International Journal of Research and Review
Vol. 10; Issue: 2; February 2023
Website: www.ijrrjournal.com
Original Research Article *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Comparative Assessment of the Umbilical Artery Doppler Velocimetry and Non-Stress Test in Evaluating the Fetal Well-Being among Women with Pre-Eclampsia

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DOI: https://doi.org/10.52403/ijrr.20230239

ABSTRACT

Background: Pre-eclampsia is defined as a systemic syndrome characterized by the new onset of raised blood pressure >140/90 mm Hg and proteinuria after 20 weeks of gestation in a previously normotensive woman. Reduction of neonatal complications of pre-eclampsia is feasible by assessment of fetal well-being. Both fetal Doppler and NST are used for the screening of high-risk pregnancies.

Methods: It was a prospective comparative tertiary care hospital based study of pre-eclamptic women admitted in department of Obstetrics and Gynaecology, Lalla Ded hospital over a period of 18 months from March 2020 to September 2021. Written informed consent was obtained from the subjects prior to recruitment to the study. A total of 232 patients who were known case of pre-eclampsia or those who develop pre-eclampsia during hospital stay were included in our study.

Results: Both NST and fetal UA Doppler velocimetry were significantly correlated with the perinatal outcome. However; UA Doppler velocimetry had more sensitivity than NST. In contrast, NST had slightly more specificity than UA Doppler velocimetry.

Conclusion: The fetal umbilical artery Doppler velocimetry improves the sensitivity for the prediction of poor perinatal outcome when it is combined with the non-stress test. Both the tests are complimentary to one another in fetal surveillance of high risk pregnancies like pre-eclampsia.

Keywords: Pre-eclampsia, Umbilical arteries, Ultrasonography, Doppler, NST, Prenatal diagnosis

INTRODUCTION

Hypertensive disorders represent the most common medical complication of pregnancy affecting between 7-15% of all gestations and account for approximately a quarter of all antenatal admissions.[1] Hypertension in pregnancy is defined as Systolic Blood pressure (SBP) of 140mm Hg or higher and Diastolic blood pressure (DBP) of 90mm Hg or higher.[2] These measurements have to be confirmed on at least two occasions 4-6 hours apart but within a period of one week.[3,4] International Society for the Study of Hypertension in Pregnancy (ISSHP) classified hypertensive disorders in pregnancy into four types – Gestational hypertension, Pre-eclampsia and eclampsia, Chronic hypertension, Pre-eclampsia superimposed on chronic hypertension.[3]

Pre-eclampsia refers to the new onset of hypertension and proteinuria after 20 weeks of gestation in a previously normotensive woman. Pre-eclampsia is defined as a systemic syndrome characterized by the new onset of raised blood pressure >140/90

mm Hg and proteinuria after 20 weeks of gestation in a previously normotensive woman.[1,5] Globally pre-eclampsia complicates 2–8% of pregnancies and contributes to 10–15% maternal death.[6] Pregnant women with pre-eclampsia are at an increased risk of adverse maternal, fetal and neonatal complications. Pre-eclampsia is strongly associated with fetal growth restriction, low birth weight, spontaneous or iatrogenic preterm delivery, respiratory distress syndrome and admission to neonatal intensive care and cerebral palsy.[6] Since the maternal mortality is on declining trend, the perinatal outcome has captured the central attention of a good corpus of scholars.[7] With the invention of electronic fetal monitoring, the hitherto unexplored world of the fetus became immediately available to contemporary technologies. The accurate diagnosis and close monitoring of high-risk pregnancies have become all the more essential. In high-risk pregnancies, the non-stress test (NST) has been used to evaluate the health of the foetus.[7] Doppler has lately been used to screen for bad outcomes in high-risk pregnancies.[8,9] A non-invasive prenatal test called the NST is used to track how the foetal heart rate changes in response to its movements. A midwife can perform an NST, which doesn't put any stress on the developing foetus. Gynecologists advise the NST when a high-risk pregnancy is in the third trimester and the foetus is at an elevated danger of dying. An earlier study demonstrated that NST, particularly over a remote foetal monitoring network, could enhance perinatal outcomes in pre-eclampsia patients.[10] NST was also suggested as an alternative for fetal surveillance.

