



MULTI VESSEL DOPPLER STUDY IN EVALUATION OF IUGR WITH CLINICAL CORRELATION

Radio-Diagnosis

Dr. Vegunta Alekhya*	Post Graduate, Department Of Radiodiagnosis And Imaging, Vydehi Institute Of Medical Sciences And Research Center, Bengaluru. *Corresponding Author
Dr. Suresh A	Professor And Head Of Department, Department Of Radiodiagnosis And Imaging, Vydehi Institute Of Medical Sciences And Research Center, Bengaluru.
Dr. Anasuyamma K	Associate Professor, Department Of Radiodiagnosis And Imaging, Vydehi Institute Of Medical Sciences And Research Center, Bengaluru.
Dr. Rachana Ramesh	Post Graduate, Department Of Radiodiagnosis And Imaging, Vydehi Institute Of Medical Sciences And Research Center, Bengaluru.
Dr. Sudhanva N	Senior Resident, Department Of Radiodiagnosis And Imaging, Vydehi Institute Of Medical Sciences And Research Center, Bengaluru.

ABSTRACT

Aim Of Work: To determine and compare the diagnostic performance of Doppler sonography of maternal uterine arteries, umbilical artery and fetal middle cerebral artery for prediction of adverse perinatal outcome in clinically suspected intrauterine growth restriction. **Materials And Methods:** Thirty singleton pregnancies beyond 28 weeks of gestation complicated by intrauterine growth restriction were prospectively examined with Doppler ultrasound of uterine arteries, umbilical artery and fetal middle cerebral artery. **Results:** Nineteen patients of the thirty included in the study population had at least one adverse outcome. Adverse outcome criteria included perinatal deaths, emergency caesarean section for fetal distress, 5 min APGAR score of less than 7, admission to NICU for complications of low birth weight. Mean birth weight of neonate at delivery was 2.18 ± 0.26 kg (2SD). 70% fetuses had birth weight of less than 2.5kg. There were 3 intrauterine deaths and 27 live births. Of the 3 intra uterine deaths two had absent diastolic flow and one had reversal of diastolic flow. The mortality in cases of reversal and absent end diastolic flow was 100% and 40% respectively, indicating grave prognosis. Of 27 live births 6 neonates were admitted to NICU, 7 neonates had 5min APGAR score of less than 7 and 9 babies were born by emergency caesarian section. **Conclusion:** PI ratio of MCA/Umb A is the most sensitive index in predicting perinatal outcome (89.5%). MCA pulsatility index is the most specific index (90.9%). Sensitivity of uterine artery Doppler to detect utero-placental insufficiency was 83%. Presence of absent or reversal of diastolic flow in umbilical artery is an ominous sign since it carries a grave prognosis and high mortality. The sensitivity of the Doppler studies can be significantly increased by studying multiple vessels. Hence we conclude that Doppler studies of multiple vessels, the utero-placental and feto-placental circulation can help in monitoring of compromised fetus and can help us predicting neonatal morbidity. This may be helpful in determining the optimal time of delivery in complicated pregnancies.

KEYWORDS

INTRODUCTION

The growth of human fetus, a complex process resulting in an increase in size over time has been the subject of extensive study. Before the advent of ultrasound evaluation, the prospective assessment of fetal growth during pregnancy has been limited to measuring the uterine size and guessing the fetal size by palpation and could only look at the infant at delivery and infer at what happened in utero. This lead to increasing perinatal mortality and morbidity. The very objective of obstetrics was getting defeated. But now, in the era of sophisticated modality of real time ultrasound, antenatal diagnosis of intrauterine growth restriction has become very easy, thus minimizing the future catastrophe.¹

The incidence of IUGR in a population where the mothers are generally healthy and well-nourished is estimated to be about 3-5%. In a population of women with hypertension or previous growth restricted fetus however the incidence increases to 15-20% or higher². The incidence of IUGR varies from region to region and even in the same region, it varies in different sub populations. In India, according to recent UNICEF surveys, the incidence of IUGR is 25-30%³. IUGR has many causes; maternal causes include hypertension, collagen vascular disease, renal disease, poor nutrition and drug or alcohol abuse which cause placental insufficiency.

Accurate antenatal diagnosis of IUGR by real time ultrasound can reduce the complications and improve the outcome. After the introduction of ultrasound the small fetuses could be identified, however it could not be determined which of these fetuses were at increased risk due to utero placental insufficiency and therefore needed special surveillance. Small fetuses were therefore monitored by non-stress test of fetal heart rate and the biophysical profile.

