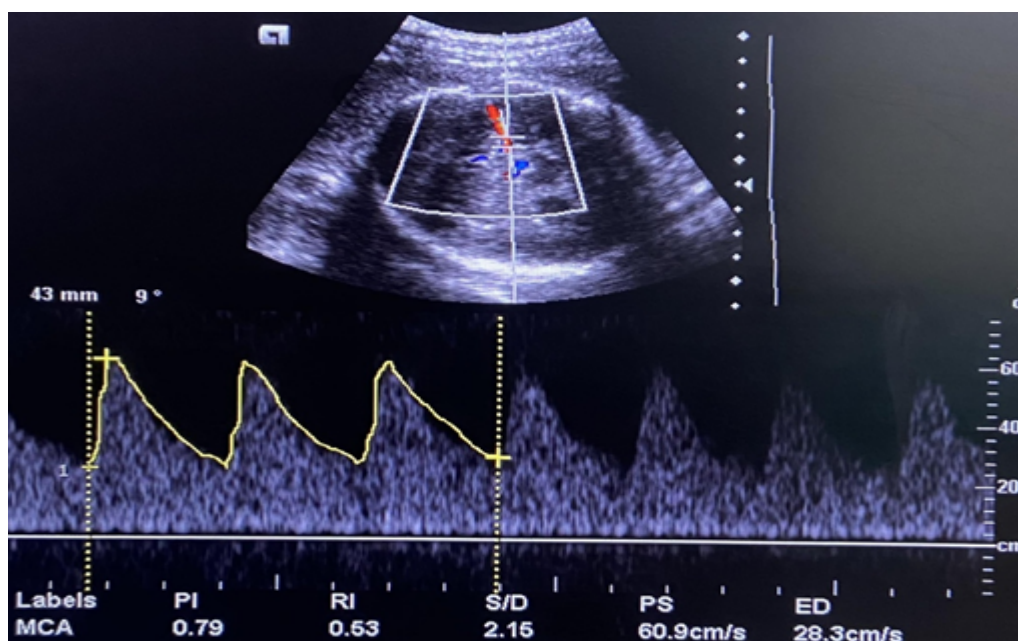
When the uterine and umbilical arteries were evaluated jointly, problems were found in 43.75 percent of the research sample (42 moms). When looking at individual arteries, the uterine arteries had a somewhat higher percentage of detection (59.37%) than the umbilical arteries (41.66 percent)

### Doppler Study Of Fetal Middle Cerebral Artery

56.2 percent (54 moms) of the 96 fetuses had decreased Pulsatility index. and 43.75 percent (n=42) had normal Middle cerebral artery Pulsatility index.



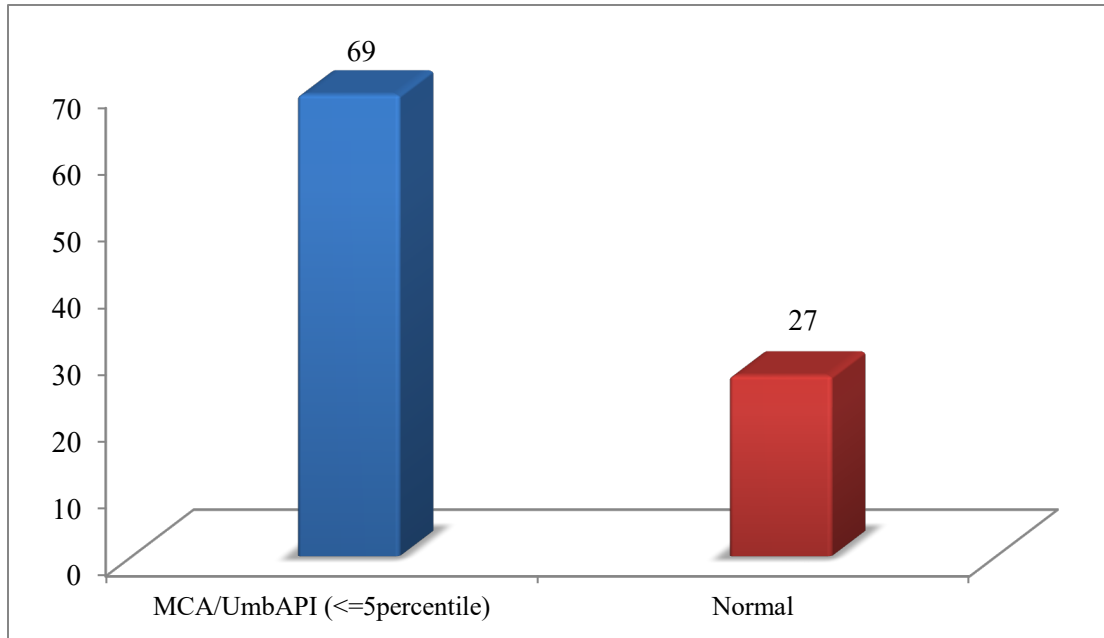
**MCA showing reverse end diastolic flow**