NST was also suggested as a preferred technique for pre-eclampsia patients in low resource settings for foetal surveillance.[11] In the third trimester of pregnancy, an UA Doppler ultrasonography is another noninvasive technique used to calculate the blood flow through the umbilical artery and reveal placental vascular resistance. The fetus is not stressed with a UA Doppler ultrasound; however a perinatologist must perform the procedure. Abnormal umbilical artery Doppler is a sign of utero-placental insufficiency and the subsequent intrauterine growth restriction (IUGR). There have been some studies on the comparative evaluation of NST and umbilical artery Doppler ultrasound to assess the fetal well-being among on the pregnant women with gestational diabetes.[12-14]However; there is a dearth of studies on evaluating the fetal status by NST and UA Doppler ultrasound among high risk with pre-eclampsia. Therefore the present study has been conducted to compare NST and UA Doppler assessments for evaluation of the adverse perinatal outcomes in women with pre-eclampsia

METHODS

It was a prospective comparative tertiary care hospital based study of pre-eclamptic women admitted in department of Obstetrics and Gynaecology, Lalla Ded hospital over a period of 18 months from March 2020 to September 2021. Written informed consent was obtained from the subjects prior to recruitment to the study. A total of 232 patients who were known case of pre-eclampsia or those who develop pre-eclampsia during hospital stay were included in our study. On admission, detailed history regarding age, sociodemographic, associated medical disorders, past surgical history, obstetric history, menstrual history, drug history and index pregnancy characteristics were studied. After thorough clinical examination (including general physical examination, systemic examination, local examination and internal pelvic examination) and routine investigations, all women were subjected to fetal Umbilical artery Doppler Velocimetry and Non-stress test. All these women were assessed for mode of delivery, timing of delivery and perinatal outcome in terms of Apgar score at 1 and 5 minutes of birth, birth weight, NICU admission and perinatal/early neonatal mortality (within one week of birth).

Inclusion criteria:

- Primigravida
- Gestational age ≥ 34weeks
- Singleton pregnancy
- Cephalic presentation
- *Those who were not in labour at the time of admission*
- *Those who were willing to participate in study*

Exclusion criteria:

- *Multiparity*
- *Gestational age <34 weeks*
- *Multiple pregnancy*
- *Congenital anomalies*
- *Postdated pregnancy*
- *Intrauterine death*
- *Acute insults like abruption, scar dehiscence, cord prolapse*
- *Other associated medical disorders*
- *Those who were not willing to participate in study*
- *Those who were in labour at the time of admission*
- *Eclampsia*
- *Chronic hypertension*

RESULTS

Out of 232 included patients, maximum no of patients 115(49.6%) were in the age group of (25-29) years, followed by 83(35.8%) in the age group of (30-34) years. Mean age of study patients was 28.6 years, ranging from 22-38 years. Of the 232 patients; about 114(49.1%) of the cases had preterm termination (before 37 weeks) and 118(50.9%) patients were terminated after completion of 37 weeks. Mean gestational age of the studied patients at delivery, was 37 weeks. Majority of the patients, accounting for 120(51.7%) had vaginal delivery compared to 112(48.3%) of patients with LSCS.

In our study; out of 232 neonates, about 128 neonates (55.2%) had good Apgar score (≥7) at "1-minute" of birth, whereas 104(44.8%) neonates had an Apgar score (<7) at "1-minute" of birth. At "5-minutes" of birth, about 154 neonates (66.4%) had an excellent Apgar score (≥7). However, 78(33.6%) neonates had a poor Apgar (<7). Around 90(38.8%) newborns had low birth weight (<2.5Kg) whereas 142(61.2%) had birth weight equal to or more than 2.5 Kg. NICU admission rate was 40.5%.

Table 1: Mode of delivery in various groups

Group	Vaginal Delivery		LSCS		P-value
	No.	%age	No.	%age	
Group A	61	80.3	15	19.7	<0.001*
Group B	14	36.8	24	63.2	
Group C	20	37.0	34	63.0	
Group D	25	39.1	39	60.9	

Group A (n=76) had normal NST and normal fetal UA Doppler velocimetry, group B (n=38) ha normal fetal UA Doppler velocimetry and abnormal NST, group C (n=54) had abnormal fetal UA Doppler velocimetry and normal NST and group D (n=64) had both fetal UA Doppler velocimetry and NST abnormal. Group A had 80% vaginal delivery rate, group B had 36.8% vaginal delivery rate, group C had 37% vaginal deliveries and group D had 39.1% vaginal deliveries. P value was <0.001 and hence highly significant.

