

DOPPLER ANALYSIS IN PREGNANCY INDUCED HYPERTENSIONTushar Patil¹, Amit C. Shah²**HOW TO CITE THIS ARTICLE:**

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ABSTRACT: A study of 50 cases was conducted to evaluate the role of Colour Doppler imaging in pregnancy induced hypertension with women over 28 weeks of gestation, the initial scan was performed immediately after the diagnosis of PIH to avoid any influence of treatment on Doppler evaluation. This study was aimed to analyze the blood flow in umbilical artery, maternal uterine artery & fetal middle cerebral artery using Doppler ultrasound.

KEYWORDS: Ultrasonography, Doppler, Colour, Pregnancy induced hypertension, Umbilical Artery, Maternal uterine artery, Fetal middle cerebral artery, Intrauterine growth retardation.

INTRODUCTION: Hypertensive disorder of pregnancy is one of the most common complications that affects human pregnancy. It is one of the leading cause of maternal & fetal mortality & morbidity.⁽¹⁾ It accounts for a total of 7.10% of perinatal mortality in developed countries and 20% in developing countries. Throughout pregnancy circulation should meet the demands of the intrauterine growing fetus. Satisfactory development of uteroplacental and fetoplacental circulation is necessary for a normal pregnancy outcome. Therefore, timely diagnosis of fetal compromise by tests of fetal surveillance is very important. A variety of invasive procedures have been tried in the past to study uteroplacental and fetal circulation. By employing color Doppler method, early detection of fetuses 'at risk' is possible. This will help the obstetrician to deliver the fetus before fetal distress develops. With the advent of pulsed wave color Doppler imaging, slow flowing small vessels can be interrogated to study the fetomaternal and cardiovascular hemodynamics. Fetal heart rate monitoring is not an ideal test for primary fetal surveillance because of its inability to recognize early stage of fetal distress (Fernando A. 1999). Doppler ultrasound of the fetal circulation allows us to investigate the fetal response to adverse conditions in utero. Patients with abnormal utero-placental flow velocity waveforms have a significantly high incidence of proteinuria, preterm delivery, cesarean section, low Apgar score and low birth weight. Among high risk patients several studies suggested a significant decrease in neonatal morbidity & mortality when Doppler evaluation was a part of fetal surveillance.⁽²⁾ The main goals of prenatal testing is to identify fetuses at increased risk for perinatal morbidity & mortality. In general population two large prospective studies failed to show significant improvement in neonatal performance associated with doppler technology.⁽³⁾ The first description of the physical principle used in color flow devices is attributed to Johann Christian Doppler an Austrian Mathematician and Scientist who lived in the first half of the nineteenth century. Doppler's first descriptions concerned changes in wavelength of light as applied to astronomical events.

In 1842, he presented a paper entitled "on the colored light of double stars and some ther Heavenly Bodies" in which he postulated that certain properties of light emitted from stars depend upon the relative motion of the observer and the wave source, He suggested that the colored appearance of certain stars was caused by their motion relative to the earth, the blue ones moving toward earth and the red ones moving away. He drew an analogy of a ship moving to meet or retreat

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from incoming ocean waves. The ship moving out to sea would meet the waves with more frequently than a ship moving towards the shoreline. Interestingly Doppler never extrapolated his postulates to sound waves. There was immediate criticism of Doppler. Just like today, critics abounded. Among them was Buys Ballot who in 1844 stated he simply did not believe Doppler. There is rather amusing account of the difficulties Buys Ballot encountered in attempting to disclaim the Doppler Effect. In 1845, he borrowed a steam locomotive from Dutch Government and arranged for a trumpet player to ride a fiat car as it approached and then left a station.

Two other trumpet players were positioned on the ground one to either side, where an observer with the ability to appreciate perfect pitch listed to an the trumpets playing the same note. Following a hailstorm and other delays, the experiment finally took place. The note was higher in pitch as it departed when compared with trumpets on the ground. Aside from verifying Doppler's observations, this experiment proved that "getting started in Doppler" was difficult to understand even then.

Even with this scientific verification, Buys Ballot and others continued to level strong criticism. Those struggling to understand the Doppler principle will be interested to know that while Doppler's postulate concerning frequency shift from moving objects was ultimately shown to be correct his extrapolation about color shift of light from stars was later proven to be wrong. He incorrectly assumed that all the stars emitted white light. In reality the colors and lines of the various stars are a function of thin surface temperature rather than their direction or velocity of movement. We are familiar with the Doppler Effect in everyday life. For example an observer stationed on a highways overpass easily notices that the pitch of the sound made from the engine of a passing automobile changes from high to low as the car approaches and then passes into the distance. The engine is emitting the same sound as it passes beneath, but the observer notices a change in pitch dependent upon the speed of automobile and its direction.

Doppler Effect is now employed in modern astronomy. It has practical application in radar detection of storm and is used in modern weather for casting. It can help to form the 'radar trap' used by police on modern highways to detect speeding automobiles in developed countries. The medical applications of Doppler are dependent upon the use of ultrasound and have been in practice for some time. Doppler systems emit a burst of very high frequency sound termed as ultrasound that is reflected off the moving red blood cells and then returned at a different frequency dependent upon the speed and direction of the moving blood. The result information is displayed as various wave for on the velocity spectral analysis.

The clinical uses of blood flow imaging systems have expanded immensely since the first measurement of flow in the heart that was performed by Satomura in 1956.

Despite its wide spread use, Doppler methods and principle are difficult to understand and implement without considerable training and experience.

AIMS AND OBJECTIVES:

1. To analyze blood flow in umbilical artery, maternal uterine artery and fetal middle cerebral artery using Doppler Ultrasound (color flow imaging) in pregnant women with pregnancy induced hypertension with reference to flow velocity waveform ratios, peak systole / end diastole (A/B) and resistance index (A- B/A).
2. To assess fetal well-being by using same parameters.

3. To analyze the perinatal outcome in hypertensive cases with respect to normal and abnormal Doppler waveforms.

MATERIALS AND METHODS: The study was conducted at Government General Hospital, Gulbarga for a period of 24 months beginning from March 2002 onwards. Patients coming to the hospitals attached to M.R. Medical College, i.e. Government General Hospital, Basaveshwar Teaching & General Hospital and Sangarneshwar Hospital, Gulbarga.

Fifty hypertensive pregnant women coming to the hospital comprised the study group. The inclusion criteria was all antenatal cases diagnosed clinically having pregnancy induced hypertension beyond 28 weeks of gestation.

The first scan was performed in each case, as soon the patient was registered in order to avoid any influence of treatment on Doppler sonogram. The gestational age was confirmed by menstrual history and ultrasound examination and was followed by color Doppler examination.

METHODS: After thorough clinical examination, the patient was explained about the non-invasive/atraumatic nature of the procedure. Synthetic ultra-gel was applied liberally over the abdomen to get a good acoustic coupling. The instrument used was ATh (USA) HDI 1500 Color Doppler ultrasound machine, with a convex transducer of 2 to 5 MHz frequency.

Doppler waveform was obtained after localizing the vessels by B-mode real time scanner. Pulsed Doppler was used to get the Doppler signals after localizing the vessels. The maximum Doppler shift frequencies were obtained and various ratios were calculated from each vessel. Doppler examination was done when the fetus was in apneic state to avoid the influence of fetal respiration on Doppler signals.

Inclusion Criteria:

1. All antenatal cases diagnosed clinically having pregnancy induced hypertension.
2. Antenatal cases beyond 28 weeks of gestational age.
3. Antenatal cases diagnosed having intrauterine growth retardation of the fetus.

Exclusion Criteria:

1. Antenatal cases with gestational age less than 28 weeks.
2. Normal routine antenatal case.
3. Twin! Multiple pregnancy.
4. Extrauterine pregnancy.
5. Antenatal cases with intrauterine fetal death.
6. Antenatal cases with congenital anomalies of the fetus.

Identification of the various Arteries:

1. Uterine Artery: Color Doppler facilitates identification of the uterine artery substantially, Transducer should be placed 2- 3cm medial to anterior superior iliac spine, directing the ultrasound beam to the lateral wall of the uterus and slightly downward towards the pelvis.
2. We have evaluated the uterine arteries on both sides.
3. Umbilical Artery: Flow velocity waveforms (FVWs) from umbilical artery can be easily obtained, for this color flow is not usually needed, Doppler signals can be acquired from different points in cord, usually from mid portion of the cord.

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4. Middle Cerebral Artery (MCA): With the color flow imaging, it is possible to identify the MCA. The first step is to secure an image of the head suitable for obtaining a measurement of biparital diameter.

RESULTS AND OBSERVATIONS: In the present study out of the fifty pregnancies induced hypertension cases, thirty-six showed positive Doppler indices in one or all the three vessels studied. The remaining fourteen cases showed no abnormal Doppler indices in any of the three vessels studied.

The physiological variations and anatomical complexities of the uteroplacental vascular tree make it difficult to obtain accurate and reproducible measurements using continuous wave Doppler, with inter-observer variations ranging from 3.9 to 17%. In later pregnancy between 37 to 40 weeks, maternal position may also alter flow patterns, with umbilical artery RI being higher in supine position than in decubitus, Furthermore, variations in uterine artery, maternal heart rate and exercise also significantly alter the waveform.

Most of the antihypertensive drugs appear to have no effect on fetornatal Blood flow. However, nifedipine appears to produce a reduction in umbilical artery resistance.

If the systolic blood pressure is greater than 140mm Hg, then resistance indices in both uterine arteries are increased. If the systolic blood pressure is less than 140 mm Hg, three separate groups may be identified those with (a) bilateral or (b) unilateral abnormalities of the waveform within the uterine arteries and (c) those with entirely normal uterine artery flow.

Age group (years)	No. of Cases
<20	31
21-25	14
26-30	03
31-35	02
Total	50

Table 1: Age Distribution of Cases

The highest age group in this study is below 20 years followed by 21 to 25 years.

SD Ratio	No. of Cases	Percent
<2.6	15	41.66
>2.6	21	58.34
Total	36	100.00

Table 2: Uterine Artery SD Ratio

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The table shows more than 50% of cases with elevated SD ratio.

Resistance Index	No. of Cases	Percent
<0.58	16	44.45
> 0.58	20	55.55
Total	36	100.00

Table 3: Uterine Artery Resistance Index

The table shows more than 50% of cases with abnormal RI in this study.

