



Importance of Doppler study of Umbilical Artery and Foetal Middle Cerebral Artery in PIH and IUGR

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Abstract

Background: PIH is associated with increased vascular resistance and decreased utero-placental perfusion resulting in an increased incidence of foetal hypoxia and impaired foetal growth. The objective of this study was to assess the diagnostic performance of S/D ratio, resistance index (RI), pulsatility index (PI) and cerebro-placental ratio (CPR) in the prediction of adverse perinatal outcome in PIH and IUGR. Objective: is to determine S/D ratio, RI, PI, CPR and assess their diagnostic values in the prediction of adverse perinatal outcome. **Material & Methods:** 50 pregnant patients with PIH and IUGR, beyond 28 weeks of gestation, were prospectively studied at P k das institute of medical college, vaniyamkulam and subjected for Doppler study of the umbilical artery and foetal middle cerebral artery. The abnormality of above parameters was correlated with the major adverse perinatal outcome. **Results:** Patients with abnormal Doppler parameters had a poor perinatal outcome, compared to those who had normal Doppler study. The cerebro-placental ratios (CPR) had the sensitivity and specificity, positive and negative predictive values of 95%, 76%, 73%, 95% respectively with Kappa value of 0.68 (good agreement) and p value of .000 which was statistically significant, for the prediction of major adverse perinatal outcome. **Conclusions:** This study shows that Doppler study of umbilical and foetal middle cerebral artery can reliably predict the neonatal morbidity and helpful in determining the optimal time of delivery in complicated pregnancies. The CPR is more accurate than the independent evaluation of S/D, RI, PI, in identifying foetus with adverse perinatal outcome.

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INTRODUCTION

The Doppler study of UA and MCA has a potential to evaluate the utero-placental circulation and fetal blood flow in non-invasive, repetitive manner.^[1] There is ample evidence from this study that Doppler indices, can reliably predict adverse peri-natal

outcome in an obstetric patient with high prevalence of PIH and IUGR. Compared to other methods of fetal monitoring Doppler has proved to be more sensitive in detecting foetal compromise early and aids in the appropriate timing of delivery.^[2] Measurement of Doppler indices only in umbilical artery correlates less well with foetal compromise than the

measurement of both umbilical artery and foetal middle cerebral vessel, just as in biophysical profile, though each parameter is affected by hypoxemia, composite score gives a better prediction.^[3]

The ratio of indices between middle cerebral artery and umbilical artery(CPR) is more accurate than independent evaluation in identifying foetus prone to growth restriction in PIH women.^[3] However it does not predict or correlate with any specific neonatal complications.

Thus Doppler study of umbilical and foetal middle cerebral artery provides an insight into difference facets of foetal response to hypoxia, has higher sensitivity for identification of perinatal mortality and morbidity in severe preeclampsia and foetal growth restriction.^[3]

MATERIAL AND METHODS

This prospective study was carried out on fifty women selected from OBG dept, at PK das institute of medical college, vaniyamkulam, ottapalam, palakkad district of Kerala from June 2018 to December 2020.

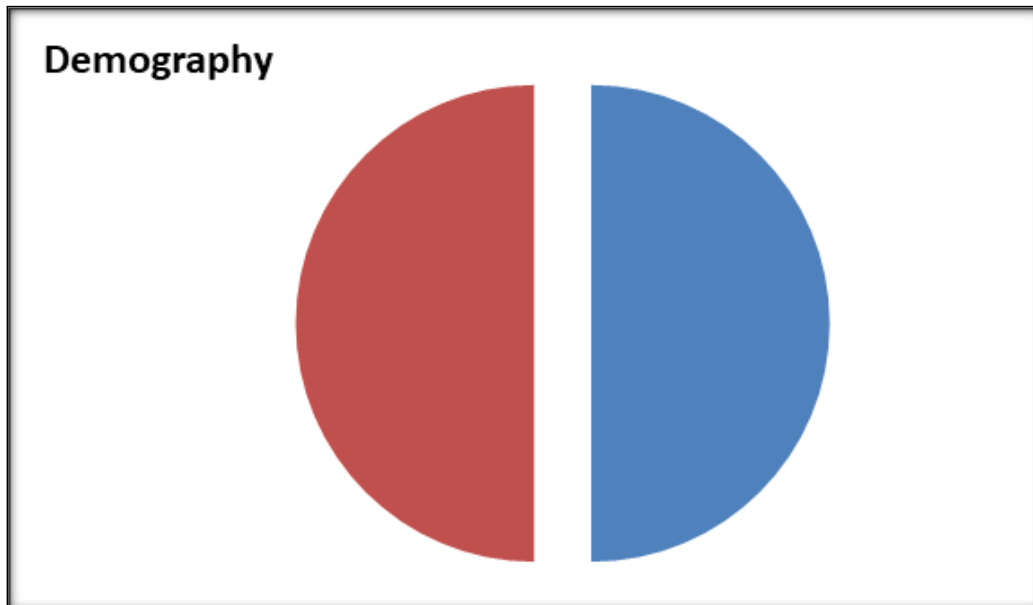
The study group comprised of clinically diagnosed severe PIH, IUGR foetus, oligohydromnios, gestational diabetes. The inclusion criteria for the study group was above mentioned high risk pregnancy with vertex presentation. All the participants were sure of their last menstrual period and had regular cycles previously.