With the introduction of Doppler Ultrasound examination it became possible to assess the utero-placental blood flow, feto-placental blood

flow and to assess the fetal blood circulation. The utero-placental and feto-placental circulation give information on the placental resistance whereas evaluating the fetal circulation using Doppler ultrasound could non-invasively assess the fetal response to hypoxia. It has become possible to identify those small fetuses that were at increased risk of perinatal morbidity and mortality due to impaired utero-placental and feto-placental circulations. Umbilical arterial (Umb A) Doppler velocimetry is the most rigorously evaluated tests of fetal well-being⁶. IUGR there is a significant reduction of middle cerebral arterial (MCA) pulsatility index when compared with those in normal fetuses⁷. At Cordocentesis, a significant correlation has been observed between hypoxemia in fetuses with IUGR and an abnormal MCA pulsatility index⁸.

This study titled "MULTI VESSEL DOPPLER STUDY IN EVALUATION OF IUGR WITH CLINICAL CORRELATION" focuses on establishing the role of Umbilical artery and Middle cerebral artery Doppler ultrasound in predicting adverse perinatal outcomes in clinically suspected IUGR pregnancies and to determine the role of Doppler velocimetry in clinical management of such pregnancies.

Aims And Objectives

- i) To evaluate the role of colour Doppler sonography in the evaluation of a pregnancy with intrauterine growth restriction.
- ii) (To determine the role of Doppler ultrasound in the management of IUGR pregnancy.

MATERIALS AND METHODS

The study was conducted for a period of one year from March[†] 23 to March 2024.

Data for the study was collected from patients attending the department of Radio-diagnosis, referred by Department of Obstetrics

and Gynecology at our college. The patients were explained in detail before the examination. Consent was taken as per P. N. D. T act.

The study included 30 antenatal women who were diagnosed as having a fetus with intra uterine growth restriction based on grey scale ultrasound findings and referred for obstetric Doppler Ultrasound if the following inclusion criteria and exclusion criteria were met.

The Inclusion Criteria Were:

1. Singleton pregnancy with gestational age more than 28 weeks.
2. Women with reliable dating of pregnancy confirmed by an early first trimester ultrasound examination using CRL or BPD or with known LMP will be selected.

The exclusion criteria were:

1. Antenatal women where IUGR was a clinical suspicion only and no grey scale ultrasound assessment was done.
2. All subjects with history of rupture of membranes, active labour, multiple pregnancies and fetuses with congenital anomalies.

Doppler US evaluation was performed following a detailed clinical history and US biometry.

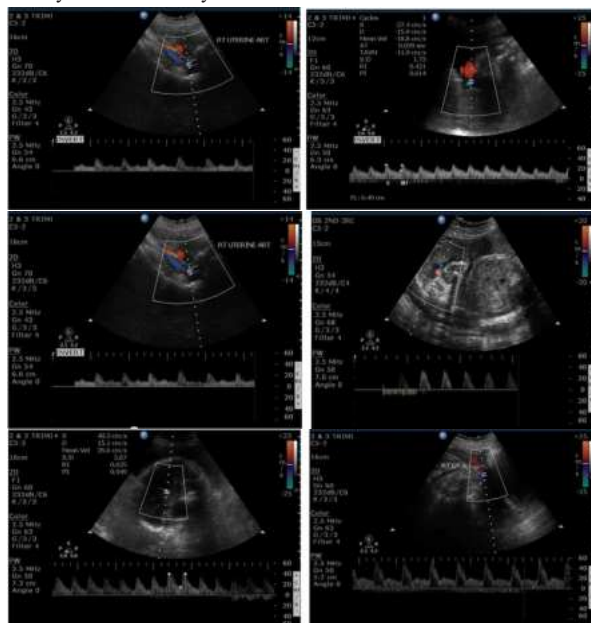


Fig No.1 Uterine artery showing normal wave forms and velocimetry, **Fig No.2** Umbilical artery showing normal wave forms and velocimetry, **Fig No.3** Middle cerebral artery showing normal waveforms and velocimetry, **Fig No.4** Uterine artery Doppler showing early diastolic notch, with high S/D, **Fig No.5** Uterine artery with diastolic notch, **Fig No.6** Umbilical artery with reduced diastolic flow.