Diastolic Notch	No. of Cases	Percent
No. of cases with notch	20	55.55
No. of cases without notch	16	45.45
Total	36	100.00

Table 4: Uterine Artery Diastolic Notch

The table shows the number of cases with uterine artery notch to be slightly more than those without notch.

Incidence	No. of Cases	Percent
Unilateral diastolic notch	12	60.00
Bilateral diastolic notch	08	40.00
Total	20	100.00

Table 5: Incidence of Uterine Artery Diastolic Notch

In the present study, it is found that the cases with unilateral notch were more than those with bilateral notch.

	No. of Cases	Percent
No. of cases with one uterine artery Doppler positive	21	44.00
No. of cases with both right and left uterine artery Doppler positive	15	36.00
No. of cases with normal uterine artery Doppler	14	20.00
Total	50	100.00

Table 6: Significance of Bilateral Notch in Uterine Artery

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The above table shows that single uterine artery Doppler sensitivity is more in comparison with bilateral study.

Umbilical artery SD Ratio	No. of Cases
<1	00
1-2	00
2-3	07
3-4	08
>4	21
Total	36

Table 7: Umbilical Artery SD Ratio

The maximum number of cases show abnormal SD ratio (>4) in our study.

Umbilical Artery RI	No. of Cases	Percent
<0.70	10	27.77
>0.70	26	72.33
Total	50	100.00

Table 8: Umbilical Artery Resistance Index

Nearly two-third of cases show abnormal umbilical artery RI value.

Sensitivity	No. of Cases	Percent
No. of cases with positive umbilical artery Doppler	27	75.00
No. of cases with negative umbilical artery Doppler	09	25.00
Total	36	100.00

Table 9: Umbilical artery percentage sensitivity

The above table shows nearly two-third of cases showing abnormal umbilical artery Doppler analysis.

Parameters	Jane A Bates (%)	Present Study (%)
Abnormal umbilical artery SD ratio	76.00	57.14
Abnormal fetal Doppler	62	42.85

Table 10: Sensitivity of Umbilical Artery Vs other Vessels

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In our study, we found that abnormal umbilical artery Doppler (SD ratio) to be more sensitive than fetal Doppler, which is comparable with the study of Jane A. Bates.

Parameters	Katherine Wenstrom	Present Study (%)
No. of cases with AEDV in umbilical artery	4.90	7.14

Table 11: Umbilical artery significance of AEDV

In our study, it was found that AEDV in umbilical artery is more sensitive in predicting adverse fetal outcome comparable with the study done by Katherine Wenstrom.

Parameters	Farmakides (%)	Present Study (%)
Umbilical artery and uterine artery abnormal	21.00	82.00
Abnormal umbilical artery	15.00	75.00
[Abnormal uterine artery	6.00	58.33

Table 12: Comparative Sensitivity of Umbilical Artery versus Uterine Artery

In our study, we found that abnormal uterine artery and umbilical artery Doppler velocimetry alone is less sensitive than umbilical artery or both studied together.

Parameters	Farmakides (%)	Present Study (%)
No. of cases with abnormal MCA Doppler	11	30.55
No. of cases with normal MCA Doppler	25	69.45
Total	36	100.00

Table 13: Middle cerebral artery sensitivity

Only one third cases show abnormal MCA Doppler findings in our study.

Parameters	No. of Cases	Percentage
Ratio of UA/MCA PI>Q.72	25/36	69.45
Ratio of UA/ MCA RI>1	19/36	52.77
Ratio of MA/UA RI <1	17/36	42.23

Table 14: MCA Criteria for Cerebral Redistribution

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In our study, it was found that ratio of PT of UA/MCA is more sensitive as compared to the study done by Katherine W. Fong.

Parameters	No. of Cases	Percentage
RI of MCA/UA ratio	71.50	53.57
Abnormal UA RI	57.00	72.23
Abnormal MCA RI	35.70	14.28

Table 15: RI of MCA versus Umbilical Artery

In our study it was found that abnormal RI of umbilical artery is more sensitive in predicting IUGR.

Parameters	Katherine WF (%)	Present Study (%)
PI of MCA	72.40	30.80
PI of umbilical artery	44.70	41.00

Table 16: PI of MCA versus Umbilical Artery

According to Katherine W. Fong, PI value of MCA is more sensitive than umbilical artery PI. In our study, PI of umbilical artery is more sensitive than that of MCA in detecting PIH/IUGR.

Parameters	No. of Cases	Percentage
Uterine artery	21/36	58.33
Umbilical artery	27/36	75.00
Fetal MCA	11/36	30.55

Table 17: Sensitivity of Various Vessels Studied

The Doppler study of umbilical artery is most sensitive of all the vessels under the study.

Investigations	Percentage
Cord Doppler imaging	71.42
Amniotic fluid volume	32.00
Biophysical profile	18.00
Non-stress test	14.00

Table 18: Sensitivity of Predicting Poor Neonatal Outcome

Doppler waveform analysis of umbilical artery (SD ratio >4) is the most accurate predictor of poor neonatal outcome in SGA fetus.

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Weight in Kgs	Less than 30 weeks	31-35 Weeks	36-37 Weeks	38 & above
<1	2			
1 - 1.5	5	9		
1.6 - 2.0		8	4	
2.1 - 2.5		1	5	4
2.6 - 3.0			7	4
>3			1	3
Total	7	18	17	8

Table 19: Comparison of birth weight and gestational age in Weeks

The above table in the present indicates that low birth weight babies were more commonly seen in 31-35 weeks gestational age group followed by 36-37 weeks age group.

Mode of delivery	No. of cases
Vaginal	20
Elective Caesarean-section	19
Emergency Caesarean -section	11
Total	50

Table 20: Mode of Delivery

The number of cases where caesarean sections were performed for maternal! Obstetric indications were 30, out of which 70% were showing abnormal waveforms, thus correlating abnormal wave pattern with the severity of hypertensive disorder.

Gestational age at delivery (weeks)	No. of Cases	Abnormal CPR (<1)	Neonatal Complication	IUGR	Perinatal death
30 weeks and Less	4	2 (50%)	3 (75%)	3 (75%)	2 (50%)
31-35 weeks	18	10 (55.55%)	7 (70%)	8 (80%)	2 (20%)
36-37 weeks	15	10 (66.66%)	7 (70%)	7 (70%)	
38 & above	13	4 (30.77%)	2 (50%)	3 (75%)	

Table 21: Abnormal CPR in Reference to Fetal Gestational Age and Perinatal Outcome

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Table compares abnormal CPR in reference to gestational age and perinatal outcome. It is clearly evident that CPR less than 1 is associated with neonatal complications IUGR and perinatal death.

DISCUSSION: Pregnancy induced hypertension is a common complication during pregnancy. Introduction of Doppler ultrasound in obstetrics allows us to study the changes in uteroplacental and fetoplacental circulation in adverse conditions like PIH. By serial Doppler studies, we can follow the sequence of changes in response to fetal hypoxemia.

In our study, we have included fifty clinically diagnosed PIH cases. None of the case is elderly primi. Of these cases, thirty-six cases (72%) were found Doppler positive for IUGR. The remaining fourteen (28%) does not show any evidence of IUGR on any single Doppler parameter. Campbell et al, 1983 observed that patients with abnormal utero-placental waveforms had a higher incidence of hypertension than those with normal wave patterns.

Many authors have linked preterm delivery with that & abnormal uteroplacental FVWs. Ducy et al (1987) studied 70 cases of hypertensive pregnancies with abnormal FVW, out of which 70.5% had preterm deliveries.

Elective C-sections were 38% and emergency C-sections were 22% of whole group.

In the present study, out of 30 C-sections performed, 70% were in the abnormal Doppler group indicating timely intervention to decrease perinatal mortality and morbidity. 42.2% had elective and 28.8% had emergency C-section.

Low birth weight (LBW) babies are more commonly associated with abnormal FVWs.

Uterine Artery: Normal value of systolic to diastolic ratio is 2.6. Increased values are seen in cases of growth retardation. More than 50% of cases show elevated systolic to diastolic ratio in the present study. Thaler et al (1992) evaluated 140 hypertensive pregnant women, out of them 27.8% had uterine artery notching.

In the present study, out of the Doppler positive cases, 20 (55.55%) cases had uterine artery notching. The upper limit for normal RI value was considered 0.58. Increased RI values indicate that there is increased risk of IUGR. In our study more than fifty percent of cases show abnormal RI. A diastolic notch is defined as "a decrease in maximal flow velocity below the maximum diastolic velocities occurring just after the systolic wave". In non-pregnant state uterine artery is a high resistance vessel. Low diastolic flow and early diastolic notching is a normal feature of the non-pregnant uterine circulation. During the second trimester, the trophoblast invades the myometrium converting the high resistance flow pattern into that of low resistance pattern characterized by increase in diastolic flow and disappearance of the notch. Persistence of notch after 28 weeks of gestation is an indicator of PIH/IUGR or both, Persistence of notch indicates unilateral vasospasm. Disappearance of notch will happen first in uterine artery which is directly under the placenta.

In the present study, number of cases with diastolic notch is approximating the same without the notch. The number of cases showing unilateral and bilateral notches forms 55.55% of total number of cases.

It is essential to study both the uterine arteries because of its variations in placental location. In case of laterally located placenta the placental side uterine artery is the main supplier and has lower resistance as compared to the opposite uterine artery. Examination of both uterine arteries is

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an Indispensable element of Doppler examination to assess placental performance and risk to the fetus. In this study, single uterine artery sensitivity is more in comparison with bilateral study. In the present study, we found that abnormal uterine artery Doppler velocimetry alone is less sensitive than umbilical artery or both studied together.

Our study is comparable to the study done by Farmakides who found that combination of uterine artery and umbilical artery Doppler study forming maximum sensitivity.

Umbilical Artery: Umbilical artery velocimetry correlates with hemodynamic changes in the fetoplacental circulation. With increase in number of tertiary stem villi & arterial channels, fetoplacental compartment develops & the impedance in the umbilical artery decreases. From 15 weeks of gestation umbilical artery resistance declines & the diastolic component appears in the waveform during early second trimester.⁽⁴⁾

Systolic to diastolic ratio is defined as the ratio of peak systolic velocity to end diastolic velocity. The upper limit of normal value is 4. A systolic diastolic ratio greater than 4 after 30 weeks of gestation is indicative of PND/IUGR. In our study, the maximum number of cases shown abnormal systolic to diastolic ratio.