Table 2: Perinatal outcome of various groups

Perinatal outcome		Group A		Group B		Group C		Group D		P-value
		No.	%age	No.	%age	No.	%age	No.	%age	
1 Min Apgar score	< 7	3	3.9	13	34.2	27	50.0	61	95.3	<0.001*
	≥ 7	73	96.1	25	65.8	27	50.0	3	4.7	
5 Min Apgar score	< 7	0	0.0	7	18.4	18	33.3	53	82.8	<0.001*
	≥ 7	76	100	31	81.6	36	66.7	11	17.2	
Birth weight (Kg)	< 2.5	1	1.3	10	26.3	24	44.4	55	85.9	<0.001*
	≥ 2.5	75	98.7	28	73.7	30	55.6	9	14.1	
NICU admissions	Yes	9	11.8	11	28.9	27	50.0	47	73.4	<0.001*
	No	67	88.2	27	71.1	27	50.0	17	26.6	
Perinatal/ Early neonatal mortality	Yes	0	0.0	5	13.2	14.	25.9	47	73.4	<0.001*
	No	76	100	33	86.8	40	74.1	17	26.6	

We observe that there is a significant difference between the groups with respect to perinatal outcome;

Table 3: Umbilical artery (UA) Doppler velocimetry correlation with perinatal outcome

Perinatal outcome		UA Doppler Normal		UA Doppler Abnormal		P-value
		No.	%age	No.	%age	
1 Min Apgar score	< 7	16	14.0	88	74.6	<0.001*
	≥ 7	98	86.0	30	25.4	
5 Min Apgar score	< 7	7	6.1	71	60.2	<0.001*
	≥ 7	107	93.9	27	39.8	
Birth weight (Kg)	< 2.5 Kg	11	9.6	79	66.9	<0.001*
	≥ 2.5 Kg	103	90.4	39	33.1	
NICU admissions	Yes	20	17.5	74	62.7	<0.001*
	No	94	82.5	44	37.3	
Perinatal/Early neonatal mortality	Yes	5	4.4	61	51.7	<0.001*
	No	109	95.6	57	48.3	

We observe that majority of neonates with an abnormal UA Doppler had significantly low APGAR score (<7) at 1 min and 5 min, low birth weight (<2.5kg), high NICU admission rate and high perinatal/early neonatal mortality rate.

Table 4: NST correlation with perinatal outcome

Perinatal outcome		NST Normal		NST Abnormal		P-value
		No.	%age	No.	%age	
1 Min Apgar score	< 7	30	23.1	74	72.5	<0.001*
	≥ 7	100	76.9	28	27.5	
5 Min Apgar score	< 7	18	13.8	60	58.8	<0.001*
	≥ 7	112	86.2	42	41.2	
Birth weight (Kg)	< 2.5 Kg	25	19.2	65	63.7	<0.001*
	≥ 2.5 Kg	105	80.8	37	36.3	
NICU admissions	Yes	36	27.7	58	56.9	0.003*
	No	94	72.3	44	43.1	
Perinatal mortality	Yes	14	10.8	52	51.0	<0.001*
	No	116	89.2	50	49.0	

We observe that majority of neonates with an abnormal NST had significantly low APGAR score (<7) at 1 min and 5 min, low birth weight (<2.5kg), high NICU admission rate and high perinatal/early neonatal mortality rate.

Table 4: Diagnostic accuracy of UA Doppler velocimetry and NST in predicting perinatal outcome

Parameter	Colour Doppler		NST	
	Value	95% CI	Value	95% CI
Sensitivity	92.4	83.46-96.72	78.8	67.49-86.92
Specificity	65.7	58.16-72.46	69.8	62.52-76.34
PPV	51.7	42.77-60.51	50.9	41.42-60.47
NPV	95.6	90.14-98.11	89.2	82.73-93.48

We observe that sensitivity and specificity of fetal umbilical artery Doppler velocimetry in predicting the perinatal outcome among pre-eclampsia women were 92.4% and 65.7% respectively. The positive predictive value and negative predictive value of UA Doppler velocimetry were 51.7% and 95.6% respectively. While as, the sensitivity and specificity of Non-stress test in predicting the perinatal outcome were 78.8% and 69.8% respectively. The relative positive and negative predictive values were 50.9% and 89.2%.