**MCA showing increased diastolic flow with reduced PI values**

### Ratio To Determine Fetal Blood Flow Redistribution

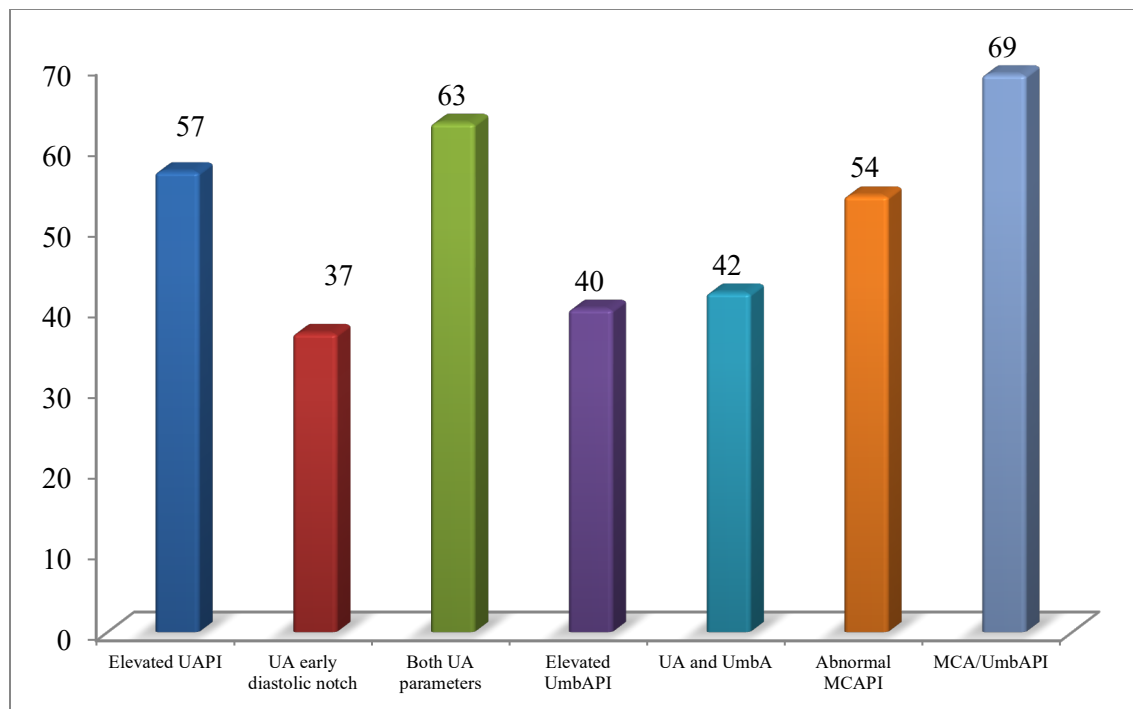
Redistribution of blood to the brain was shown in 71.87 percent (69fetuses) of the foetuses, as demonstrated by a ratio of PI in the MCA and umbilical arteries.