As shown by Fleischer et al about 40% of hypertensive pregnancies have increased resistance in the umbilical artery which is significantly associated with IUGR & perinatal mortality & morbidity.⁽⁵⁾

More than two-third of cases showed abnormal umbilical artery Doppler analysis. In our study, we found abnormal umbilical artery Doppler (SD ratio) to be more sensitive than fetal Doppler, which is comparable with study of Jame A. Bates.

Absent end diastolic velocity (AEDV) is more sensitive in predicting adverse fetal outcome comparable with study done by Katherine Wenstorm.

From the above observations, it was noted that umbilical artery circulation was more predictive than that of uterine artery in the prediction of neonatal outcome. The efficacy for detecting adverse perinatal outcome was even higher when both uterine and umbilical artery were considered together.

Fetal Middle Cerebral Artery: Normal value of resistance index of MCA is 0.7. Doppler values less than this was considered abnormal in our study. Normal pulsatility index of MCA is 1.3. Values less than this was considered abnormal.

Only one-third cases show abnormal MCA Doppler findings in the present study.

According to Katherine WF, the criteria for cerebral redistribution are as follows:

- a) Ratio of PI of umbilical artery! MCA more than 0.72.
- b) Ratio of RI of umbilical artery! MCA more than 1.
- c) Ratio of RI of MCA/ umbilical artery less than 1.
- d)

In our study, we found the ratio of PI of umbilical artery! MCA is more sensitive as compared to study done by Katherine W. Fong.

SUMMARY

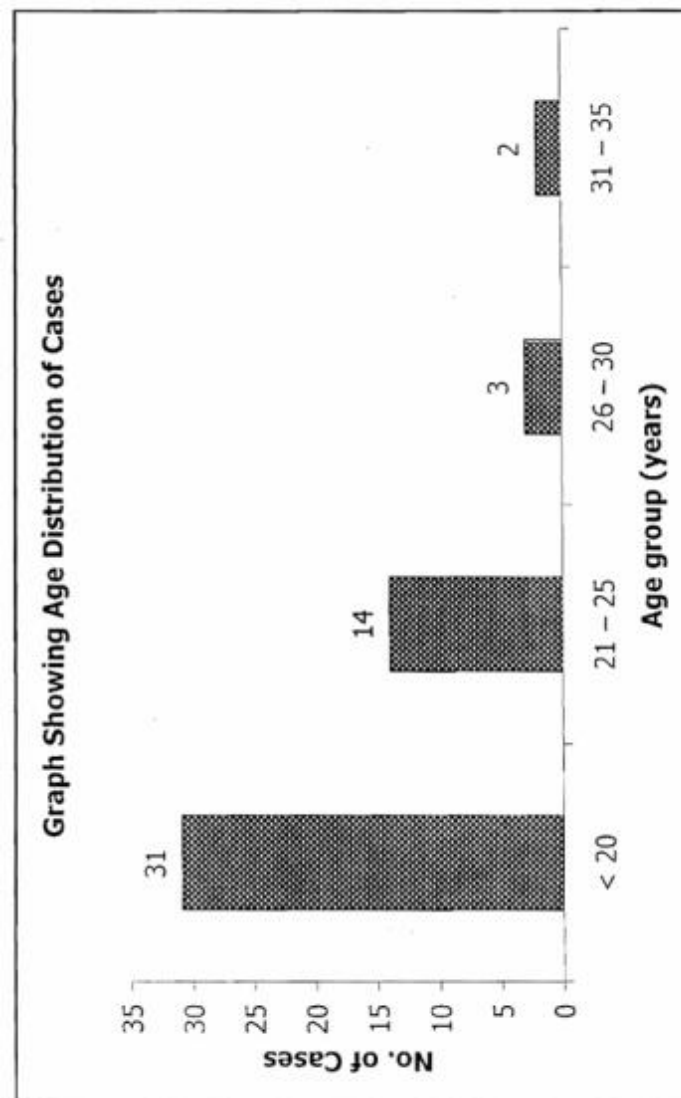
- Fifty cases diagnosed clinically having PIH, with gestational age more than 28 weeks were studied by serial Doppler ultrasonography as a part of antenatal fetal monitoring. The three vessels studied were uterine artery, umbilical artery and fetal middle cerebral artery. Various indices used were systolic/ diastolic (SD) ratio, resistance index (RI) and pulsatility index (PI).
- The highest age group in the study is below 20 years followed by 21-25 years. None of the cases are elderly primi.
- Out of the 50 cases studied, 36 cases (72%) were found Doppler positive for IUGR, the remaining 14 cases (28%) does not show any evidence of any abnormal single Doppler parameter or evidence of IUGR.
- Of the 36 cases, 20 (55.55%) of cases showed raised RI values.
- Raised values of systolic/ diastolic ratio were seen in 21 (58.34%) cases.
- 20 out of 36 cases showed diastolic notch, which was unilateral in 12 cases and bilateral in 8 cases.
- In this study, single uterine artery sensitivity is more in comparison with bilateral study.
- The maximum number of cases (21) show abnormal umbilical artery SD ratio of more than 4 in our study.
- In our study nearly two-third cases showed abnormal resistance index.
- Out of the 36 Doppler positive cases, 27 cases (75%) showed positive umbilical artery Doppler.
- In our study, we found abnormal umbilical artery Doppler (SD ratio) to be more sensitive than fetal Doppler, which is comparable with study of Jane A Bates.
- Absent end diastolic velocity in umbilical artery is more sensitive in predicting adverse fetal outcome comparable with the study done by Katherine Wenstrom.
- Only one-third cases show abnormal MGA Doppler findings in our study.
- In our study, It was found that ratio of PI of umbilical artery/ MCA is more sensitive as compared to the study done by Katherine W.Fong.
- In our study, it was found that RI of umbilical artery alone is more sensitive than the ratio of RI of MCA umbilical artery in detecting PIH/ IUGR.

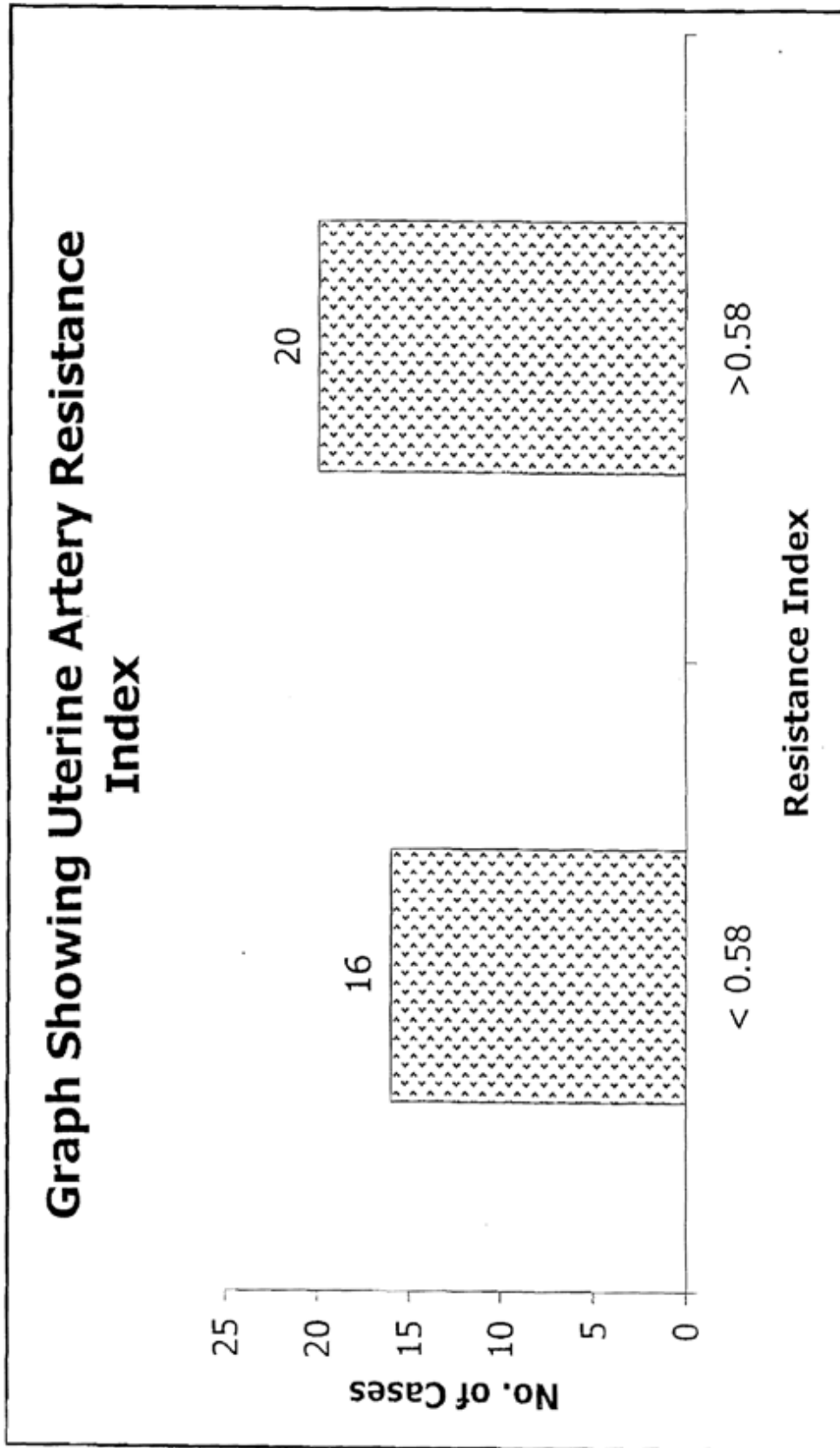
CONCLUSION:

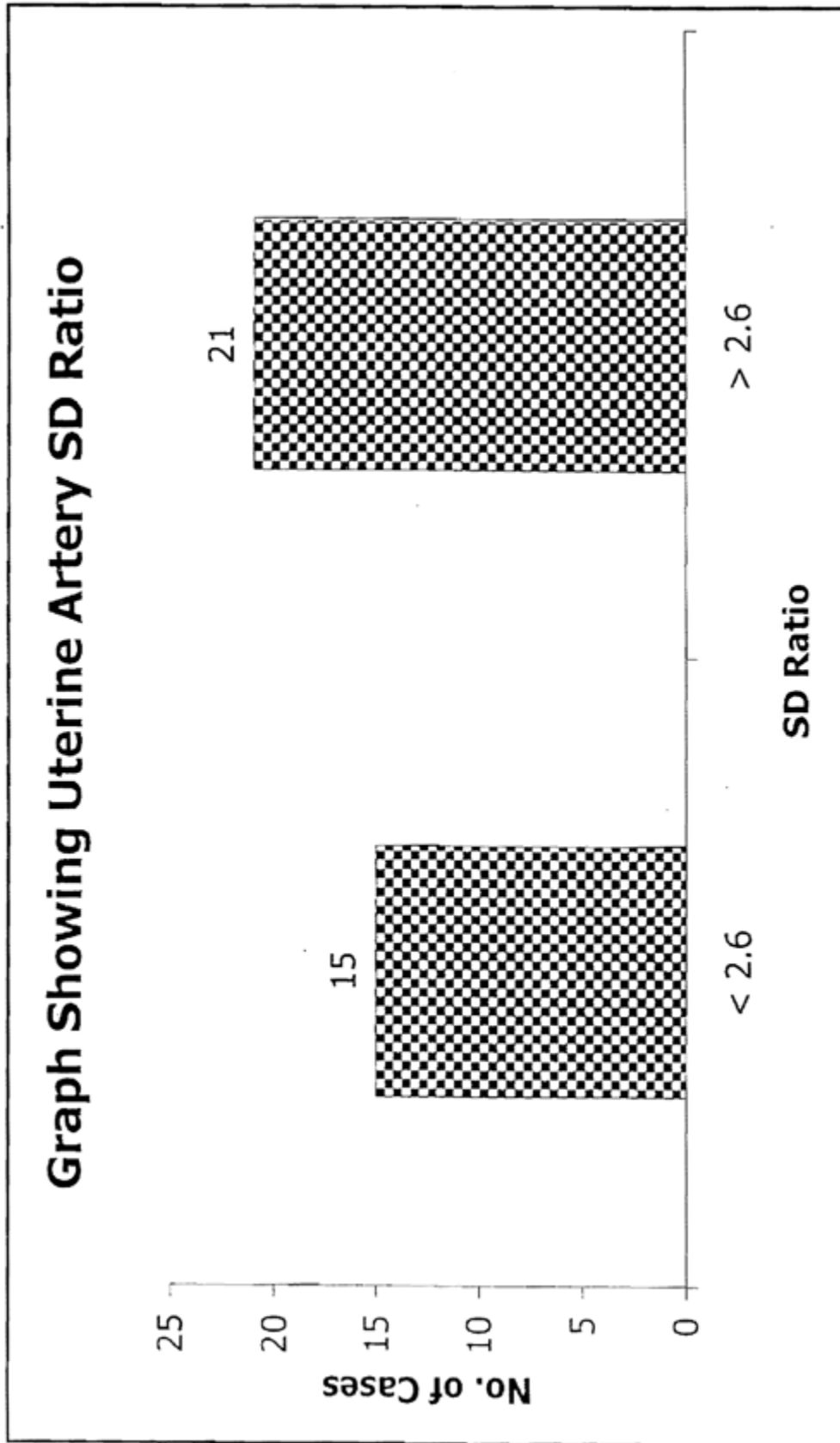
- Pregnancy induced hypertension is associated with significant fetal morbidity and mortality.
- There is progressive fall of vascular resistance in uterine, placental and umbilical arteries as gestational age increases. This will result in high end-diastolic blood flow in all these blood vessels.
- Uterine artery diastolic notch is associated with severe form of hypertension and higher incidence of intrauterine growth restriction.
- Middle cerebral artery is less sensitive than umbilical artery.
- Absent end diastolic flow (AEDE) and reverse end diastolic flow (REDF) indicates severe fetal distress and is associated with 75% of perinatal mortality.