Obstetrics ultrasound was carried out after taking informed written consent and subjected for Doppler examination of the UA and MCA. The women were followed by serial Doppler

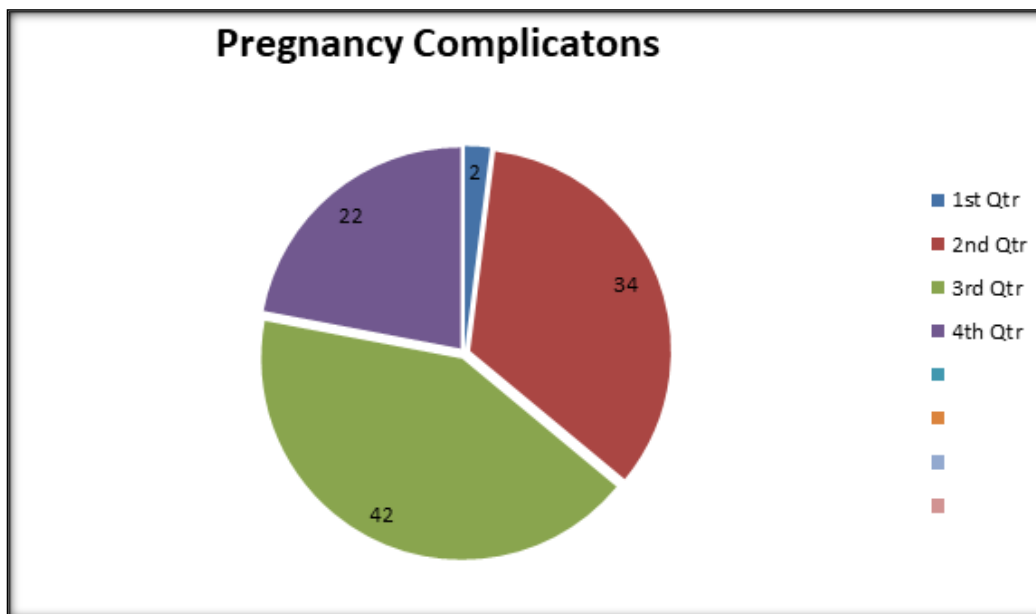
assessment and the results of the last Doppler reading before delivery was considered in the subsequent correlation with perinatal outcome. flow velocity wave form were recorded from the UA and MCA. The S/D ratio, RI, PI, of UA were noted in a standard plane using Philips, hd 11, colour doppler with frequency of 3.5MHZ. Doppler study was considered abnormal when S/D ratio, RI, PI of UA is more than 2 standard deviation and MCA is less than 5th percentile for the gestational age according to the standard reference values. The abnormality of above parameters were analysed and correlated with the maternal and perinatal outcome. Perinatal adverse outcomes were studied under major and minor adverse outcome. The major adverse outcomes were perinatal death, hypoxic ischemic encephalopathy;intraventricular haemorrhages, peri ventricular leucomalacia pulmonary haemorrhage and necrotizing enter colitis. Minor outcomes were includes caesarean delivery for foetal distress, Apgar score below 7 at 5 minutes, sepsis, hypoglycaemia, hyperbilirubinemia, admission to neonatal intensive care units.

Cerebro-placental ratio (CPA) was calculated from PI of MCA divided by PI of UA. CPR is constant during last 10 weeks of pregnancy.^[4,5] Reference value of 1.08 was taken as cut off value for the prediction of adverse outcome in accordance to TruijenSPM et al.^[6]The pregnancy were followed up and the final maternal and perinatal outcome of each case was noted. Various intra partum and neonatal indicators were used to assess the outcome.