Fig No.7 Umbilical artery showing absent end diastolic flow, **Fig No.8** Umbilical artery showing reverse end diastolic flow.

Statistical Analysis

The diagnostic statistics were used to find the diagnostic value of Umb A PI, MCA PI and MCA/Umb A PI in relation to perinatal outcome. The sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were determined for all Doppler measurements using the following formulae.

$$\text{Sensitivity} = A/A+C \times 100$$

$$\text{Specificity} = D/B+D \times 100$$

$$\text{Positive Predictive Value} = A/A+B \times 100$$

$$\text{Negative Predictive Value} = D/C+D \times 100$$

$$\text{Diagnostic Accuracy} = A+D / \text{Total number of cases}$$

A = True positive B = False positive C = False negative D = True negative

Statistical Software: The statistical software namely SPSS 11.0 and Systat 8.0 were used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables etc.

RESULTS

A prospective study of 30 antenatal patients was done after considering the inclusion and exclusion criteria. Flow velocity waveforms of the uterine, umbilical, middle cerebral arteries were obtained from all the 30 cases and were analyzed.

All our patients ranged from 19 years to 31 years. Majority of the patients (80%) were in 20-30 years age group. The average age of the patients was 24.5 years. Least number of patients was seen in the age group of more than 30 years.

In our study group of 30 antenatal mothers, the gestational age at the time of Doppler examination ranged between 29 - 38 weeks.

In the study group of 30 antenatal mothers, the clinical presentation and the indications for the Doppler examination were shown below.

Clinical presentation	Number	Percentage
1.IUGR only	8	26.67
2.IUGR and pregnancy induced hypertension (PIH)	17	56.67
3.IUGR with Anemia	5	16.67
4.IUGR with bad obstetric history	2	6.67

56.67% of patients had pregnancy-induced hypertension which is the most common cause for IUGR in our series. Only IUGR as the indication for the Doppler study was seen in 26.67%. IUGR with anemia complicating pregnancy was present in 16.67% of cases. Bad obstetric history was seen in 6.67%.

Uterine Artery Doppler Studies

Changes In Uterine Artery Resistance Index (ri)

RI	NUMBER	PERCENTAGE
ELEVATED	21	70
NORMAL	9	30
TOTAL	30	100

21 mothers (70%) had an elevated uterine artery RI and 9 patients (30%) had normal uterine artery RI.

Distribution Of Elevated Uterine Artery (ri)

	NUMBER	PERCENTAGE
Only one uterine artery with elevated RI	9	30
Both uterine arteries with elevated RI	12	40
No elevation of RI	9	30
TOTAL	30	100

In our study we had 9 patients (30%) with only one uterine artery showing an elevated RI and 12 patients (40%) had bilaterally elevated RI. Only 9 patients (30%) were showing normal resistance indices.

Uterine Artery Early Diastolic Notch

Diastolic notch	Number	Percentage
PRESENT	19	63.3
ABSENT	11	36.7
TOTAL	30	100

Persistent uterine artery early diastolic notch.

19 antenatal mothers (63.3%) had a persistent early diastolic notch in the uterine artery whereas 11 patients (36.7%) had normal uterine artery flow waveform.

Distribution Of Uterine Artery Early Diastolic Notch

	NUMBER	PERCENTAGE
One uterine artery	8	26.6
Both uterine arteries	11	36.7
No early diastolic notch	11	36.7
TOTAL	30	100

8 patients (26.6%) had only a unilateral persistent early diastolic notch

and another 11 (36.7%) had a bilateral notches.

Changes In Uterine Artery Using Both Parameters

Flow velocity profile	NUMBER	PERCENTAGE
ABNORMAL	21	70
NORMAL	9	30
TOTAL	30	100

Doppler findings in the uterine artery using both parameters (RI, diastolic notch).

21 of the 30 antenatal mothers (70%) with IUGR showed an abnormal uterine artery flow velocity profile, when all two parameters (RI, presence of persistent early diastolic notch) were considered.

Umbilical Artery End Diastolic Velocity Flow Pattern

	NUMBER	PERCENTAGE
TOTAL	30	100
POSITIVE DIASTOLIC FLOW	24	80.0
ABNORMAL	5	16.7
REVERSAL	1	3.33

Absence or reversal of end diastolic velocity.

Five fetuses (16.7%) showed absence and 1 fetus (3.33%) had reversal of end diastolic umbilical artery flow with the total of 6 fetuses (20.0%) having abnormal waveform.