- Cerebroplacental ratio (CPR) of less than one is associated with significant neonatal complications, intrauterine growth retardation (IUGR) and perinatal death.
- So to conclude, color Doppler study of feto-maternal circulation in high-risk pregnancy like pregnancy induced hypertension (PIH) is valuable in prediction of adverse perinatal outcome.

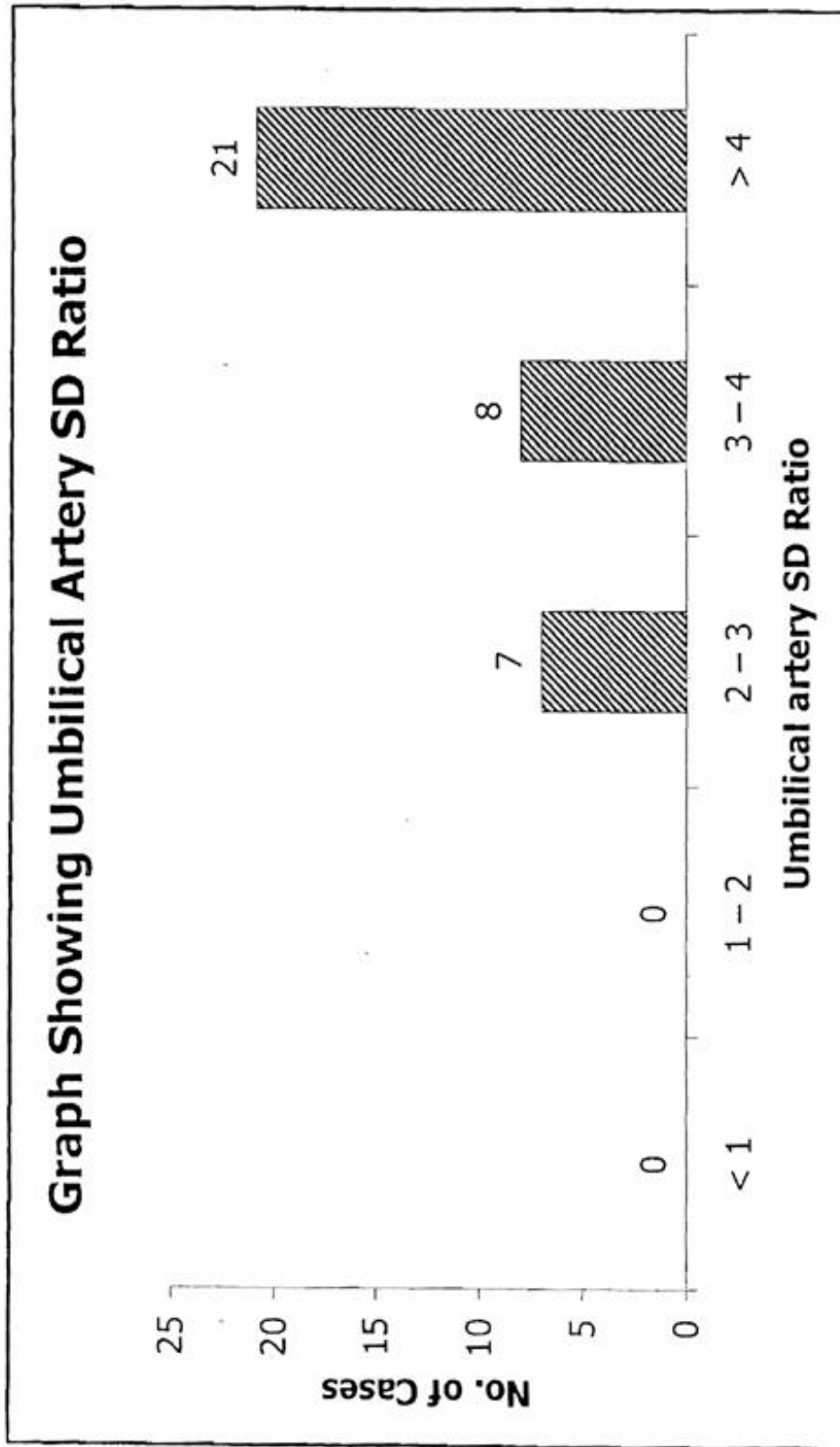
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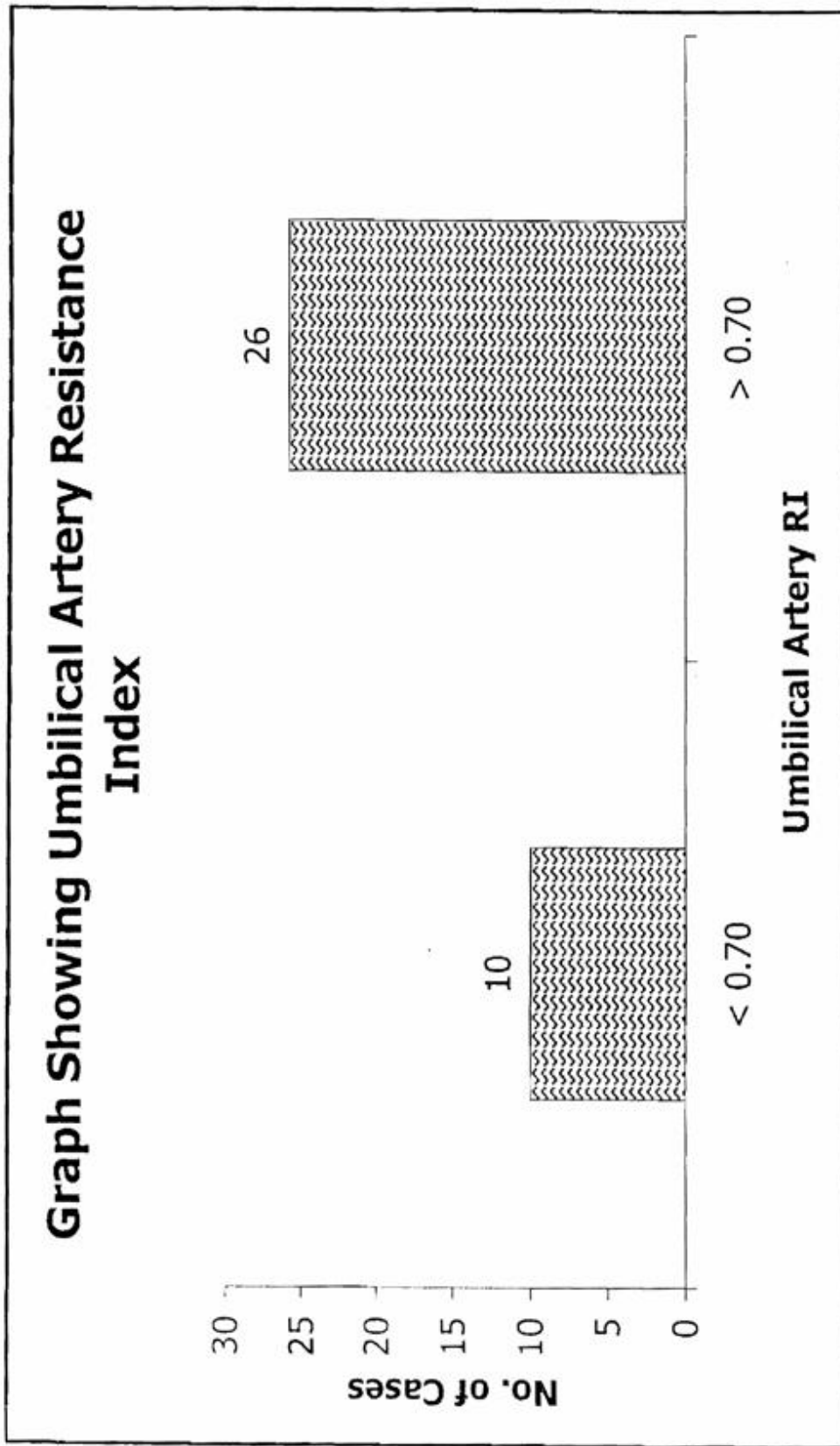
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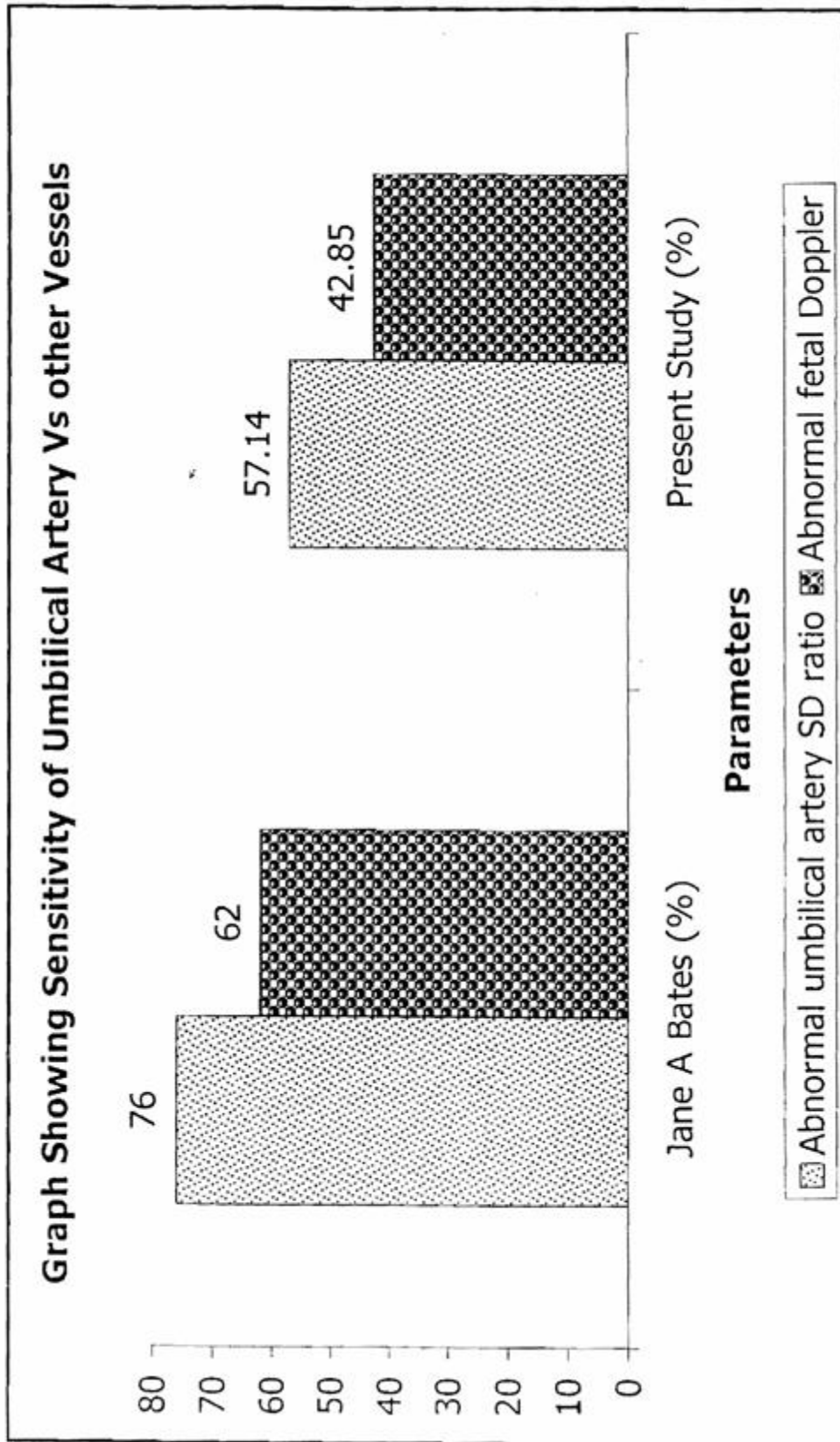