Data analysis: Collected data were analysed by sensitivity and specificity, predictive value, kappa statistics and" p" value.



Prigravida_50%. Multigravida_50%



1. GDM -2%, 2. PIH-34%, 3. PIH+IUGR-42%, 4. IUGR-22%

RESULTS

Out of 50 patients 25 were primigravida and 25 were multi gravida, representing 50%each. Seventeen patients were having PIH,

21patients were having IUGR, and 11 patients had both. Mean maternal age was 25.16yrs.

Out of 17 patients of severe PIH, abnormal Doppler study was noted in 5 patients and normal Doppler study in rest of 12 patients.



out of 5 patients of abnormal Doppler study, one patient shows abnormal values in all indices, in two patients S/D ratio, RI, PI, were normal, but PI of MCA and CPR were abnormal, one patient had increased S/D ratio with normal RI, PI, of umbilical artery and PI of MCA with abnormal CPR of less than 1.08 and one patient had reversal of end diastolic flow.

There were 2 perinatal deaths in the above group, one stillborn and another neonatal death. the weight of the fresh stillborn was 1.1kg, it was an induced, preterm, vaginal, non-instrumental delivery, ante nately mother had oligohydromnios with non-reactive NST, all the Doppler indices were abnormal, and BPP of 6 out of 10. Neonatal death occurred within 24 hrs after delivery, of baby weight 1.2kg. It was a induced, preterm, vaginal, non-instrumental delivery. Baby had a low 1 and 5 minute Apgar score received resuscitation and ventilator support, cause of death was HIE, antenatal, Doppler had shown reversal of diastolic flow.

In those who were having normal Doppler study numbering 12, one had stillbirth of male baby weight 1 kg. it was, induced, preterm, vaginal, non-instrumental delivery. Ante nately mother showed oligohydramnios with non-reactive NST and BPP of 6. there were 8 preterm deliveries and 4 term deliveries, 10 labours were induced. There were 3 instrumental deliveries and 2 lscs, one term lscs done for thick meconium and another preterm lscs for type 2 decelerations. Two neonates born were not having any of minor adverse outcome, rest were having 1 or 2 minor adverse outcome, out of which 1 had RDS, sepsis and hyperbilirubinemia and same

neonate required resuscitation for poor Apgar score at 1 minute.

Out of 21 patients who were having IUGR, 11 were primi -gravida and 10 multi gravida, abnormal Doppler study was noted in 11 patients. One patient showed absent diastolic flow with brain sparing effect, subsequently baby had a neonatal death due to HIE, on 3 rd day of NICU stay. Antenatal mother had oligohydromnios with non-reactive NST and BPP score of 6. It was induced preterm vaginal, non-instrumental of delivery of female baby of weight 1.1kg. There were 6 term and 5 preterm deliveries. Induction was required in 8 patients and 3 deliveries were by instruments. There were 4 lscs and indications were type 2 decelerations in three and one was elective lscs for IUGR. All babies survived except one who had neonatal death on the day 20, because of HIE. No of patients showed type 2 decelerations and 2 showed meconium staining during intra partum period. 1 baby had RDS and 1 baby N EC, rest of the babies had 1 or 2 minor adverse peri -natal outcome. Average birth weight in above group was 1,68 kg with all babies having asymmetrical IUGR.

In 10 Patients who had normal Doppler study, 7 had term delivery, 5 required induction, and 1 instrumental delivery. There were 4 LSCS. Two for type 2 decelerations, one for IUGR, and one for previous lscs. All the babies did not have any major adverse perinatal outcome. In rest of the babies born, 2 had sepsis, 9 had hyperbilirubinemia, 3 had hypoglycaemia and 1 RDS. The average birth weight was 2.3kg. 11 patients in the study population were having both PIH and IUGR constituting 22% of the whole group. Abnormal Doppler was noted in 10 patients, raised S/D ratio and abnormal P.I



of UA and MCA was the most common abnormal indices present in above cases, whereas C.P.R of <1.08 was observed in all the 10 patients. 2 patients had absent diastolic flow and one patient reversal of diastolic flow, all demonstrated "brain sparing effect". In the absent diastolic group, one had LSCS for type 2 decelerations with birth weight of 1.16kg, baby could not be survived because of pulmonary haemorrhage and HIE. Another patient had induced pre term vaginal delivery of fresh still born of weight 1kg. One who showed reversal of diastolic flow had a induced, preterm, fresh, stillborn baby of weight 1.25 kg.