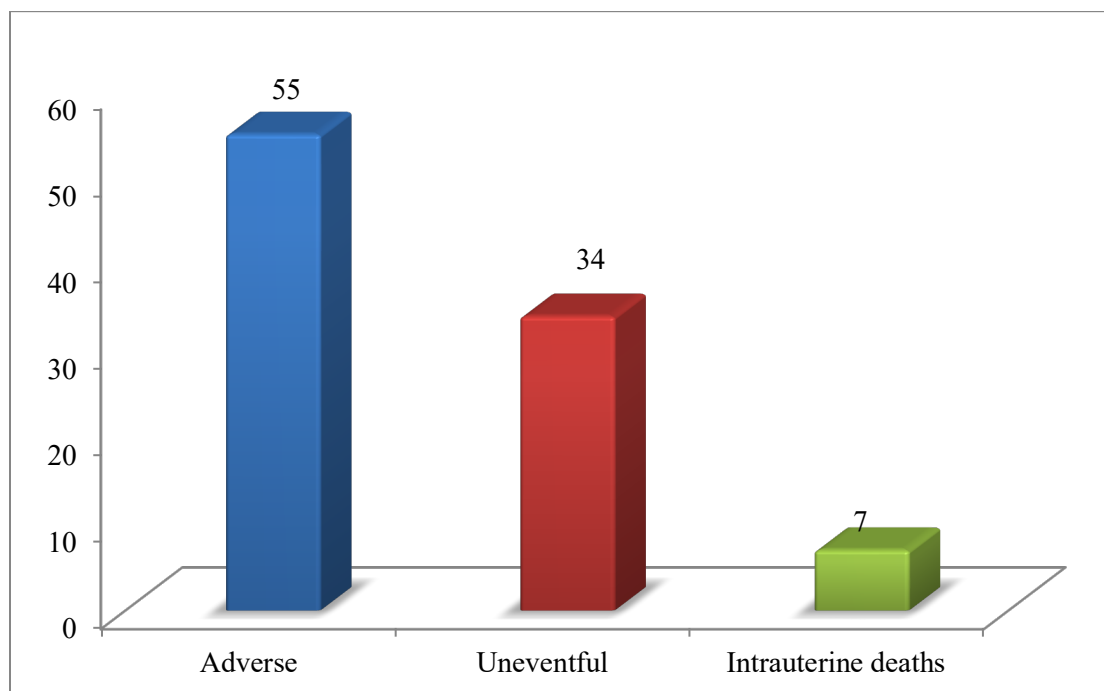
**Table 1: Performance characteristics of Doppler indices**

Doppler indices	Number	Percentage
1.ElevatedUAPI	57	59.37%
2.UAearlydiastolicnotch	37	38.54%
3.BothUAparameters	63	65.62%
4.Elevated UmbA PI	40	41.66%
5.UA and UmbA	42	43.75%
6.Abnormal MCA PI	54	56.25%
7. MCA/UmbA PI	69	71.87%





