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Original Research Article

Evaluation of Ophthalmic Artery Doppler: A Window into Cerebrovasculature in Women with Pre-Eclampsia

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Abstract:

Aim: The present study aimed to evaluate ophthalmic artery Doppler in pre-eclamptic women and to find out if doppler changes correlate with the severity of pre-eclampsia.

Materials and Methods: The present prospective observational Comparative study was conducted in the Department of Obstetrics and Gynaecology, L.L.R.M. Medical College, Meerut from January 2021 to June 2022 after taking approved from institutional ethical committee. A total of 80 cases of pre-eclampsia and 40 healthy gestational matched controls were enrolled in the study after taking informed consent. Maternal outcomes were recorded in relation to ophthalmic artery Doppler findings and other ocular parameters. Neonatal outcome was noted in terms of weight, growth assessment, APGAR score, NICU admission and mortality.

Result: Out of 120 women, 80 were pre-eclampsia and 40 were healthy controls. Mean age in cases were 26.58±4.30years and in control 26.00±4.19years ji. P value between cases and control of PSV (p=0.001), PR (p=0.003), PI(0.001), RI (p=0.002) were statistically significant in case of pre-eclampsia as compared to control (normotensive group). In present study for pre-eclampsia the cut-off value for PSV cm/sec, Peak ratio, Pulsatility index and Resistive index were 0.631, 0.579, 0.439 and 0.540, respectively to make a prognosis/outcome of preeclampsia. With these cut-off values, PSV cm/sec and Peak ratio had shown the higher sensitivity and specificity. These tests were demonstrating the accuracy of risk factors for preeclampsia. The PSV cm/sec, Peak ratio, Pulsatility index and Resistive Index were not significantly different large area under the curve (AUC) on the ROC curve.

Conclusion: The present study concludes that ophthalmic artery Doppler is a novel innovation option in assessment of patients with pre-eclampsia and there is orbital vascular impedance reduction with orbital hyperperfusion in severe pre-eclamptic women compared with mild pre-eclamptic and healthy pregnant women.

Keywords: Ophthalmic artery Doppler, pre-eclampsia, pre-eclamptic women.

Introduction

In India, the incidence of pre-eclampsia is reported to be 8-10% among the pregnant women [1]. They form one member of a deadly triad along with hemorrhage and infection that contribute greatly to maternal morbidity and mortality during pregnancy andchildbirth [2].

Regardless of etiology, the cascade of events that lead to pre-eclampsia syndrome is characterized by a nest of abnormalities that result in vascular endothelial damage and subsequent vasospasm, transudation of plasma, ischemia and thrombotic sequalae. These disorders are often associated with many complications like HELLP syndrome, pulmonary edema, cardiovascular accidents, DIC, life threatening hepatic and renal involvement and even multiorgan failure, neurological involvement may vary from headache and drowsiness to seizures, hemiplegia and coma. The risk posed to fetus includes IUGR, hypoxemia, premature birth, intrauterine deaths. Specifically visual disturbances develop in 25% of women with severe pre-eclampsia but blindness is rare with an incidence of 1 to 3% in eclampsia. Pre-eclampsia can present with complication in the eye in 30% to 100% of women. The three most common ocular complications are hypertensive retinopathy, exudative retinal detachment and cortical blindness".

These disorders are characterized by endothelial dysfunction and vasospasm of vessels in the retina. Retinal angiospasm is an almost constant accompaniment of toxemia of pregnancy. When

marked spastic changes occur early in pregnancy, they indicate presence of severe toxemia process which unless the toxemia is controlled or pregnancy terminated, endangers the viability of the child and mother's health. Acute cerebral complications in pre-eclampsia such as eclampsia intracranial hemorrhage and cerebral edema account for at least 75% of maternal deaths related to preeclampsia disorder. Identification of women who are at risk of cerebral complications that are associated with adverse pregnancy outcome must be the goal of pre eclamptic management. Persistent interest has been observed in the evaluation of the intracranial circulation in pre eclamptic women. MRI can be safely used to study intracranial blood flow in pregnancy but it is not cost effective, requires expertise to evaluate and is contraindicated in some women, such as those with ferromagnetic implants. Other radiological imaging modalities for evaluating intracranial blood vessels, such as catheter angiography and radionuclide imaging are known to be hazardous to the fetus due to ionizing radiation and are therefore contraindicated in pregnancy. Transcranial Doppler ultrasound is documented as the safest and fastest means of studying intracranial vessels.