In rest of 7 patients, 5 had neonatal death, 2 were after emergency lscs for type 2 deceleration, and babies had low 1 and 5 minute Apgar score, required resuscitation, babies succumbed on 6 th and 3rdpost natal day due to HIE and RDS. In rest of the 3, it was induced, preterm,vaginal delivery, all babies

had low 1and 5 minute Apgar score requiring resuscitation in all,3 required ventilator support. all had a features of HIE.

In rest of the 2 patients with abnormal indices,one had emergency preterm LSCS for type 2 decelerations and baby survived after 10 days of neonatal stay. Another patient delivered preterm vaginally with type 2 decelerations and low 1 mint Apgar score, requiring resuscitation and ventilator support, and survived after the NICU stay of 7 days.

There was only one case of gestational diabetes mellitus in the study population, with normal Doppler indices and maternal, perinatal outcome

Statistical methods and analysis

Sensitivity and specificity, positive predictive value of S/D ratio, in the prediction of adverse perinatal outcome.

		Outcome		
S/D Ratio > 2.4		Abnormal	Normal	
	Abnormal	True Positive (a)n=17	False positive (b)N=11	a+b28
	Normal	False negative (c)N=5	True negative (d)n=17	c+d22
		a+c 22	b+d 28	

1. Sensitivity=17/17+5=77.27%=.77 (good)
2. Specificity=17/17+11=60.07=0.6=(average)
3. Positive predictive value=17/17+11=60.07%=.6(average)
4. Negative predictive value=17/17+5=77.27%=.77(good)

Kappa value was obtained by $K = \frac{Oa - Ea}{N - Ea}$.

Oa=observed count of agreement

Ea= expected count of agreement.

N=total no of subjects

Oa was obtained as=a+d. Ea was obtained by=a+b X a+c/N + c+d x b+d/N. According to this formula, kappa value for S/D ratio was .3=fair agreement and p value 0.0004 (significant) and was calculated by software PEPI. According to this formula, kappa value for s/d ratio was point 0.3 (fair agreement) and p value .004(significant) and was calculated by

software PEPI. “Kappa” value to assess the agreement between S/D ratio and perinatal outcome was according to Chapman and Hall. <0.20=poor agreement, 0.21-0.4=fair agreement, 0.4-0.6=moderate agreement, 0.61-0.8=good agreement, 0.81-1=very good agreement.

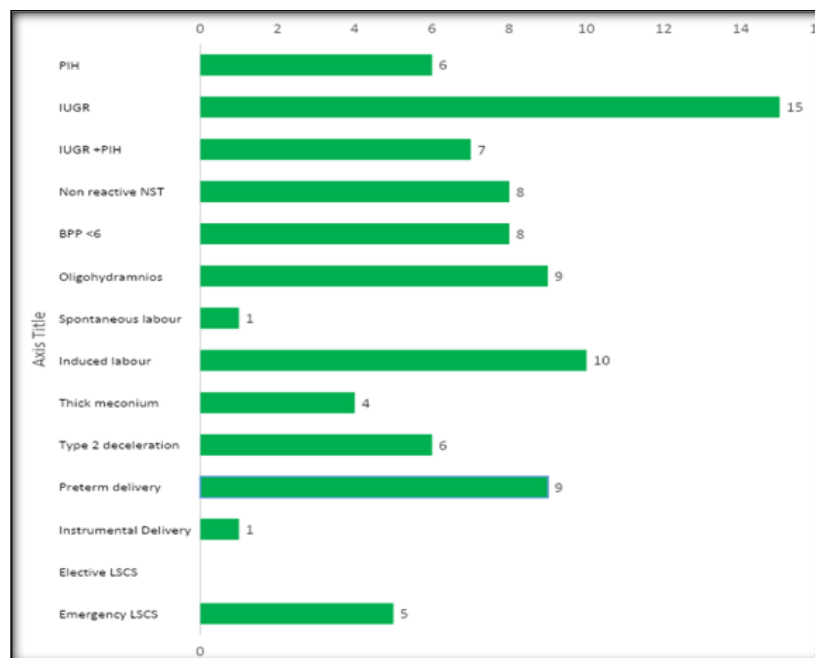
So similarly, Sensitivity, specificity, positive and negative predictive values of resistance index of umbilical artery in the prediction of adverse perinatal outcome was 47%, 88% 8%, 66.66% respectively. Kappa value=0.38 (fair agreement), P value=0.002(significant).