Fig1: Lead time calculation in group D

DISCUSSION

In the present study on the comparative evaluation of NST and UA Doppler velocimetry for the assessment of the adverse perinatal outcomes in women with pre-eclampsia, we have comprehensively analyzed patient's data on the basis of socio-demographic aspects, fetomaternal clinical parameters, perinatal outcome, correlation of perinatal outcome with NST and UA Doppler velocimetry. We observed that with an average of 28.6 years, majority of patients (49.6%) were belonging to the age group of 25-29 years, which is comparable with multitude of studies. For instance; Yelikar et al reported an average age of likewise patients as 26 years.[15] Singh D et al and Gour et al reported that majority of their patients were belonging to the age group of (21-30) years.[16,17] Another study conducted by Raj et al in which mean age of the subjects studied was 28.7 years ranging from 21-39 years, which is comparable with our study.[18] In the present study; we observed that 49.1% of the cases were terminated preterm. Mean gestational age was 37 weeks ranging from 34-40 weeks. Our results are in concordance with the study conducted by Mandal et al, in which 46% women gave birth to preterm babies.[19] Similar results were reported by Yelikar et al, in which mean gestational age at delivery was 37.3 weeks.[15] Similar study was conducted by Raj et al[57] in which mean gestational age at delivery was at 34.29 weeks with the range from 30-38.14 weeks.[18] In the present study; majority of the patients, accounting for 120(51.7%) had vaginal delivery compared to 112(48.3%) of patients with LSCS. Contrary to this; Raj A et al and Chakraborty B et al reported that majority of their patients had LSCS compared to vaginal deliveries.[18,20]In present study, we compared the perinatal outcome in terms of Apgar score at 1 & 5 minutes of birth, birth weight, NICU admission and perinatal/early neonatal mortality among four groups and found that the difference in perinatal outcome among four groups was statistically significant. We observed that majority of neonates with an abnormal fetal UA Doppler velocimetry had significantly low APGAR score (<7) at 1 min and 5 min, low birth weight (<2.5kg), high NICU admission rate and high perinatal/early neonatal mortality rate. Similar results were reported by Mandal et al, where among all babies, 16% had Apgar score <7 at 5 minute of birth.[19] In group C, 27 out of 54(50%) cases had low Apgar at 1-minutes of birth. But group C had a better perinatal outcome than 95.3% cases with low Apgar in group D. At 5-minutes of birth, out of 78 cases totally with low Apgar-5, 53(82.8%) belongs to group D. In group C, 18 out of 54(33.3%) cases had low Apgar-5. But had a better perinatal outcome than 82.8% cases with low Apgar-5 in group D. Similar study was done by Subramanian V et al on 200 patients with high risk pregnancies. In their study among the 29 cases in group IIA, where decision was taken based on non-reactive NST, only 9 cases had low Apgar which proves the false positivity of NS. In group IIB, there were 7 cases with low Apgar. The reason behind this though the NST was reactive, could have been the fact that these fetuses were already compromised (had abnormal Doppler findings) and could have face an insult during the process of labour. Anyway these babies had better outcome when compared to group III babies of which 98% had low Apgar.

In our study, in group A, 98.7% cases had normal birth weight. Similarly, in group B also, 73.7% cases had normal birth weight. In group C, 44.4% had low birth weight (birth weight <2.5 Kg). In group D, majority of the neonates (85.9%) had low birth weight. Similar results were also observed in study conducted by Yelikar et al in which group D, where both NST and colour Doppler were abnormal had the majority of neonates with low birth weight with least mean birth weight, averaging 1,378 ± 230 g.[15] Whereas group A had majority of cases with normal birth weight with highest mean birth weight.[15] In the present study among the 94 cases admitted in NICU, only 20

were from the group A and B. In group A, NICU admission is 11.8%. In group B, where NST was abnormal, only 11 cases were admitted among the 38. In group C and D, 50% & 73.4% were admitted in NICU. Similar results were seen in study conducted by Paliwal S et al where group A had best perinatal outcome in terms of NICU admission.[22]There were only 10% NICU admission in the group A with normal NST and normal colour Doppler. In contrast 78.57% of neonates required NICU admission when both were abnormal (group D). Gour A et al had the similar results in their study done to compare the efficacy of Doppler velocimetry and NST in predicting the fetal compromise in utero in cases of pre-eclampsia.[17]

In our study, out of 66 neonates who died either in antenatal period (intrauterine fetal death), during the course of labour (stillbirth) or in early neonatal period, no mortality seen in group A. Whereas, in group D, perinatal or early neonatal mortality rate was highest with 73.4%. Our results are in agreement with the study conducted by Yelikar et al[31], where majority of the perinatal deaths were from group D, six out of 18 women in that group.[15] Another study conducted by Radhika et al found that group A where both the tests results were normal had majority of cases (55%, 11/20) and had the least morbidity.[23] Whereas, group D which had the maximum no of cases of pre-eclampsia with IUGR (81.25%), had both the tests abnormal, and had the worst perinatal outcome.[23]