However, it is not simple to use, has poor spatial resolution and is not readily available. Doppler ultrasound of ophthalmic artery has been utilized to study the orbital circulation and assess ocular as well as retrobulbar diseases [3]. Embryological, functional and anatomic similarities between orbital and intracranial vasculature have enabled investigators to obtain information on the less accessible intracranial vasculature and cerebrovascular hemodynamics that can be reflected directly in Doppler parameters of ophthalmic artery.

The development of Doppler ultrasonographic technology has provided an opportunity to obtain both qualitative and quantitative assessment of maternal and fetal hemodynamics. Doppler ultrasonographic changes in ocular blood flow resulting from changes in mean arterial blood pressure at the level of eye and changes in intraocular pressure can help in evaluating pre-eclampsia severity. Ophthalmic artery also has anatomical continuity with intracerebral circulation being a direct branch of internal carotid artery. The lack of bony, Fatty, or gaseous structures in the eyeballs makes insonation of the ophthalmic artery by the trans orbital route technically feasible.

Analysis of the spectral Doppler waveform of the maternal ophthalmic artery may act as a window into Cerebrovasculature hence may provide a safe, noninvasive, inexpensive, and readily available, with quick interpretation, functional point of care imaging modality which can be used to assess the cerebral effects of pre- eclampsia. Ophthalmic artery sonography is well tolerated by patients and does not take long to perform. There is also paucity of literature comparing the ocular changes among pre-eclampsia and normotensive pregnant Indian women. Thus, present study is an endeavour to evaluate ophthalmic artery Doppler in pre eclamptic women and to find out if Doppler changes correlate with the severity of pre-eclampsia.

Aims and Objectives:

- To study the ophthalmic artery doppler parameters in preeclamptic women
- To correlate maternal and fetal outcomes with ophthalmicartery Doppler parameters.

Material and Methods

The present prospective observational comparative analytical study was conducted in the Department of Obstetrics and Gynaecology, L.L.R.M. Medical College, Meerut from January 2021 to June 2022 after taking approval from institutional ethical committee. A total of 80 cases of pre-eclampsia and 40 healthy age and gestational age matched controls were enrolled in the study after taking informed consent.

Inclusion Criteria

- Antenatal women presenting with pre- eclampsia as cases.
- Singleton pregnancy
- Normotensive healthy pregnant women as control.

Exclusion Criteria

- Chronic hypertension
- Pregnancy with complication other than pre-eclampsia
- Twin or higher order pregnancy
- Pre pregnancy or gestational diabetes
- Preexisting ophthalmological disease
- Connective tissue disorder

Methodology

Women fulfilling inclusion criteria were enrolled for the study after taking informed written consent. Complete history regarding chief complaints, past obstetric history, menstrual history, medical history, history of current pregnancy and symptoms such as headache, epigastric pain, photophobia and photopsia (light flashes) was taken.

Gestational age was calculated using reliable LMP and it was confirmed with a first trimester scan. Blood pressure of the patients was recorded using a calibrated desktop mercury column sphygmomanometer and the stethoscope after a rest period of at least 10 minutes. Complete general,

systemic and obstetric examination was done. All routine and specific investigations as per requirement was performed. Each participant underwent ophthalmic evaluation by an ophthalmologist that involved visual acuity testing, intraocular pressure measurement and fundoscopy. Visual acuity was tested bedside in each eye using the Snellen chart. Intraocular pressure was measured using a Schiotz/non- contact tonometer after the application of 0.5%w/v paracaine hydrochloride eye drops solution.

Fundoscopy was performed in a darkened side room using direct ophthalmoscope after dilatation of eyes with 0.5% tropicamide eye drop solution. Results were interpreted according to Keith Wegner's classification.