Analysis Of Both Uterine And Umbilical Arteries

	NUMBER	PERCENTAGE
Both Uterine and Umbilical Arteries Changes	24	80
Only Uterine Artery Changes	21	70
Only Umbilical Artery. changes	18	60

80% of the study group (24 mothers) showed abnormalities in either the uterine or umbilical arteries when both were assessed together. When individual arteries were considered, uterine arteries showed better pick up rates (70.0%) than the umbilical arteries (60%).

Fetal Middle Cerebral Artery Doppler Study

PI	NUMBER	PERCENTAGE
DECREASED	11	36.7
NORMAL	19	63.3
TOTAL	30	100

36.7% (n=11) of the 30 fetuses had decreased Pulsatility index and 63.3% (n=19) had normal Middle cerebral artery Pulsatility index.

DISCUSSION

Fetal growth and development is a natural process for each and every human kind, which has aroused the interests of all clinicians for many years, since not all fetuses grow or develop equally. Intrauterine growth restriction does not imply a specific pathophysiology but merely a result of a series of events occurring along several possible pathways. Hence, accurate antenatal diagnosis must decide whether the fetus is constitutionally small for gestational age or small as a consequence of impaired placental perfusion. Doppler flow velocity analysis can be valuable in solving this problem, by examining uterine arteries (utero-placental circulation), umbilical arteries (feto-placental circulation) and middle cerebral artery (fetal-circulation). Our study was done in 30 pregnant women, who were diagnosed as having fetuses with intrauterine growth restriction based on clinical suspicion and grey scale ultrasound examination.

Numerous studies with varying results have been published and difficult to compare. This controversy can partly be explained by small number of patients enrolled, varying sample sizes and techniques as well as different criteria used to define the adverse perinatal outcome. As can be seen yet no universally accepted standard for defining an abnormal Doppler flow velocity waveforms as well as the pregnancy outcome measure, so conflicting observations might continue to emerge.

Age Incidence: It is observed that the maximum number of pregnant women were in the age group of 21-25 years (50%). This can be attributed probably for the increased pregnancy rate in these age groups. PIH is more common in primigravida due to first time exposure

to chorionic villi. The age ranged from 19-31 years.

Distribution Of Gestational Age

In this study all patients underwent Doppler study in the third trimester of their pregnancy with 70% being investigated between 31 - 35 weeks of gestation. The earliest study was done at 29th week of gestation. Hence most pregnancies were monitored between 31-35 weeks, when the fetus would have begun developing sufficient lung maturity to survive outside the uterus. Symmetrical IUGR accounts for 20-30% and asymmetrical IUGR accounts for 70-80%. In asymmetrical IUGR insult begins later than symmetrical IUGR, usually after 28 weeks of gestation. Hence 31- 35 weeks of gestation probably could be more common.

Etiology of IUGR

Among women where a cause for IUGR was identified, 56.67% had pregnancy induced hypertension (PIH), 16.67% had anemia complicating pregnancy. This can be attributed to asymmetrical IUGR which accounts for 70-80% in which utero- placental insufficiency (PIH) was the most common cause. Hypertensive disorders are present in 30% to 40% of pregnancies complicated with IUGR. Bad obstetric history as a cause is seen in 6.67%. Eight patients (26.67%) of the study group had no detectable cause for IUGR

Uterine Artery

In the present study, the persistent early diastolic notch beyond 26 weeks of gestation showed a sensitivity of 78.9%. This is slightly higher than the study by Colemann et al who showed sensitivity of the uterine artery notch as 76% for adverse perinatal outcome. This may be because of the included women was with bilateral notches in Colemann study, whereas in present study presence of diastolic notch either left or right nor both were included. However, the analysis done by Farrell et al for reliability of early diastolic notch in uterine artery as predictor for uteroplacental insufficiency revealed a sensitivity of 88%.

The sensitivity of RI was 73.7% in our study in comparison with that of Benson and Doubilet (67%) and Colemann et al (83%). This discrepancy may be contributed to different cut of levels of resistive index, varying between 0.5 to 0.62. Best screening test is measuring placental site uterine artery RI. If the placenta is situated at the midline, the highest RI is best predictor.

When both Doppler parameters were taken into account, the sensitivity of uterine artery Doppler for predicting perinatal outcome was 83%. This is in agreement to the study by Zimmermann et al, who found a combination of several Doppler parameters to be superior to a single parameter.