In present study all neonatal parameters were statistically correlating with fetal UA Doppler velocimetry findings. In our study Apgar score was found statistically correlating with fetal Umbilical artery Doppler velocimetry findings. This finding validates the fact that umbilical artery Doppler shows the extent of fetoplacental perfusion during the fetal diastole and is a recognized tool to show intrauterine fetal status. Similar study was conducted by Chakraborty B et al, where more than two-third (25 out 35) of study group had high umbilical artery Doppler indices.[20] Among the neonates, low Apgar score was found statistically correlated with raised Doppler indices, 52% against 10% (p=0.01). Sharma et al got almost findings in their study in 2010. A number of studies have examined the relationship between fetal blood flow velocity and Apgar score less than 7 at 1 and 5 minutes.[24] Rochelson B et al, did not find significant association of abnormal umbilical artery S/D ratio and low Apgar scores.[25] However, in contrast Brar HS et al and Seyam YS, found a significant association of abnormal Umbilical artery S/D ratio with a low Apgar score.[26,27]

In this study, birth weight of study neonates was also found statistically correlating with fetal Umbilical artery Doppler velocimetry. Similar results were observed in a study conducted by Subramanian V et al, where among 152 cases with normal colour Doppler, 93% of the babies had normal birth weight.[21] Among those with abnormal colour Doppler, most of the babies had low birth weight. The NICU admission rate was also found significantly high for patients with abnormal fetal UA Doppler velocimetry groups. Our results are in agreement with study done by Subramanian V et al, where most of the babies with abnormal fetal UA Doppler velocimetry required NICU admission.[21] Another study conducted by Suryavanshi MR et al to study the efficacy of Doppler velocimetry of umbilical artery in patients with hypertensive disorder of pregnancy or intrauterine growth retardation to determine fetal outcome.[28] In this study, about 23.8% were kept in neonatal intensive care unit. These findings match the study of James Ducey et al.[29] We found that perinatal/early neonatal outcome was significantly associated with fetal UA Doppler velocimetry. Likewise results have been reported by Ley D et al, Kurkinen M et al, who also reported higher mortality rates in those fetuses with absent or reversed end-diastolic flow.[30,31] According to the study by Rochelson B et al, and Brar HS et al, AEDF/REDF in Umbilical velocimetry was

associated with catastrophic perinatal outcome and aggressive perinatal management was advised in high risk groups complicated by either hypertensive disorders of pregnancy or intrauterine growth restriction.[25,26] Our study also agrees with their suggestion.

Similarly, patients with NST had significantly low APGAR score (<7) at 1 min and 5 min, low birth weight (<2.5kg), high NICU admission rate and high perinatal/early neonatal mortality rate. The correlation of NST in predicting perinatal outcome in pre-eclampsia was statistically significant. Around 76.9% and 86.2% with normal NST had good APGAR score (≥7) at 1 & 5 minutes of birth respectively. Whereas, out of 102 patients with abnormal NST, 72.5% and 58.8% had poor APGAR score at 1& 5 minutes of birth (p<0.001). APGAR-1 & 5 was found to be statistically correlating with NST findings. In a study conducted Bano et al, 42.8% neonates had Apgar score <7 at 5 minute in nonreactive while 3.4% had low Apgar score in reactive group.[32] They concluded that non-reactive NST is significantly related to poor Apgar score and reactive NST to good Apgar score. This finding is consistent with our study.

In our study, 80.8% with normal NST had normal birth weight whereas out of 102 patients with abnormal NST, 63.7% had low birth weight. Our study showed that abnormal NST had more low birth weight babies and found to be statistically significant (p<0.001).