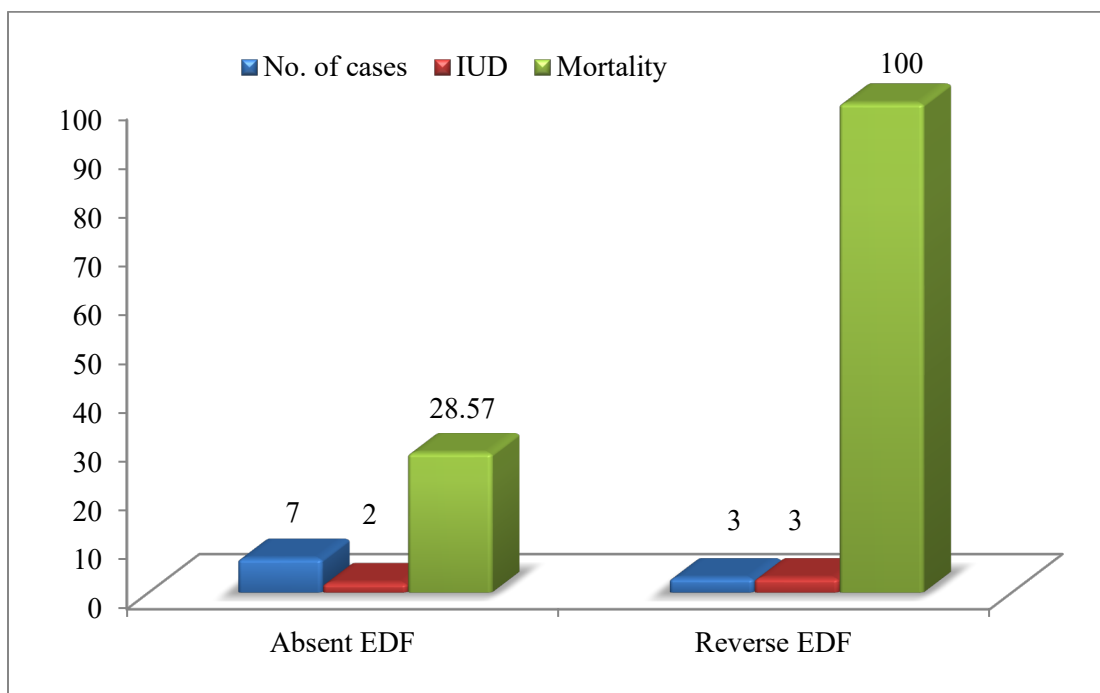
### Analysis of Perinatal outcome



There were 89 live births and 7 deaths that occurred in the womb. With 89 deliveries, 41 infants required care in a neonatal intensive care unit. At 5 minutes, 42 of the newborns had an APGAR score of less than 7, and 16 of the births were deemed urgent enough to need caesarean section.

The average weight of a baby delivered was  $2.3 \pm .0519$  kg. Of the newborns weighed in, 46 were under 2.5 kilogrammes at delivery. There was at least one negative perinatal outcome in 62 fetuses. The outcomes were positive for the remaining 34 pregnancies.

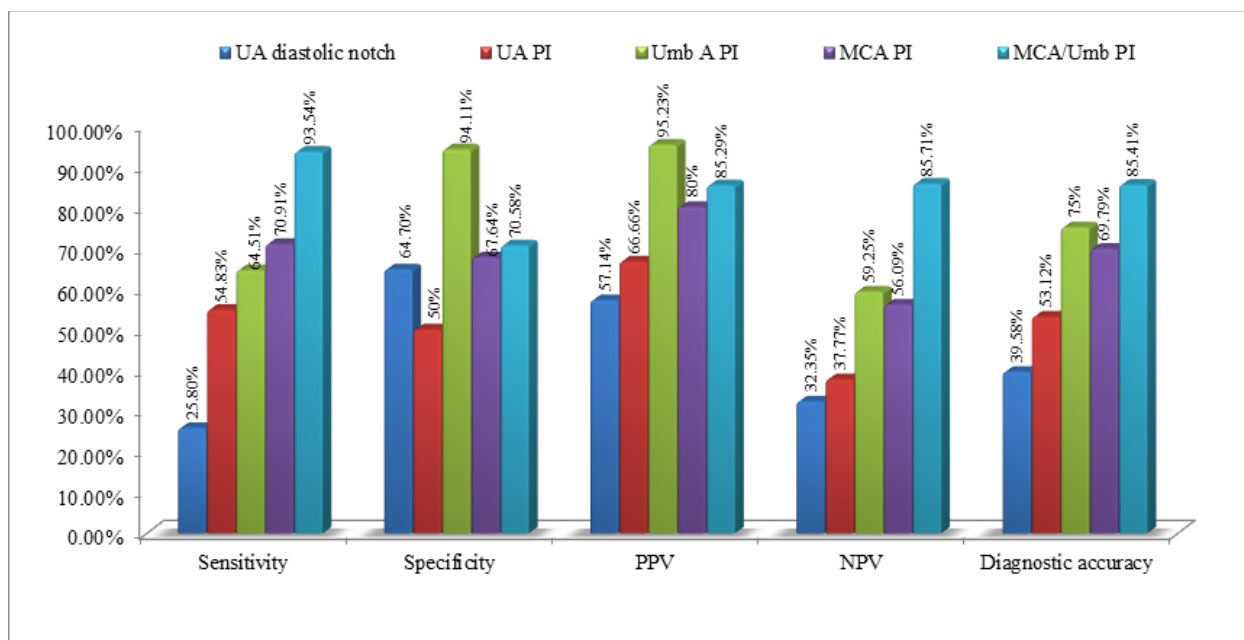
### Perinatal mortality v/s absent / reversal of diastolic flow



Seven fetuses, or 7.29 percent, had abnormalities in end diastolic flow velocity, either completely absent or reversed. Two of the five intrauterine fatalities had missing diastolic flow, and three exhibited reverse diastolic flow. Patients with nonexistent or reverse end diastolic flow had a 100% mortality rate, whereas those with normal flow had a 28.57% rate of death.