The Doppler ultrasonography of right ophthalmic artery was performed by experienced radiologist, who was blinded to information on the participant's clinical data,

Participants was examined in a supine position with both eyes closed and are instructed to direct their eyes straight ahead and to avoid squeezing the eye lids.

Linear array transducer was used with frequency between 7 to 15 MHz and the right eye was evaluated. Transducer was applied directly to the closed eyelid over upper aspect of eyeball following application of adequate amount of water-soluble ultrasound gel to ensure sufficient communication between the transducer and the skin thus promoting sound waves transmission to the globe.

Eyeball was examined in sagittal and horizontal plane. Initial B mode scan was followed by colour Doppler imaging to identify the ophthalmic artery. Ophthalmic artery is identified by the direction of flow (towards probe) and pulsatility.

Three to five consistent cardiac cycle were obtained and stored electronically. The mean of three consecutive waveform was recorded for the resistance index, pulsatility index, peak systolic velocity, end diastolic velocity and peak ratio and the average of the three readings were recorded in the datasheet

Maternal outcomes were recorded in relation to ophthalmic artery Doppler findings and other ocular parameters. Neonatal outcome in terms of weight, growth assessment, APGAR score, NICU admission and mortality noted.

The data obtained for all the women was tabulated and analyzed systematically.

Observation and Results

A total of 120 women were enrolled in study and data were tabulated and analyzed as follows.

Table 1: Number of patients in case (pre-eclampsia) and control (healthy) groups

Case				**Control**	
Mild		**Severe**			
N	%	n	%	n	%
40	33.33	40	33.33	40	33.34

Out of 120 women, 80 were pre-eclampsia and 40 were healthy controls. In pre-eclampsia cases 40 were without severe features while 40 were with severe features.

Table 2: Comparisons of mean Age (years) in between (pre-eclampsia) case and control (healthy)

		Case (n=80)		**Control (n=40)**		**Chi Sq.**	**p-Value**
		n	**%**	**n**	**%**		
Age (years)	≤25 years	42	52.50	19	47.50		
	26-30 years	31	38.75	20	50.00		
	31-35 years	4	5.00	1	2.50		
	36-40 years	3	3.75	0	0.00	0.85	0.836
	Mean±SD	26.56	±4.30	26.00	±4.19	-0.48	0.632

Mean age in cases were 26.58±4.30 and in control 26.00±4.19. On the basis of age distribution both groups were comparable (p=0.632)

Table 3: Comparisons of mean Period Gestation (weeks) in between case and control

		Case (n=80)		**Control (n=40)**		**Chi Sq.**	**p-Value**
		n	**%**	**n**	**%**		
Period Gestation (weeks)	20-32 weeks	5	6.25	4	10.00		
	33-36 weeks	31	38.75	15	37.50		
	≥37 weeks	44	55.00	21	52.50	2.08	0.354
	Mean±SD	36.51	2.81	35.17	4.24	-1.58	0.118

Mean POG in cases was found to be 36.51±2.81 WOG and in control 35.17±4.24WOG. On the basis of period of gestation, both groups were comparable(p=0.118)

Table 4: Comparison of frequencies of different gravida in between group

Gravida	Case (n=80)		Control (n=40)		Chi Sq.	p-Value
	n	%	n	%		
G1	35	43.75	19	47.5	4.03	0.402
G2	29	36.25	08	20		
G3	10	12.5	04	10		
≥G4	06	7.5	09	22.5		

In the study, most of the Pre eclamptic cases were found to be primigravidas (43.7%) followed by gravida two (36.25%) while in control groups, maximum were primigravidas (47.5%).P value 0.402

Table 5: Comparison of frequencies of Booking status in between group

BookingStatus	Case (n=80)		Control (n=40)		Chi Sq.	p- Value
	n	%	n	%		
Booked	12	15	25	62.5	0.54	0.463
Unbooked	68	85	15	37.5		

Pre-eclampsia group were unbooked cases (85%) as compared to booked (15%). Among controls 62.5% were booked and 37.5% were unbooked .P value=0.463

Table 6: Comparison of frequencies of different socioeconomic status in between group