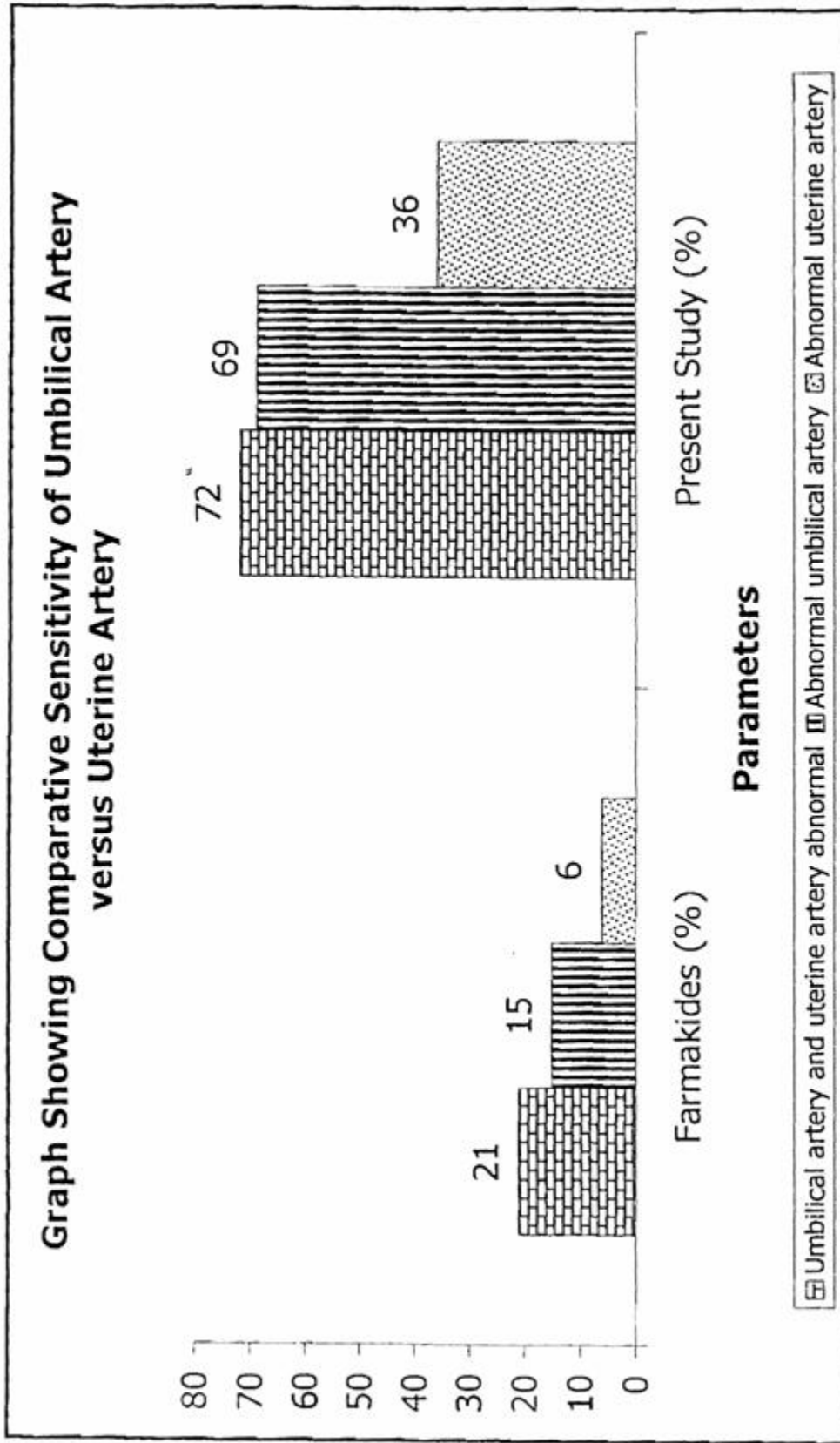


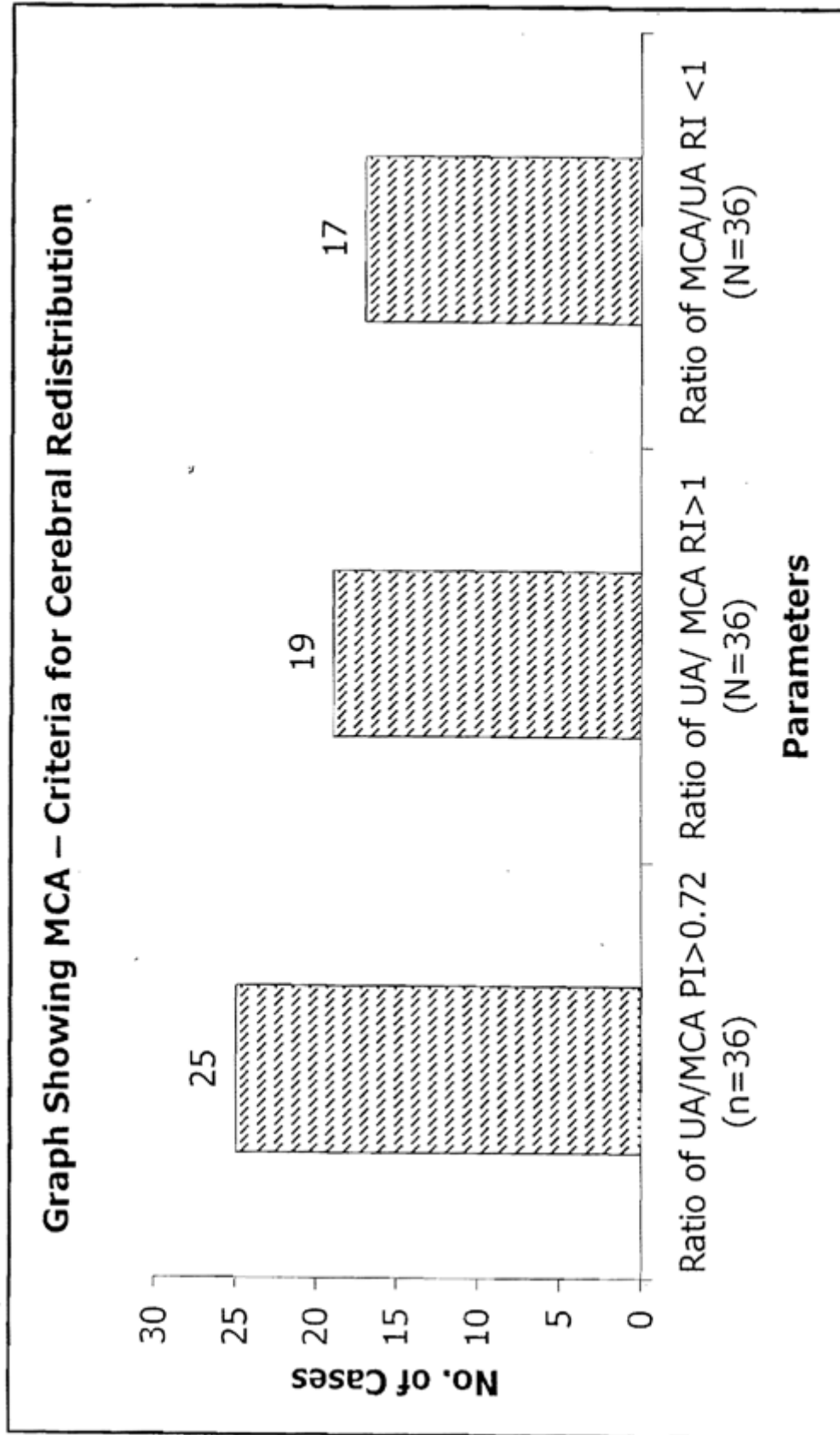


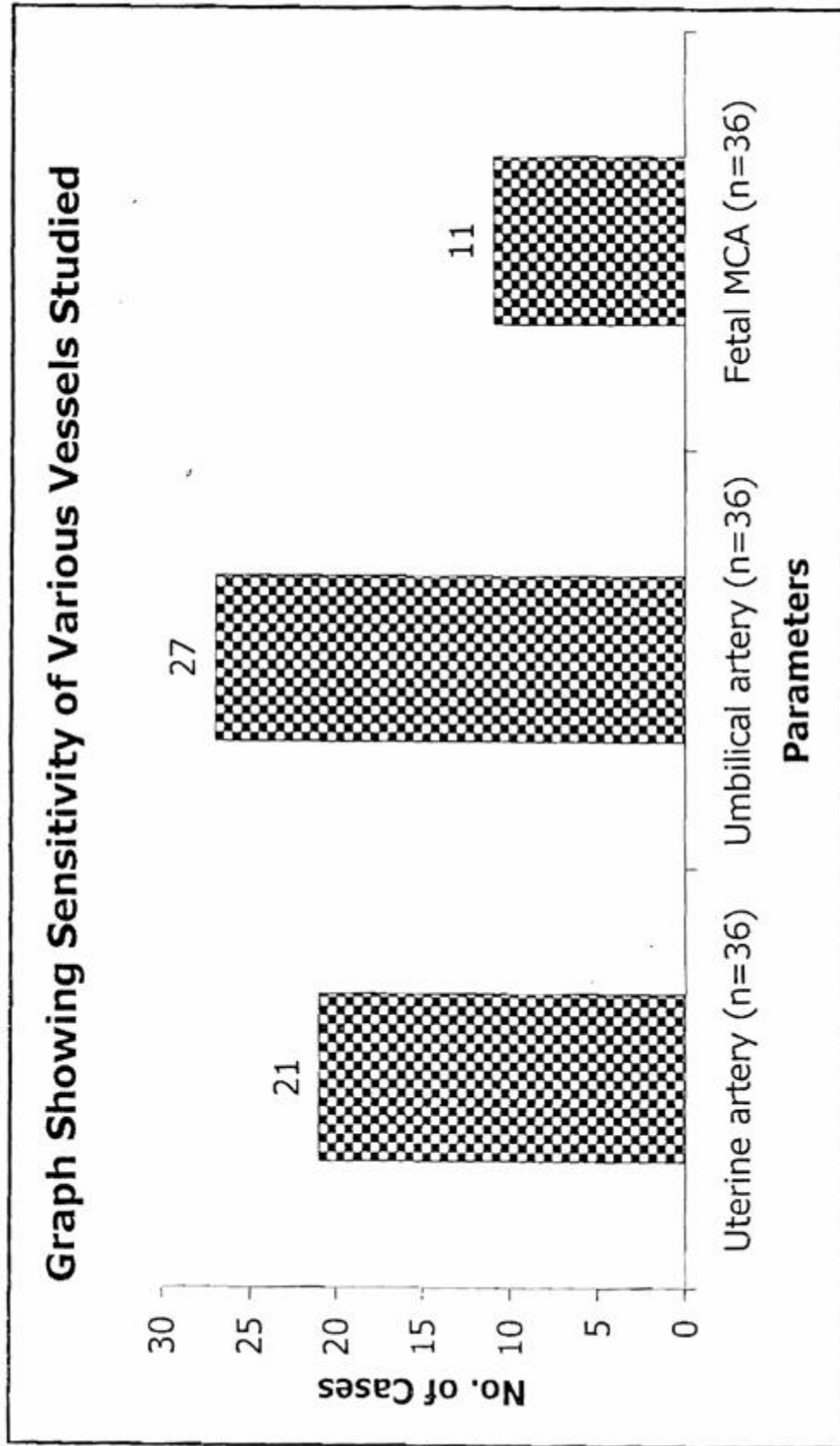


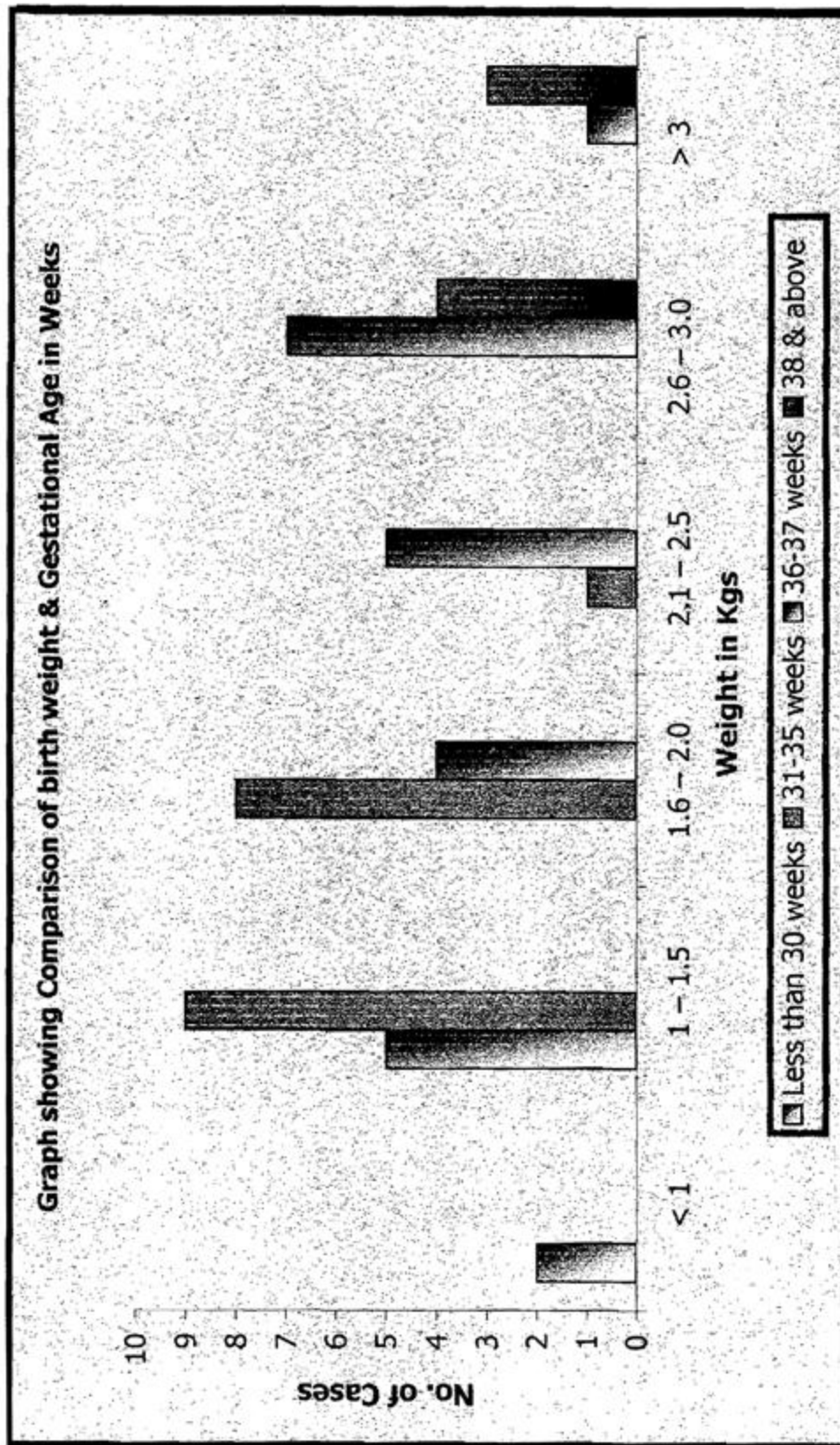


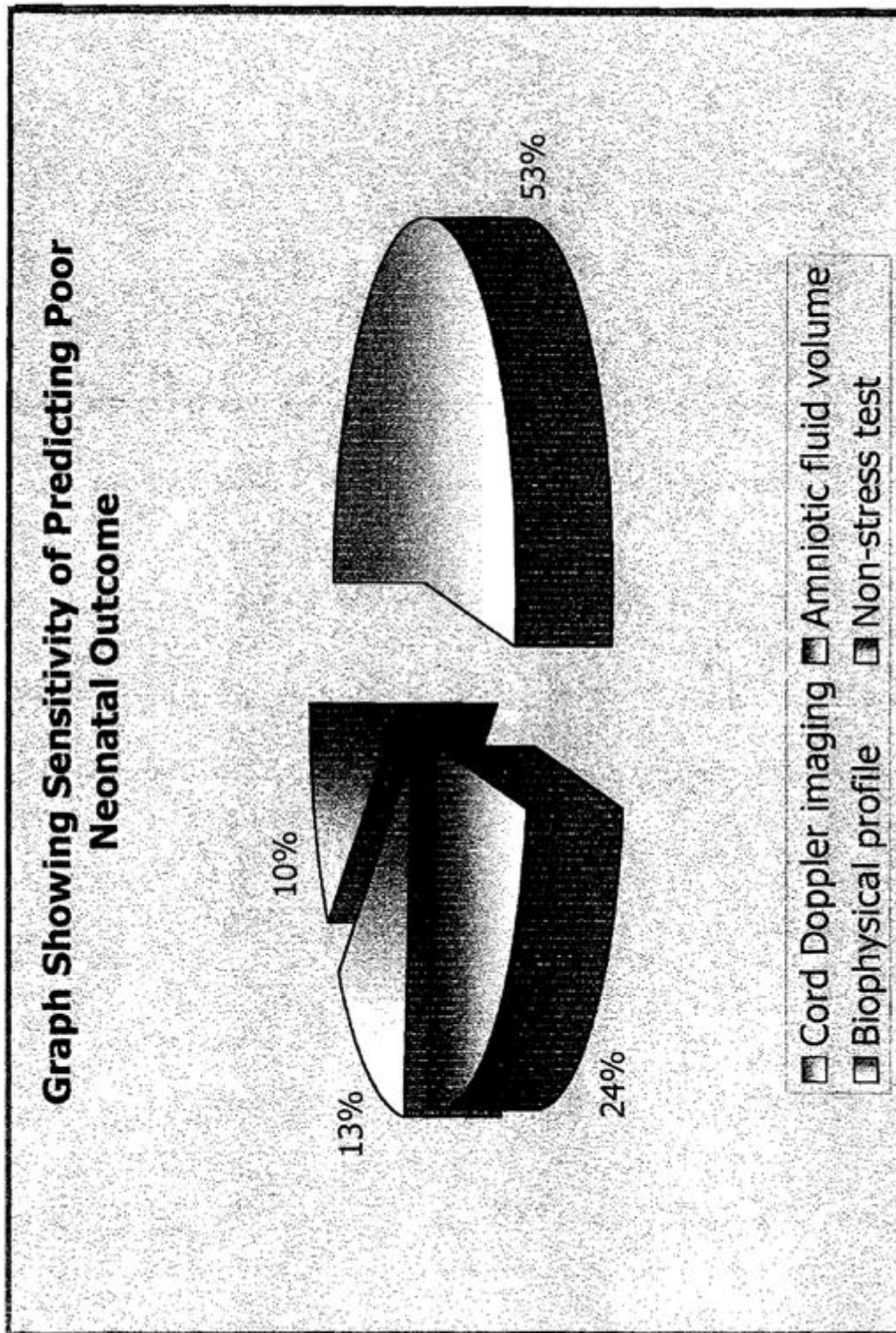




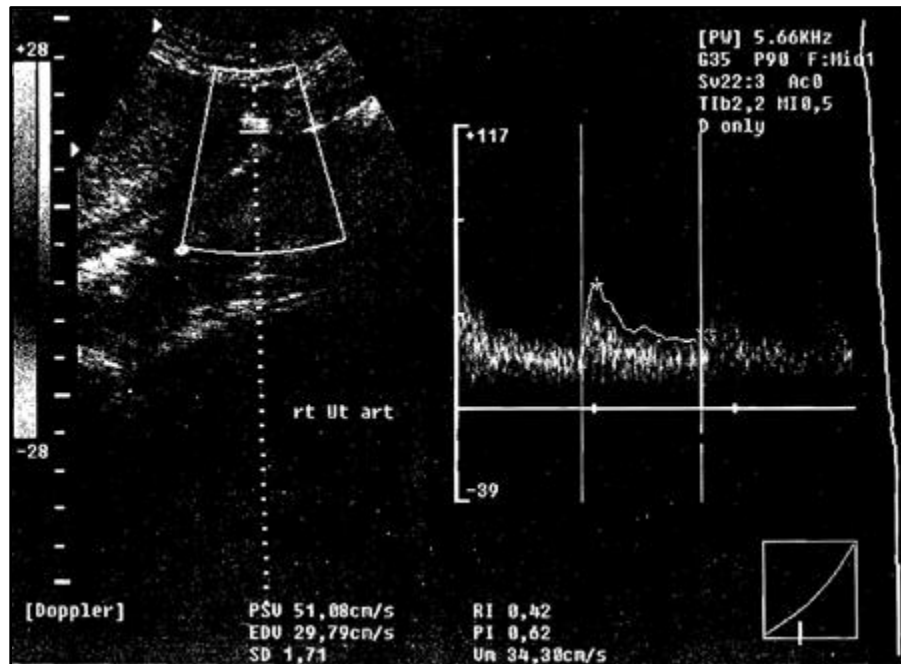