**Table 2: Comparison of Doppler indices with adverse perinatal outcome**

Doppler index	TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	Diagnostic accuracy
UA diast, notch	16	22	12	46	25.80%	64.70%	57.14%	32.35%	39.58%
UA PI	34	17	17	28	54.83%	50%	66.66%	37.77%	53.12%
Umb A PI	40	32	2	22	64.51%	94.11%	95.23%	59.25%	75%
MCA PI	44	23	11	18	70.91%	67.64%	80%	56.09%	69.79%
MCA/Umb PI	58	11	10	4	93.54%	70.58%	85.29%	85.71%	85.41%



## Discussion

The fact that some foetuses develop and grow in the opposite direction from others is a mystery that has baffled doctors for years. Intrauterine growth restriction is not indicative of a singular pathology but rather the end consequence of a chain of events occurring along a variety of causal routes. Therefore, an appropriate prenatal diagnosis must determine whether the foetal size is a result of impaired placental perfusion or a fundamentally modest size for the gestational age. Doppler flow velocity studies of the uteroplacental (uterine arteries), Feto-placental (umbilical arteries), and fetal-circulation systems may be invaluable in resolving this issue (middle cerebral artery).

We used clinical suspicion and grey scale ultrasound imagery to diagnose 96 pregnant women as having infants with intrauterine growth restriction.

There has been a lot of published study, but the results have been all over the map. The limited number of patients recruited, the diverse sample sizes and methods, and the

varying criteria utilised to identify the unfavourable perinatal outcome may all contribute to this inconclusive finding. Major and minor gestational overgrowth were also studied, along with populations at high and low risk.

There does not seem to be a universally accepted definition of aberrant Doppler flow velocity waveforms or the pregnancy outcome measure, therefore conflicts concerning compliance may continue.

It has been observed that between the ages of 21 and 25, the largest proportion of pregnant women sought medical attention (39.29 percent). This may explain why there is a higher birth rate among women of these ages. Participants' ages varied between 19 and 37.

Our research included only instances when Doppler examination was performed during the second or third trimester, with 56.25% of those examinations taking place between 31- and 35-weeks' gestation. The leading research was conducted during the 26th week of pregnancy. Therefore, most

pregnancies were insured between the ages of 31 and 35, when the baby has enough mature lungs to survive outside the uterus.

### **Etiology of IUGR**

In cases when a woman's diet was shown to be the cause of IUGR. Pregnancy-induced hypertension (PIH) affected 14.58% of women, while anaemia affected 7.29% of expecting mothers. While 9.37% of the patients in the research group had a previous negative obstetric result, 62.75% of the group had no obvious explanation for IUGR.

### **Uterine artery**

Colemann *et al.* [18] found that a pre diastolic notch of the uterine artery was 76% sensitive to unfavourable perinatal outcome, the present study indicated that a persistent early diastolic notch after 26 weeks of gestation was only 25% sensitive. For example, in the Coleman research, all of the women included had PIH and both pre- and post-diastolic notches, but in the current study, we included instances in which the diastolic notch was present on one side or the other, but not all patient had PIH. The current research found that PI in the uterine artery was 54.83 percent sensitive. A study by Mojgan Barati [19] found that PI in the uterine arteries had a 79 percent sensitivity in predicting neonatal outcome. The sensitivity of PI in the uterine artery was also calculated to be 88% by Albaiges *et al.* Since there were fewer PIH patients in the current investigation, it may explain why there were different results.

### **Umbilical artery**

There was a sensitivity of 64.21 percent found when measuring umbilical artery pulsatility index. While one research found PI in the umbilical artery to be 64% sensitive in predicting perinatal outgrowth (D. Gramellini *et al.* [16]), another (Manoj kumar veerabathini [20]) found it to be 82.5 sensitive During high-risk

pregnancies, the umbilical artery was the primary monitoring site. Since the umbilical artery is a symbol of the fetoplacental system, it first indicates placental resistance. Since there were fewer PIH patients in the current investigation, it may explain why there were different results. The sensitivity of PI in the umbilical artery was calculated to be 58.3% in another investigation conducted by K W Fong *et al.* [21] Compared to the 37% observed in the research by Benson and Doubilet, we found that 10.41% of foetuses in our study had absent or reversed end diastolic flow velocity [22]

### **Fetal blood circulation and redistribution**

Fifty-five percent of the foetuses had abnormalities in the pulsatility index of the foetal MCA. Results showed that PI of the embryonic middle cerebral artery was 70.96% sensitive and perceptive. The sensitivity of MCA for predicting perinatal outgrowth was 68% in research by Arduini and Rizzo [23], and 77.5 % in a study by Manoj kumar veerabathini [20] Our research found that the MCA PI / Umb PI was 93.54 percent sensitive in predicting perinatal outcome. Similar to the research by Manoj kumar veerabathini [20] (87.5 percent) and ahead of the study by D Gramellini *et al* (68 percent).