Umbilical Artery

In the present study the umbilical artery PI had a sensitivity of 84.2%. According to D.Gramellini et al, the sensitivity of PI in the Umbilical artery in predicting perinatal outcome was 64%. Umbilical artery was the main vessel used for monitoring high risk pregnancies. This is because umbilical artery represents fetoplacental system and primarily reflects placental resistance. In present study as there is more number of PIH cases probably this can be attributed for difference in the studies. Another study by K W Fong et al showed the sensitivity of PI in the umbilical artery as 58.3%. Absence or reversal of the end diastolic flow velocity was seen in 20% fetuses in our study compared with that of 37% in the study by Benson and Doubilet.

Fetal Blood Circulation And Redistribution

The pulsatility index of the fetal MCA was decreased in 37% of fetuses. In the present study fetal middle cerebral artery PI had a sensitivity of 57.8%. In Arduini and Rizzo study the sensitivity of MCA in predicting perinatal outcome was 68%. Considering the location of MCA, the PI varies. So it is important that the artery be identified precisely and with certainty.

The redistribution calculated from the ratio of the PI in the MCA to PI in umbilical artery showed 63% of the fetuses to redistribute their cardiac output than either umbilical artery PI (60%) or middle cerebral artery (36.7%) alone. The sensitivity of MCA PI / Umb PI of our study is 89.5% in predicting perinatal outcome. These results are slightly higher to D Gramellini et al study (68%), probably this may be attributed to small sample size.

Prediction Of Perinatal Outcome

63 % (n=19) fetuses had at least one adverse outcome. Remaining 37% (n=11) fetuses had favorable outcome. There were 3 Intra uterine deaths and 27 live births. Of the 3 IUD's two had absent diastolic flow and one had reversal of diastolic flow. The mortality in cases of reversed and absent end diastolic flow was 100% and 40% respectively, indicating grave prognosis. Of the 27 live births 6 neonates were admitted to NICU, 7 neonates had 5min APGAR score less than 7, and 9 babies were born by emergency caesarian section. These results are slightly higher than Gramellini et al this can be contributed to difference in perinatal mortality and morbidity rates from western standards to Indian standards.

By using Doppler ultrasound results for analysis, the MCA/Umb A pulsatility index ratio had a higher sensitivity and positive predictive value for predicting the adverse perinatal outcome than the MCA and the Umb A pulsatility indices.

Our findings agree with the results of the studies that have shown MCA/UmA PI Doppler ratio to be more useful than UmA PI or MCA PI in predicting the adverse outcome. Comparison between different studies would be meaningful if uniform of standardized criteria were used.

Our studies confirmed with those of Gramellini et al. that best results are obtained when we used MCA / Umb A PI ratio, rather than pulsatility indices of Middle Cerebral Artery and Umbilical Artery separately.

Summary

We studied about 30 pregnancies with clinical suspicion of IUGR. Mean birth weight at delivery was 2.18kg +/- 0.26 kg (2SD). 70% of neonates (n=21) had birth weight of less than 2.5 kg. 63 % (n=19) fetuses had at least one adverse outcome. Remaining 37% (n=11) fetuses had favorable outcome. There were 3 intra uterine deaths and 27 live births. Of the 27 live births 6 Neonates were admitted to NICU. 7 neonates had 5 min APGAR score of less than 7 and 9 babies were born by emergency caesarian section.

The sensitivity of uterine artery Doppler study to detect adverse perinatal outcome was 83% when two Doppler parameters were considered.

The sensitivity of Doppler examination of the umbilical artery using PI in predicting perinatal outcome was 84.2%. Doppler studies of the umbilical artery and uterine artery together had a better sensitivity than that of the individual vessels.

The MCA/umbilical PI ratio showed more fetuses to redistribute their cardiac output than the abnormal MCA PI or Umb A PI. The cerebro-umbilical ratio provided a better predictor of intrauterine growth restriction and adverse perinatal outcome than either the middle cerebral artery or umbilical artery alone. Our studies confirm with those of Gramellini et al that best results are obtained when we used MCA/UmA PI Ratio, rather than PIs of middle cerebral artery and Umbilical artery separately.