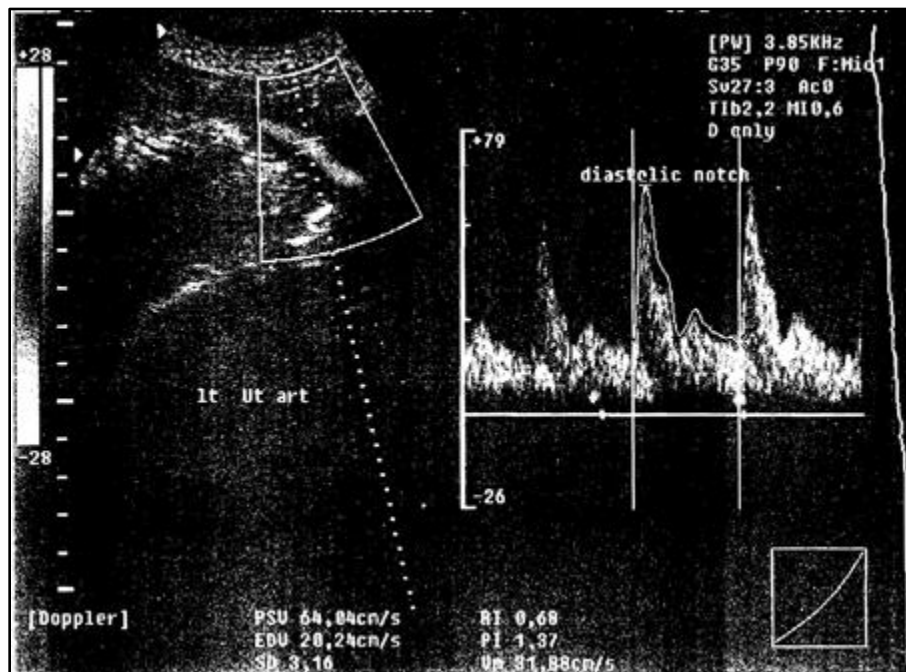




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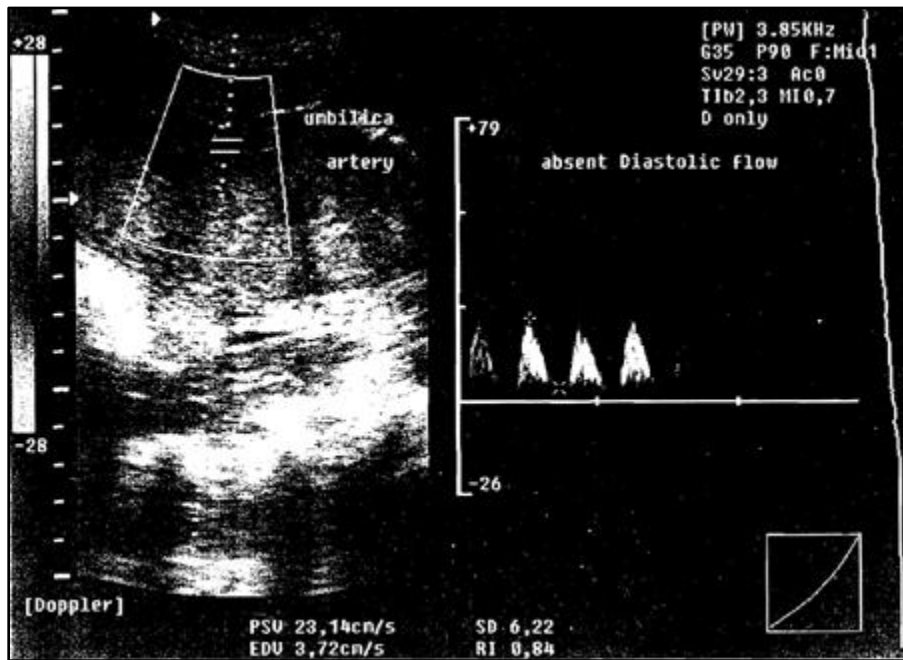


Color & Pulse Doppler imaging of Right Uterine Artery Shows Normal Doppler Parameters with no Diastolic Notch.