Sixty-four out of every 100 foetuses (n=62) had some kind of problem. The remaining 35.41% of embryos were successful births (n=34). There were 89 live births and 7 fatalities that occurred within the uterus. Two of the IUDs didn't have any diastolic flow at all, while three others had diastolic flow going in the other direction / reversed end diastolic flow. Patients with a absent of end diastolic flow had a 28.75 percent death rate, while those with reversal of flow had a 100 percent mortality rate. Of the 89 live births, 41 infants were admitted to the neonatal intensive care unit (NICU), 42



infants had an APGAR score of less than 7 at 5 minutes, and 16 infants were delivered through emergency caesarean section. This is a marginal improvement over the findings of Gramellini *et al.* Reasons for this include the disparity between prenatal morbidity and death rates in the West and India.

When compared to only the MCA and Umb A pulsatility indices, the CPR (MCA/Umb A pulsatility index ratio) computed from Color Doppler ultrasonography data shown better sensitivity and positive predictive value for predicting the adverse perinatal outcome.

We found that the MCA/Umb A PI Doppler ratio was more predictive of a poor outcome than either Umb A PI or MCA PI alone, which is consistent with previous research. If all research utilised the same metrics, there would be a lot more value in comparing results. Research conducted by Manoj kumar veerabathini *et al.* was confirmed by our lab. indicates the MCA / Umb A PI ratio (CPR) outperforms the individual pulsatility indices of the Middle Cerebral Artery and the Umbilical Artery.

### Summary

When clinical criteria indicated a possibility of IUGR, around 96 pregnancies were examined. The average birth weight was  $2.3 \pm 0.519$  kg. Nearly half of all newborns (n=46) weighed less than 2.5 kilogrammes at delivery. Of the fetuses studied, 64.58 percent (n=62) had at least one undesirable outcome. The remaining 35.41% (n=34) of the pregnancies were successful. Seven women (out of a total of 89 newborns) lost their lives due to prenatal problems. A total of 89 babies were delivered alive, and 41 of them required treatment in a hospital's NICU. Of the babies delivered, 42 had an APGAR score of less than 7 at 5 minutes, and 16 of the deliveries were considered urgent enough to need a caesarean section. Studies using the uterine artery pulsatility

index were only 54.83 percent sensitive in predicting low birth weight or adverse perinatal outcome.

Doppler examination of the pulsatility index of the umbilical artery was 64.51 percent sensitive to predicting perinatal outcome. Doppler scans of the uterine artery and the umbilical artery together were more sensitive than either vessel alone.

Compared to the MCA/umbilical PI ratio, the cardiac output of fetuses with an abnormal MCA PI or Umb A PI was more likely to be misdirected. Studies have demonstrated that the cerebro umbilical ratio is a better predictor of intrauterine growth restriction and unfavourable perinatal outgrowth than either the middle cerebral artery or the umbilical artery alone. In agreement with Gramellini *et al.*, our study demonstrates that the MCA/Umb The individual PIs for the middle cerebral artery and the umbilical artery are inferior to a PI Ratio when it comes to prognosis.

### Conclusion

Fetal growth restriction causes changes in blood flow that directly affect the brain and the umbilical-placental circulation. Fetuses with elevated placental and/or decreased cerebral resistance may have a Doppler index that represents both of these regions.

Prognosis of perinatal outcome may be improved by estimating both the uteroplacental and fetoplacental circulations simultaneously. An aberrant MCA PI or Umb A PI is less predictive of a poor perinatal outcome than the cerebro placental ratio (MCA/UA PI) in presumed IUGR. Middle cerebral artery to umbilical artery PI ratio provides superior outcomes compared to individual PI measurements of the MCA and UA. Absence or backwards movement / reversal of diastolic blood flow in the umbilical artery is a terrifying portent. It has been established that Doppler ultrasound

imaging during pregnancy monitoring improves outcomes for high-risk pregnancies with intrauterine growth restriction and may provide indirect evidence of foetal impairment.

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