Socioeconomic status	Case (n=80)		Control (n=40)		Chi Sq.	p-Value
	n	%	n	%		
Upper (class I)	03	3.75	03	7.5	3.34	0.502
Upper Middle (class II)	08	10	02	05		
Lower Middle (class III)	19	23.7	20	50		
Upper Lower (class IV)	40	50.0	10	25		
Lower (class V)	10	12.5	05	12.5		

In cases maximum number was found to be in the upperlower socio-economic status while in control maximum number was found to be in lower middle socio-economic status. p value=0.502

Table 7: Comparison of frequencies of different Symptom status in between group

Symptoms		Case (n=80)		Control (n=40)		Chi Sq.	p-Value
		n	%	n	%		
Breathlessness	Yes	21	26.25	04	10	4.100	0.043
	No	59	73.75	36	90		
Pedal edema	Yes	65	81.25	15	37.5	0.007	0.464
	No	15	18.75	25	62.5		
Headache	Yes	45	56.25	10	25	6.88	0.009
	No	35	43.75	30	75		

In all women predominant symptom was pedal edema (81.25% in cases vs 37.5% in controls) followed by headache (56.25% in cases vs 25% in controls) .Breathlessness was note in 26.25% of cases as compared to control (normotensive patients) 10%. Headache found statistically significant among cases. P value=0.009.

Table 8: Comparison of mean blood pressure between the groups

	Case (n=80)		Control (n=40)		t	p- Value
	Mean	±SD	Mean	±SD		
Systolic BP (mmHg)	152.30	12.62	130	10.95	-6.89	<0.001
Diastolic BP (mmHg)	110.55	6.13	88	7.17	-15.81	<0.001

The mean systolic and diastolic blood pressure in cases (pre eclamptic women) was higher i.e. 152.30±12.62 mmHg and 110.55±6.13mmHg respectively as compared tocontrol (130±10.95 mmHg and 88±7.17 mmHg) .P value <0.001

Table 9: Comparison of frequencies of deranged LFT, KFT, and platelet count in between group

		Case (n=80)		Control (n=40)		Chi Sq.	p- Value
		n	%	n	%		
LFT	Normal	45	56.25	40	100	5.52	0.019
	Deranged	35	43.75	0	0.00		
KFT	Normal	31	38.75	40	100	0.02	0.034
	Deranged	49	61.25	0	0.00		
Plateletcount	Normal	28	35.00	35	87.5	0.19	0.045
	Deranged	52	65.00	5	12.05		

Thrombocytopenia was found more frequently in preeclamptic women (65% vs 12.05%) followed by deranged KFT (61.25 % vs 38.75%)) and LFT was deranged in 43.75% in cases. p value of all these parameters were found to be statistically significant.

Table 10: Comparison of frequencies of Mode of delivery in between group

Mode of delivery	Case (n=80)		Control (n=40)		Chi Sq.	p- Value
Vaginal	30	37.5	28	70.00		
Caesarean	50	62.5	12	30.00	1.15	0.812

In comparison between cases and control regarding mode of delivery, maximum percentage of preeclamptic women had cesarean delivery. Vaginal mode of delivery was more in controls compared to cases p =0.812.

Table 11: Comparison of frequencies of Maternal Complications in between group

		Case (n=80)		Control (n=40)		Chi Sq.	p-Value
		n	%	n	%		
HELLP	Yes	43	53.75	0	0.00	0.07	0.054
	No	37	46.25	40	100.00		
Pulmonary Edema	Yes	20.0	25.0	2	5.0	0.05	0.024
	No	60.	75.0	38	95.0		
Acute kidney injury	Yes	11	13.75	0	0.00		
	No	69	86.25	40	100.00	1.46	0.022
Abruption	Yes	4	52.5	0	0.00	1.41	0.023
	No	76	47.5	40	100.00		
Coagulation defect	Yes	29	36.25	0	0.00	3.46	0.043
	No	51	63.75	40	100.00		

Maternal complications were found in higher frequency in preeclampsia group compared to healthy controls & difference was statistically significant. The mean PSV (cm/sec), Peak ratio, Pulsatility index, Resistive Index and EDV (cm/s) were 33.03±1.80, 2.19+-0.88, 1.39±0.49, 0.66±0.05 and 9.25±1.38 respectively in case and 36.86±3.92, 2.02±0.42, 1.86±0.36, 0.75±0.05, and 8.50±0.52 in controls. The mean PSV (cm/sec), Pulsatility index, and Resistance Index were significantly lower in case as compared to control.