Among 130 patients with normal NST, 72.3% did not required NICU admission, whereas, among 102 patients with abnormal NST, 56.9% neonates required NICU admission immediately after birth. It is evident that cases with abnormal NST had more NICU admissions and found to be statistically significant (P value is 0.003). Our results are in accordance with the study conducted by Singh D et al to study fetal Doppler waveform velocimetry and NST in PIH and IUGR patients, in which those with normal NST, 40% required NICU admission.[16]In a study conducted by Bano et al, 28.5% of neonates with nonreactive NST required NICU admission.[32]

Among 130 patients with normal NST, 89.2% patients did not have perinatal mortality, whereas among 102 patients with abnormal NST, 51% had perinatal or early neonatal death. (p <0.001). Similar results were seen in a study conducted by Jamatia A et al.[33] Bagum et al[81] observed that reactive NST group showed favourable fetal outcome and non-reactive NST showed significant increase in overall abnormal outcome, low 1 & 5 minute Apgar score, more NICU admissions and more perinatal mortality rates.[34] They concluded that NST is a valuable tool for the assessment of fetal wellbeing in high risk pregnancies.

We observed that sensitivity and specificity of fetal umbilical artery Doppler velocimetry in predicting the perinatal outcome among pre-eclampsia women were 92.4% and 65.7% respectively. The positive predictive value and negative predictive value of UA Doppler velocimetry were 51.7% and 95.6% respectively. While as, the sensitivity and specificity of non-stress test in predicting the perinatal outcome were 78.8% and 69.8% respectively. The relative positive and negative predictive values were 50.9% and 89.2%. A study between NST and Doppler waveforms was also done by Ott WJ et al, where Doppler was found to be more efficacious than NST.[35] When both NST and Colour Doppler were abnormal it indicates that these fetuses suffer from severe placental insufficiency. They concluded that the hemodynamic changes picked by Doppler occur in compensatory phase in high risk pregnancies like pre-eclampsia. Fetal heart rate abnormalities occur much later in decompensatory phase, which is a late sign of fetal compromise. Our study agrees with this observation. Similar study was conducted by Mandal et al showed that sensitivity of colour Doppler was more than NST (66% Vs 49.3%) whereas NST was more specific than Doppler (86% Vs 75.8%).[19] Both of them had poor predictive value. Higher sensitivity

and higher PPV of Doppler in comparison to NST suggests that Doppler is better in predicting fetus compromise in utero than NST. Another study conducted by Choudhary N et al showed sensitivity and specificity of Doppler velocimetry was 43% and 100%, PPV of Doppler velocimetry and NST 100% and 28% respectively and NPV of Doppler velocimetry and NST 90% and 84% respectively.[36] This signifies that an abnormal Doppler is more accurate in predicting fetal compromise than an abnormal NST. While few investigators have found that Doppler velocimetry is better than NST in picking up the cases which are at high risk of poor perinatal outcome.[18,34, 35]

Our study showed that when both NST and UA Doppler velocimetry were abnormal, baby weight and gestational age at birth were low. But NICU admissions and the perinatal/early neonatal deaths were high. Though both tests are effective in predicting the perinatal outcome, significant advantage of UA Doppler velocimetry over NST was observed in group D, the UA Doppler changes occur earlier than NST giving a significant lead time upto 20 days with an average of 4.84 days. This lead time is very important as babies can be delivered or can be followed up during this period to gain a pulmonary maturity, which may be crucial for a preterm fetus, steroid prophylaxis may be administered to accelerate the lung maturity. Hence, no single test result should be considered for decision making in case of pre-eclampsia because each test reflects different aspects of maternal and fetal pathophysiology. Therefore, combined fetal testing modalities such as Doppler, NST and BPP provide a wealth of information regarding fetal health.

CONCLUSION

The present study demonstrated that an abnormal NST following an abnormal fetal Umbilical artery Doppler is associated with the worst perinatal outcome. In cases with abnormal fetal Umbilical artery Doppler velocimetry if the prospects for neonatal survival are good, it is better to deliver the fetus before NST becomes abnormal. Fetal Umbilical artery Doppler alone is better than NST in predicting the perinatal outcome in pre-eclampsia. The fetal umbilical artery Doppler velocimetry improves the sensitivity for the prediction of poor perinatal outcome when it is combined with the non-stress test. Both the tests are complimentary to one another in fetal surveillance of high risk pregnancies like pre-eclampsia. The clinical scenario however dictates the choice of the appropriate test. Hence by combining the two, and acting appropriately, the incidence of adverse perinatal outcome may be reduced.

Declaration by Authors

Ethical Approval: Approved
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: Priyanka Kundal, Rukhsana Sami, Anu Sharma et.al. Comparative assessment of the umbilical artery doppler velocimetry and non-stress test in evaluating the fetal well-being among women with pre-eclampsia. *International Journal of Research and Review*. 2023; 10(2): 305-314. DOI: *https://doi.org/10.52403/ijrr.20230239*

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