CONCLUSION

The umbilical-placental and cerebral vascular beds are directly involved in the hemodynamic adjustments of fetal growth restriction. A Doppler index that reflects both of these areas can be useful for identifying fetuses with increased placental and/or decreased cerebral resistance

Assessment of both the utero-placental circulation and the fetoplacental circulations together is more sensitive to predict perinatal outcome, than assessment of each alone. In suspected IUGR, cerebro-umbilical ratio (MCA/UA PI) is a better predictor of adverse perinatal outcome than an abnormal MCA PI or Umbilical Artery PI. Best results are obtained when we use MCA/UA PI Ratio, rather than PIs of middle cerebral artery and Umbilical artery separately.

Presence of absent/reversal of diastolic flow in Umbilical artery is an ominous sign since it carries a grave prognosis and high mortality.

Doppler imaging is of value for monitoring the pregnancy because it can provide indirect evidence of fetal compromise and is known to improve outcomes of high risk pregnancies with Intrauterine growth restriction. Hence Doppler evaluation is complementary to all other

surveillance modalities.

REFERENCES

1. Lugo G.Cassady. Intrauterine growth retardation clinico pathological findings in 233 conscriptive infants. *Am J Obstet Gynecol* 1971; 109: 615-122.
2. Galbraith RS, Kershmar EJ, Peirce WN, Low JA. The clinical prediction of intrauterine growth retardation. *Am J Obstet Gynecol* 1979; 133: 281-286.
3. Devi PIC, Krishna menon MK, Bhaskar Rao K. Postgraduate obstetrics and gynecology. Orient long man; 3rd Edn 1998; 2114
4. Seeds J.W. Impaired fetal growth: definition and clinical diagnosis *Obstet Gynecol* 1984; 64: 303-310.
5. Sendhi Jain, Manju Puri. Diagnosis of intrauterine growth retardation –A review *Obstet and Gynec today* 2001; 11: 670-673.
6. Kok JH, Devi Ouden AL, Verloove-Venhorick SP, Brand R. Outcome of very preterm small for gestational age infants : the first nine years of life. *Br J Obstet and Gynecol* 1989; 105: 162-168.
7. Neilson JP, Alfirevic Z. Doppler Ultrasound in high risk pregnancies In : Neilson JP, Crowther CA, Hudnott CED, Hofmeyr GJ, Keirse MJNC, eds *Pregnancy and child birth module of the cochrane database of systematic reviews*. Available in Cochrane library [data base on disk and CD rom]. Issue 3, Oxford, England: Cochrane collaboration, 1998.
8. Ven den Wijngaard JW, Groenenberg IL, Wladimirrobb JW, et al. Cerebral Doppler ultrasound of the fetus. *Br J obstet Gynaecol* 1989; 86: 845-849. 9. Fleischer A, Schuman H, Farmakides G et al. Uterine artery Doppler velocimetry in pregnant women with hypertension. *Am j obstet Gynecol* 1986; 154: 806-813.
10. Arduini D, Rio G, Romenini C and Mancuso S. Fetal blood flow velocity wave form as predictors of growth retardation. *Obstet Gynecol* 1987; 70(1): 7-10.
11. Vanden Wijngaard JW, Groenenberg IL, Wladimirroff JW, et al. Cerebral Doppler ultrasound of the fetus. *Br J Obstet Gynaecol* 1989; 96:845-849. 12.Arduini D, Rizzo G. Prediction of fetal outcome in small for gestational age fetus: comparison of Doppler measurements obtained from different fetal vessels. *J Perinat Med* 1992; 20:29-38.
13. Gramellini D, Folli MC, Raboni S, Vadora E, Merialdi A. Cerebral-umbilical Doppler ratio as a predictor of adverse perinatal outcome. *Obstet Gynecol* 1992; 79:416-420.
14. R.A.North, C.Ferrier, D Long, K. Townend, and P.Kincaid Smith. Uterine artery Doppler flow velocity wave forms in the second trimester for the prediction of preeclampsia and fetal growth retardation. *Obstet Gynecol* 1994; 83: 378-386.
15. Harrington K, Carpenter RG, Nguyen M, et al: Changes observed in Doppler studies of the fetal circulation in pregnancies complicated by pre- eclampsia or the delivery of a small-for-gestational age baby. I. Cross- sectional analysis. *Ultrasound Obstet Gynecol* 1995; 6(1):19-28.
16. Chan FY, Pun TC, Lam P, Lam C, Lee CP, Lam YH. Fetal cerebral Doppler as a predictor of perinatal outcome and subsequent neurological handicap. *Obstet Gynecol* 1996; 87:981-988.