Table 12: Comparison of mean Ophthalmic Artery Doppler in between group

	Case (n=80)		Control (n=40)		t	p-Value
	Mean	±SD	Mean	±SD		
PSV (cm/sec)	33.03	1.80	36.86	3.92	4.648	0.001
Peak ratio	2.19	0.88	2.02	0.42	-3.035	0.003
Pulsatility index	1.39	0.49	1.86	0.36	3.467	0.001
Resistive index	0.66	0.05	0.75	0.05	5.843	0.002
EDV (cm/sec)	9.25	1.38	8.50	0.52	-2.020	0.066

P value of PSV (p=0.001), PR (p=0.003), PI(0.001), RI (p=0.002) were statistically significant in case of pre-eclampsia as compared to control (normotensive group).

Table 13: Comparison of frequencies of Visual Acuity and Intraocular pressure in between group

Variables	Range	Case (n=80)		Control (n=40)		Chi Sq.	p- Value
		n	%	n	%		
Visual Activity Log MAR	0.00	44	55	38	95		
	0.00-1.00	35	43.75	2	5.00	5.76	0.056
	>1.00	1	1.25	0	0.00		
Intraocular pressure (mmHg)	10-20	79	98.75	40	100		
	>20	1	1.25	0	0.00	0.13	0.715

In visual acuity Log MAR in case of pre-eclampsia group 69%is found to be higher in range of 0.00 and in 29% found in between the range of 0.01-1.00,as compared to control where 100% was found in the 0.00 group. p value (0.056) which is statistically insignificant. In case intraocular pressure (98.75%) was found in the rangeof 10-20mmHg and only one case had IOP >20% as compared tocontrol where all women had low IOP , p=0.715 which is statistically insignificant.

Table 14: Comparison of frequencies of fundus Grade, in between groups

		Case (n=80)		Control (n=40)		Chi Sq.	p- Value
		n	%	n	%		
Fundus Grade	0	31	38.75	40	100	4.66	0.324
	1	27	33.75	0	0.00		
	2	18	22.5	0	0.00		
	3	4	5	0	0.00		

Fundus changes were noted in preeclampsia group ranging from grade 1 to grade 3. The comparison of frequencies of Birth weight in between case and control group. <2.5 kg birth weight was significantly more in case(61.25%) as compared to control(38.75%), whereas >2,5 kg birth weight was more in control group (67.5%).p=0.20 statistically significant.

Table 15: Comparison of frequencies of Birth weight at 5 min in between groups

		Case (n=80)		Control (n=40)		Chi Sq.	p- Value
		n	%	n	%		
Birth weight	<2.5	55	68.75	13	32.5	5.43	0.020
	≥2.5	25	31.25	27	67.5		

Table 16: Comparison of frequencies of APGAR Score at 5 min in between groups

		Case (n=71)		Control (n=40)		Chi Sq.	p- Value
		n	%	n	%		
APGAR Score at5 min	<8	36	50.7	9	22.5	8.43	0.004
	≥8	35	49.2	31	77.5		

50% of newborns in cases had APGAR <8 as compared to control (22.5%) at 5 min. p value (0.004) statistically significant.

Table 17: Comparison of frequencies IUD and NICU Admission in between group

		Case (n=71)		Control (n=40)		Chi Sq.	p- Value
		n	%	n	%		
IUD	Yes	9	11.25	0	0.00	0.35	0.033
	No	71	88.75	40	100		
NICU Admission	Yes	32	45	6	15	0.02	0.042
	No	39	55	34	85		

Babies of Pre-eclampsia (45 %) required NICU admission more compared to babies of normotensive women (15%) and 8% IUD seen in cases as compared to none in control, p=0.033 statisticallysignificant.