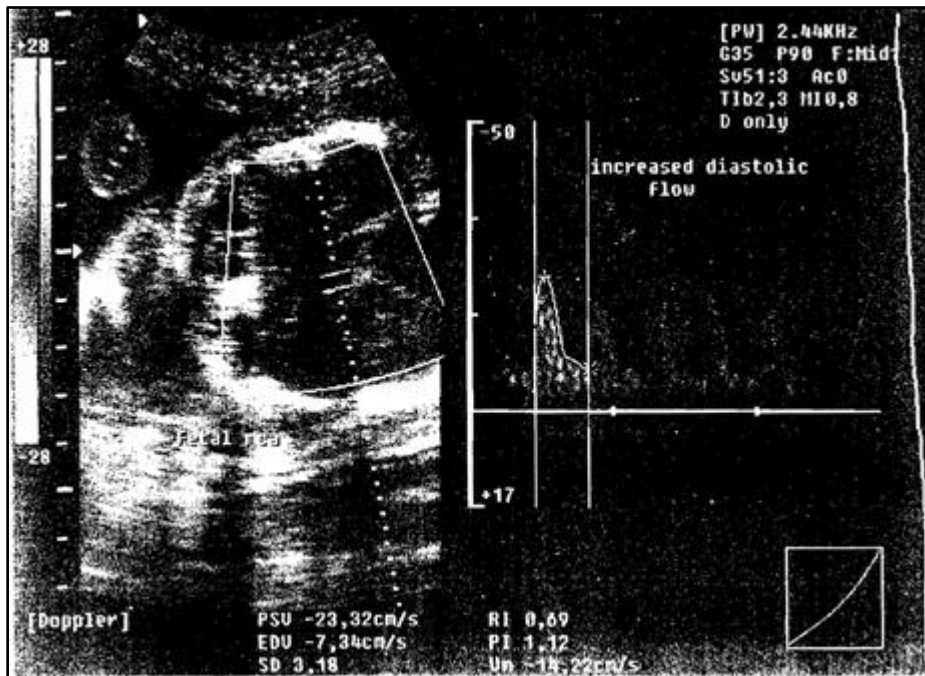


Color & pulse Doppler imaging of left uterine artery shows persistent diastolic notch at 32 weeks of Gestation with raised RI & SD ratio

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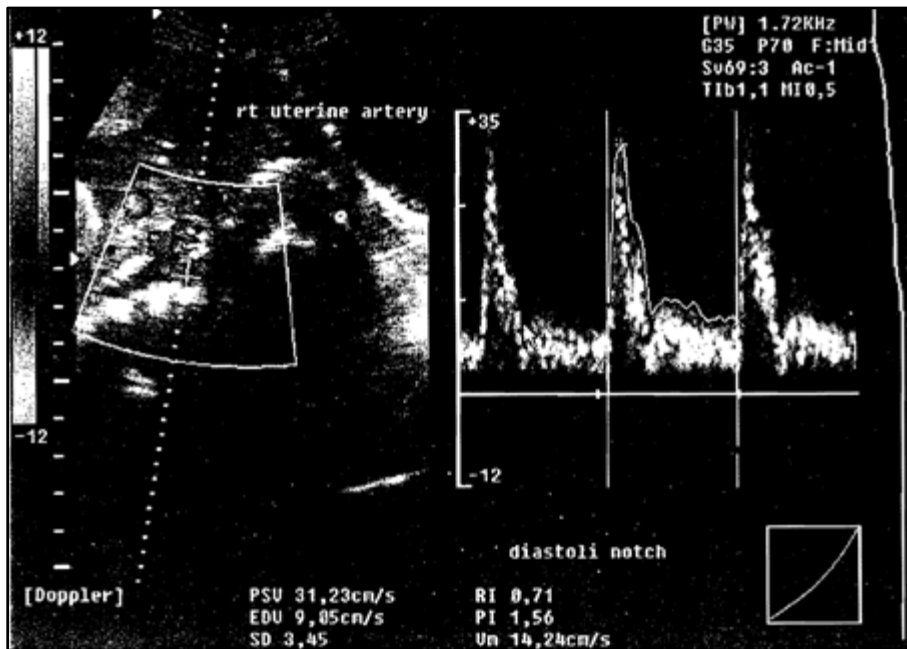


Color & Pulse Doppler Imaging of Umbilical Artery shows Absent End Diastolic Flow with Raised RI & S/D Ratio.

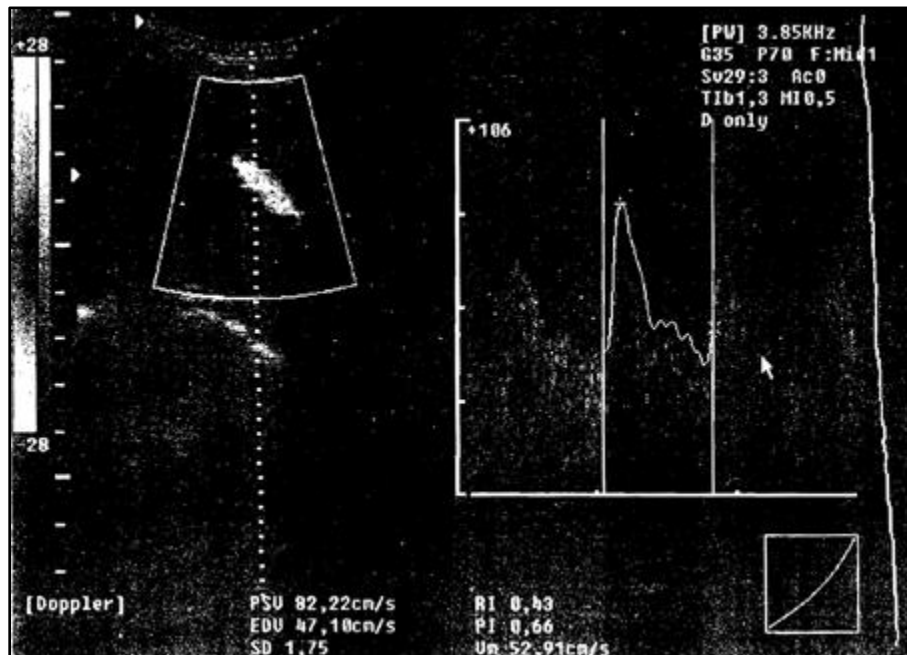


Color & Pulse Doppler imaging of Fetal MCA shows Cerebral Redistribution with Reduce RI & PI values

ORIGINAL ARTICLE

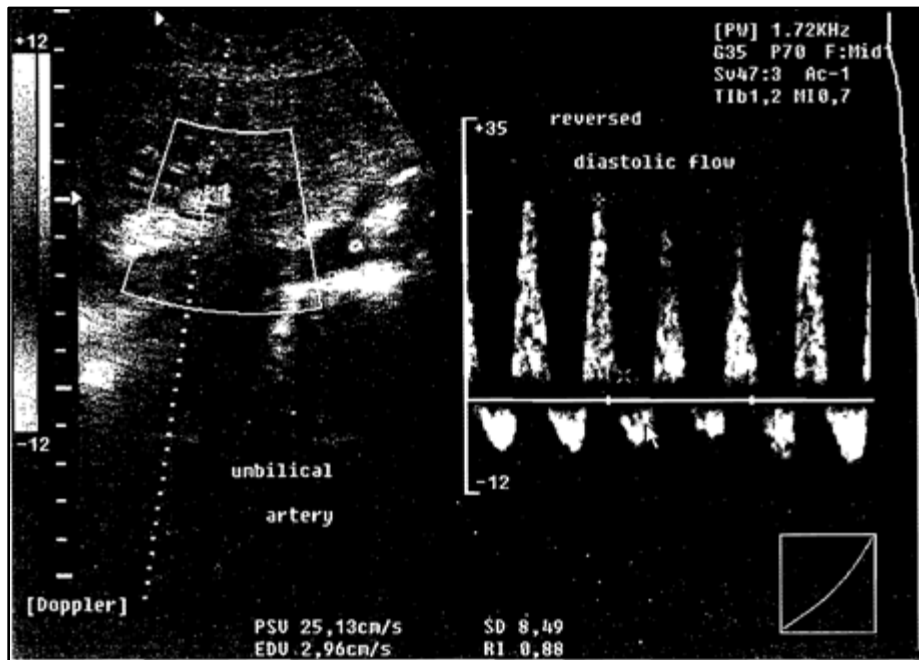


Color & Pulse Doppler Imaging of Right Uterine Artery Shows Persistent Diastolic Notch at 34 weeks of Gestation with Raised RI & S/D Ratio

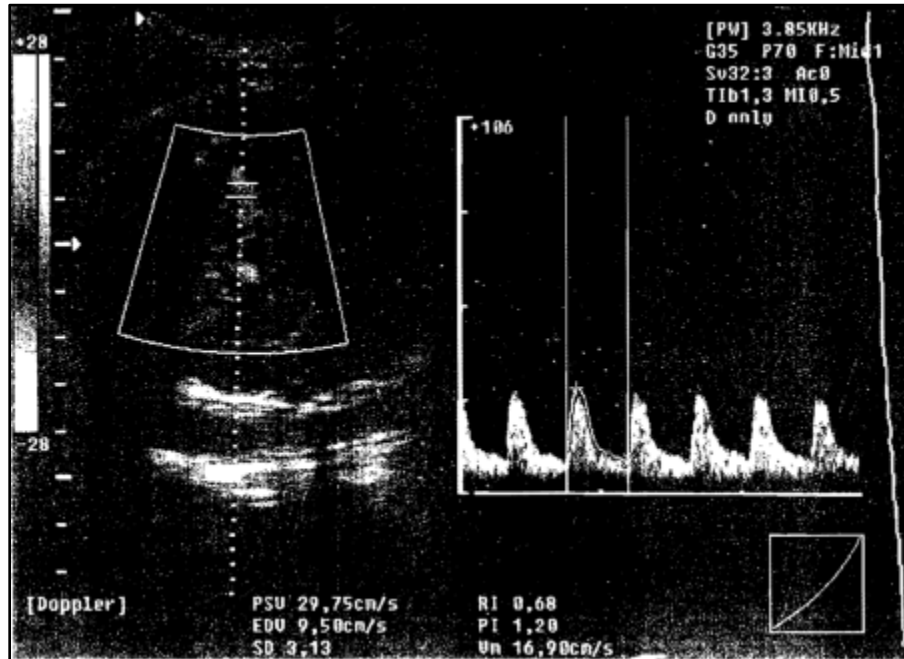


Color & Pulse Doppler Imaging of Left Uterine Artery Shows Persistent Diastolic Notch at 34 weeks of Gestation with Normal RI & S/D

ORIGINAL ARTICLE



Color & Pulse Doppler imaging of Umbilical Artery Shows Reverse Diastolic Flow Raised RI & S/D Ratio



Color & Pulse Doppler Imaging of Fetal MCA shows increased Diastolic Flow with Reduced RI & PI Values

ORIGINAL ARTICLE

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