Sensitivity, specificity, positive predictive value and negative predictive value of pulsatility index of umbilical artery in the prediction of adverse perinatal outcome were 57.89%, 93.54%, 84.6%, 78.37%. Kappa value =0.55(moderate agreement) p value=0.000 (significant).

Sensitivity, specificity, positive and negative predictive value of CPR in the prediction of major adverse perinatal outcome were 95%, 76.66%, 73.03% 95.83%.kappa value=0.68 (good agreement)p value=0.000(significant) Results of our study for major adverse perinatal out come.

Results of our study for prediction of major adverse perinatal outcome

	Sensitivity	Specificity	Positive predictive value	Negative predictive value	K value	P value
S/D ratio of U.A	77.27%	60%	60.07%	77.27%	0.37%	0.004(significant)
R.I of UA	47.8%	88%	78%	66.66%	0,38%	0.002(Significant)
PI of UA	57.89%	93.54%	84.6%	78.37%	0.55	0.000(significant)
CPR	95%	76,66%	73.06%	95.83%	0.68	0.000(significant)



Bar chart showing pregnancy complications in abnormal P.I > 1.5 patient

In analysis our adverse perinatal outcome, the results of BN Lakhkar et al,^[12] Katherine w fong et al,^[13] Dandolo Grsmellini et al,^[14] A singh et al,^[15] can be compared, which is as follows.

Results of BN Lakhkar et al

	Sensitivity	Specificity	+ve predictive value	_ predictive value
UA S/D ratio	75%	41.3%	25%	86.3%
RI of UA	58%	71.7%	35%	86.8%
PI of UA	58%	56.5%	35%	86.8%
CPR	66.6%	73.9%	40%	89.4%

Results of Katherine w. Fong et al

	Sensitivity	Specificity	+ve predictive value	-Ve predictive value
PI of U/A	58.3%	81.8%	22.2%	95.7%
CPR	62.5%	75.5%	18.5%	95.8%

Results of Dandolo Gramellini et al

	Sensitivity	Specificity	+ve predictive value	-ve predictive value
PI of UA	64%	90.7%	72.7%	86.7%
CPR	68%	98.4%	94.4%	88.0%

Results of A. Singh et al

	Sensitivity	Specificity	+ve predictive value	-ve predictive value
PI of UA	66%	97.5%	95.23%	79.59%
CPR	80%	90%	85.71%	85.71%

DISCUSSION

In our study 5 out of 17 patients in PIH group, 11 out of 21 patients in IUGR group and 10 out of 11 patients in IUGR and PIH group representing 29.41%, 52.38%, 90.99% in each demonstrated an abnormal umbilical artery wave form. This is in keeping with the observation made by Hyun Yoon et al,^[6] where 51% of the patients with PIH demonstrated an abnormal umbilical artery Doppler indices. Ducey et al has reported 65% of his patients with PIH had abnormal umbilical Doppler indices.^[7] they suggested that severity of the disease correlates with the degree of placental

ischemia occurring in patients with preeclampsia, that patients with abnormal Doppler velocimetry have poor outcomes and thus that classifying patients with hypertension according to vascular pattern by Doppler velocimetry identifies women with significant disease better than does those clinical classification currently being used.^[8,9]

our study is also in obedience to the above study, where 5 out of 17 patients in PIH group, 11 out of 21 in IUGR +PIH group and one patient in GDM group showed normal Doppler study, consequently there was only one still birth in PIH group only, in rest of the



patients babies born were not having any of the major adverse outcome, were born near term, were having more birth weight, good Apgar score, had one or two minor adverse perinatal outcome.^(10,11)

Our study is consistent with observation made in many studies where babies born with abnormal Doppler indices showed higher induction rate, preterm delivery, meconium stained, type 2 decelerations at the time of the delivery.^(12,13) Instrumental interventions were also common in the above babies, along with less birth weight, less 1 and 5 minute Apgar score, required more resuscitation, ventilatory support, more NICU stay. the features of

HIE, IVH, PH, NEC were also higher with abnormal Doppler parameter group^(14,15)