On comparison of mean Ophthalmic Artery Doppler between preeclampsia without and with severe features, PSV (cm/sec), Pulsatility index, and Resistive index were significantly decreased in preeclampsia p value < 0.005.

Table 18: Comparison of mean Ophthalmic Artery Doppler in between Preeclampsia without Severe feature andpreeclampsia with severe feature

	Control		Preeclampsia		Severe Preeclampsia		f	p- Value
	Mean	±SD	Mean	±SD	Mean	±SD		
PSV (cm/sec)	35.86	3.92	33.17	1.77	32.85	1.84	11.05	0.000
Peak Ratio	2.02	0.42	2.09	0.46	2.9	0.82	1.51	0.002
Pulsatility index	1.86	0.36	1.34	0.48	1.44	0.50	6.51	0.002
Resistive index	0.75	0.5	0.65	0.06	0.67	0.05	17.93	0.000
EDV (cm/sec)	8.50	0.52	9.12	1.33	9.42	1.44	2.72	0.070

In present study for pre-eclampsia the cut-off value for PSV cm/sec, Peak ratio, Pulsatility index and Resistive index were 0.631, 0.579, 0.439 and 0.540, respectively to make a prognosis/outcome of preeclampsia. With these cut-off values, PSV cm/sec and Peak ratio had shown the higher sensitivity and specificity. These tests were demonstrating the accuracy of risk factors for preeclampsia. The PSV cm/sec, Peak ratio, Pulsatility index and Resistive Index were not significantly different large area under the curve (AUC) on the ROC curve (Figure 1).

Table 19: Sensitivity, Specificity PPV and NPV of PSV cm/sec Peak Ratio Pulsatility Index and Resistive Index cut-off for the Identifying of preeclampsia with severe features by analyzing AUC

	Cut off	AUC	p-Value	Sensitivity	Specificity	PPV	NPV
PSV (cm/sec)	34.5	0.631	0.113	67.0	57.1	28.6	25.5
Peak Ratio	2.9	0.579	0.339	92.9	50.0	45.1	70.8
Pulsatility index	1.5	0.439	0.457	72.6	47.3	85.7	61.3
Resistive index	0.75	0.540	0.627	57.5	50.0	50.0	67.0
EDV (cm/sec)	8.5	0.485	0.851	53.8	42.9	87.0	88.2

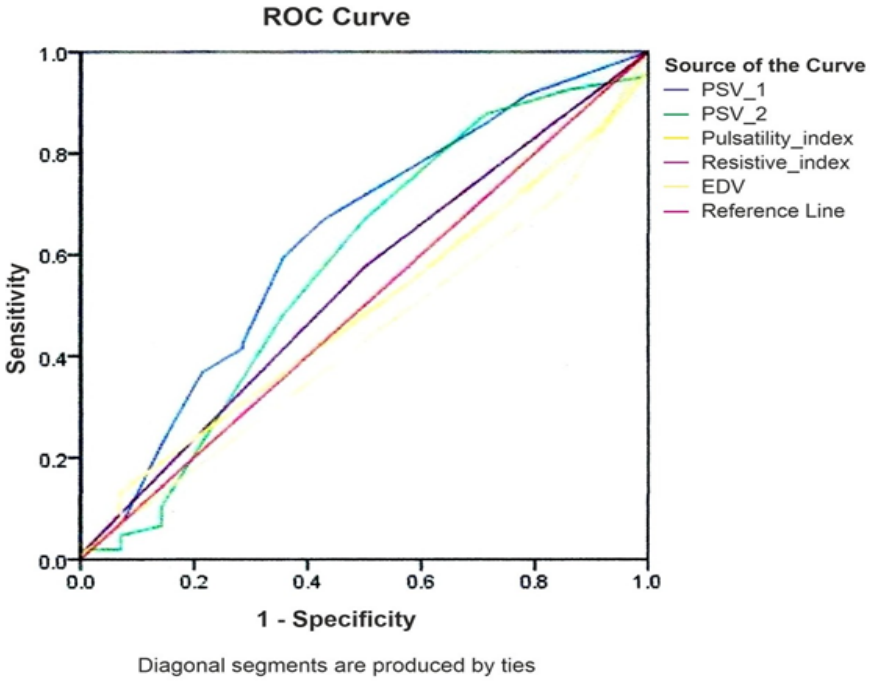

Figure 1: Receiver operating characteristic (ROC) curve analysis of diagnosing of preeclampsia. Each receiver characteristic curve is expressed as a solid line. AUC: area under the curve

Discussion

Most of the women in our study belonged to age ≤ 25years (52.50% of cases 47.50% of control) followed by 26-30 years age group (38.75% of cases and 50.0% of control). Mean age was 26±4.19. This was in consistence with study done by Reddy et al. [4] in Andhra Pradesh on 112 cases of preeclampsia and eclampsia. Similarly study done by A L D Diniz et al. [5] in July 2008 the mean age was found to be 26 years.

In our study maximum number of women were primigravida i.e., 43.75 % pre-eclampsia cases and 47.5% healthy controls. Gestational age at which women presented with pre- eclampsia was 22 to 42weeks. Majority (44%) developed preeclampsia after 37 weeks of gestation. Mean gestational age was 36.5±2.81 weeks. D S Matias in 2014 in his study found that maximum number of pre-eclampsia cases presented at 37 weeks. The pre-eclampsia cases in this study were mostly unbooked (85%) while 37.5% of women being unbooked in control group. Our findings are supported by the study of Olatunji RB et al. [3] in Nigeria where 56% of cases were unbooked significantly differing from 18% in controls. According to modified Kuppuswamy classification 62.5% of subjects in our study belonged to upper lower and lower class. These findings were comparable to earlier studies. In present study for age and gravida (p=0.8) and (p=0.4) were found to be statistically insignificant and not associated with ophthalmic artery Doppler changes.

Studies conducted by DS Matias et al. [6], Kane SC et al. [7] and similar study done in December 2020 by Yang XY [8] also found no correlation between gestational age and ophthalmic artery doppler changes. One contradicting study which was done in Nov 2020 Sapantzoglou I et al. [9] found out that 2853 pregnancies contained 76 (2.7%) that developed PE, including 18 (0.6%) that delivered with PE at <37 weeks gestation.

According to literature ocular changes were more commonly observed in cases of pre-eclampsia with severe features than non-severe pre-eclampsia. We noted that ophthalmic artery changes have significant association with raised Blood pressure (P< 0,001). Mean systolic and diastolic blood pressure for Pre-eclampsia showing Doppler change was 152.3 mmHg±12.62 and 110.55±6.13mmHg respectively. While in healthy

control mean blood pressure were 130±10.95 mmHg and 88±7.17 mmHg respectively. T Hata et al. [10] in 1997 were the first one to use ophthalmic artery Doppler for prediction of pre-eclampsia. The MAP value in mild preeclampsia was higher than that in normotensive nonpregnant women or normotensive pregnant women ($p<0.05$). Study conducted by CA de Oliveira [11] April 2013 observed that cases had mean systolic BP of 157.8±18.2 mmHg and diastolic of 102.3±14.7mmHg while control had mean systolic and diastolic BP of 100.1±10.8mmHg and 60.8±11.0mmHg.

The recent study done by Selima et al. [12] in April 2022 observed that mean BP of pre-eclampsia with severe feature was 172.50 +9.57 mmHg (systolic) & 117.50±5.00 mmHg (diastolic) whereas that of pre-eclampsia and normotensive were 146±5.35/104±5.35 mmHg and 104.17±8.95 /69.79±7.29 mmHg respectively comparable to our study.

Our study found significant association of PSV (p 0.001), PR (0.003), PI (0.001), RI (0.002) with disease severity. The mean of PSV (33.17+-1.77) in pre-eclampsia without severe feature was higher as compared to mean PSV (32.85±1.84) in pre-eclampsia with severe features. Peak ratio being higher (2.19±0.88) in pre- eclampsia compared to normotensive women (2.02±0.42) .End diastolic volume was found to be insignificant (p-0.006) comparedto other Doppler parameters.