CONCLUSIONS

In this prospective study of 50 patients with PIH, IUGR babies born to mother with abnormal Doppler indices had poorer outcome compared to mother with normal Doppler parameters. The sensitivity, specificity, +ve and -ve predictive value for the detection of adverse perinatal outcome was higher for CPR when compared to S/D ratio, R.I.P.I of umbilical artery alone.^[14,15]

REFERENCES

1. Alfirovic Z, Stampalija T, Dowswell T. Fetal and umbilical Doppler ultrasound in high-risk pregnancies. *Cochrane Database Syst Rev.* 2017;6(6):CD007529. doi: 10.1002/14651858.CD007529.pub4.
2. Maulik D. Doppler ultrasound velocimetry for fetal surveillance. *Clin Obstet Gynecol.* 1995;38(1):91-111. doi: 10.1097/00003081-199503000-00011.
3. Eagle M. Doppler ultrasound--basics revisited. *Br J Nurs.* 2006;15(11):S24-30. doi: 10.12968/bjon.2006.15.Sup2.21238.
4. Zohav E, Zohav E, Rabinovich M, et al. Third-trimester Reference Ranges for Cerebroplacental Ratio and Pulsatility Index for Middle Cerebral Artery and Umbilical Artery in Normal-growth Singleton Fetuses in the Israeli Population. *Rambam Maimonides Med J.* 2019;10(4):e0025. doi:10.5041/RMMJ.10379
5. Grüttner B, Ratiu J, Ratiu D, et al. Correlation of Cerebroplacental Ratio (CPR) With Adverse Perinatal Outcome in Singleton Pregnancies. *In Vivo.* 2019;33(5):1703-1706. doi:10.21873/invivo.11659
6. Truijen SPM, Hayhoe RPG, Hooper L, Schoenmakers I, Forbes A, Welch AA. Predicting Malnutrition Risk with Data from Routinely Measured Clinical Biochemical Diagnostic Tests in Free-Living Older Populations. *Nutrients.* 2021;13(6):1883. doi:10.3390/nu13061883
7. Fattori A, Giacchi R, Sebastiani M, Lungarotti F. Doppler velocimetry: first choice diagnostic procedure in angiology. *Ital J Surg Sci.* 1986;16(1):41-5.
8. Stuart B, Drumm J, FitzGerald DE, Duignan NM. Fetal blood velocity waveforms in normal pregnancy. *Br J Obstet Gynaecol.* 1980;87(9):780-5. doi: 10.1111/j.1471-0528.1980.tb04613.x.
9. Ducey J, Schulman H, Farmakides G, Rochelson B, Bracero L, Fleischer A, et al. A classification of hypertension in pregnancy based on Doppler velocimetry. *Am J Obstet Gynecol.* 1987;157(3):680-5. doi: 10.1016/s0002-9378(87)80028-5.
10. Maulik D, Yarlagadda P, Youngblood JP, Ciston P. The diagnostic efficacy of the umbilical arterial systolic/diastolic ratio as a screening tool: a prospective blinded study. *Am J Obstet Gynecol.* 1990;162(6):1518-23. doi: 10.1016/0002-9378(90)90915-t.
11. Campbell S, Diaz-Recasens J, Griffin DR, Cohen-Overbeek TE, Pearce JM, Willson K, Teague MJ. New doppler technique for assessing uteroplacental blood flow. *Lancet.* 1983;1(8326 Pt 1):675-7. doi: 10.1016/s0140-6736(83)91970-0.



12. Lakhkar BN, Rajgopal KV, Gourishankar PT. Doppler Prediction of Adverse Perinatal Outcome in PIH and IUGR. *IJRI*. 2006;16(1):109-116.
13. Fong KW, Ohlsson A, Hannah ME, Grisaru S, Kingdom J, Cohen H, et al. Prediction of perinatal outcome in fetuses suspected to have intrauterine growth restriction: Doppler US study of fetal cerebral, renal, and umbilical arteries. *Radiology*. 1999;213(3):681-9. doi: 10.1148/radiology.213.3.r99dc08681.
14. Gramellini D, Folli MC, Raboni S, Vadora E, Meriardi A. Cerebral-umbilical Doppler ratio as a predictor of adverse perinatal outcome. *Obstet Gynecol*. 1992;79(3):416-20. doi: 10.1097/00006250-199203000-00018.
15. Detti L, Mari G, Cheng CC, Bahado-Singh RO. Fetal Doppler velocimetry. *Obstet Gynecol Clin North Am*. 2004;31(1):201-14. doi: 10.1016/j.ogc.2003.12.002.

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