Studies giving similar results were conducted by DS Matias [6] in 2020 showing PSV, PR, MV & EDV to be higher in women with preeclampsia ($P<0.05$), Olatunji RB et al. [3] also showed that resistive index, pulsatility index were lower in pre-eclampsia, whereas peak ratio being higher in pre eclamptic groups, with one contradicting finding which was PSV being higher in women with pre-eclampsia which is inconsistent with our study where PSV being lower in women with pre-eclampsia.

Findings of CA de Oliveira [11] in 2013 who conducted a study on ophthalmic artery doppler in pre-eclampsia which was comparable to our study showed mean of PI (1.13±0.31), RI (0.63±0.09) being low whereas PR (0.89±0.12) being high in pre- eclampsia. T Hata et al. [10] in 1997 showed that pulsatility index was significantly lower in pre-eclampsia ($p<0.05$) compared to normotensive women which is comparable to our study.

Chiemelie Onwudiegwu et al. [13] in 2020 stated that no significant difference between the groups concerning end- diastolic velocity was found ($p=0.535$). Contradicting our study E Kalafat et al. [14] in January 2018 found the pulsatility index of the ophthalmic artery did not show a clinically useful sensitivity or specificity at any cut-off for early- or late- onset PE, other studies including my study showed a peak ratio being a sensitive.

Among cases in our study a Staggering 69.81% had normal visual acuity (0.00) while only 29.25% of cases had visual acuity in the lower range (0.00-1.00), among controls 100% women had normal visual acuity. $p=0.056$ which is statistically insignificant in our study. Supporting similar findings is the work of Chiemelie Onwudiegwu et al. [13] in Nigeria where majority of Cases as well as controls had visual acuity ≤0.05.$p=0.36$.

Intraocular pressure in our remained normal in 99.06% cases and 100% in control $p=0.715$. Contradicting our finding Chiemelie Onwudiegwu et al. [13] found intraocular pressure to be higher among pre eclamptic groups. Association between Perinatal outcome and ophthalmic artery Doppler changes

In our study 61 % of cases (babies of pre-eclampsia) were below <2.5kg as compared to control (32%) $p<0.2$ which is Statistically significant, therefore significant correlation found between various perinatal outcome like prematurity, Low birth weight, APGAR Score, NICU admission with ophthalmic artery doppler changes in cases with non-severe and severe pre-eclampsia ($p<0.02$).

Aquino LO et al. [15] found that mean birth weight of babyof women with pre-eclampsia were 2505.00±588.47 kg while that of normotensive women were 3102±268.37kg. Association between birth weight and OAD changes were found to be statistically significant ($p=0.003$) with our study.

In case of APGAR Score study done by L D Diniz et al. [5] on ophthalmic artery doppler as measure of severe pre-eclampsia that APGAR in women with severe pre-eclampsia were 6.6±1.9, 8.4±1.2 compared to healthy controls were 8.9±1.0, 9.2±0.8 were statistically significant ($p=0.002$) found comparable to our study.

Limitations of the study:

One of the limitations of this study was small sample size (due to COVID-19 outbreak during study period). This was an observational analytical study and possible confounder such as use of antihypertensive drugs may influence the results. Hence, further studies with large sample size are necessary to evaluate the influence of antihypertensive medications on cerebral blood flow and to identify cut off values of ophthalmic artery Doppler indices in pregnant women with pre-eclampsia.

Conclusion

The present study indicates that detection of cerebral over perfusion by ophthalmic artery doppler sonography may be a real marker of the

risk of cerebral hemorrhage, therefore, it may be used as an indicator of the severity of pre-eclampsia.

Moreover, with the availability of USG doppler at almost every tertiary care centre monitoring of these high risk pregnancies by ophthalmic artery Doppler, could identify cases that are at lower risk of cerebral complications, hence would allow delaying delivery in them to achieve gestation age that have increased chances of neonatal survival thereby reducing complications of iatrogenic prematurity too.

Our study concludes that ophthalmic artery doppler is a novel innovation option in assessment of patients with pre-eclampsia and there is orbital vascular impedance reduction with orbital hyperperfusion in severe pre-eclamptic women compared with mild pre-eclamptic and healthy pregnant women.

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