Al-Azhar International Medical Journal

Volume 4 | Issue 9 Article 19

9-1-2023

Section: Obstetrics and Gynecology

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How to Cite This Article

Ali, Samir Abdalla; Atalla, Emad Mohamed Ibrahim; and Awad, Ahmed Abdelhamid Ahmed (2023) "The Value Of Middle Cerebral versus Umbilical Artery Doppler In The Prediction Of Neonatal Outcome Among Primi Gravida With Hypertension," *Al-Azhar International Medical Journal*: Vol. 4: Iss. 9, Article 19.
DOI: https://doi.org/10.58675/2682-339X.2004

ORIGINAL ARTICLE

The Value of Middle Cerebral Versus Umbilical Artery Doppler in the Prediction of Neonatal Outcome Among Primi Gravida with Hypertension

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Abstract

Background: **Doppler ultrasonography is typically used to examine umbilical arteries (UA), however, recent research has shown that middle cerebral artery (MCA) Doppler examination is equally effective and strongly recommends it.**

Aim and objectives: **This study sought to determine how well the ratio of the MCA to UA pulsatility could be used to predict a newborn's outcome in Primi Gravida with hypertension.**

Patients and methods: **Women who have Primi Gravida with hypertension participated in this cohort research. Between December 2021 and November 2022, emergency personnel and workers at Al Hussien University Hospital's foetal care unit 100 patients with severe preeclampsia who visited the prenatal clinic and emergency room at the Obstetrics and Gynecology Department, College of Medicine, Alhussien University Hospital underwent ultrasounds.**

Result: **With a *P* value of 0.009, 62.5% sensitivity, 71.43% specificity, an estimated positive predictive value of 29.41, and a negative predictive value of 90.91, the MCA/UA pulsatility index (PI) ratio demonstrated a high neonatal intensive care unit (NICU) predictive value.**

Conclusion: **Doppler data, which includes cerebral and umbilical velocimetry, can be helpful in treating preeclampsia patients and in determining when to deliver the patient in order to save the foetus because it gives information on how the placental anomaly will affect the foetus.**

Keywords: Doppler, Hypertension, Middle cerebral artery, Neonatal outcome, Prediction, Primi gravida, Umbilical artery

1. Introduction

Hypertensive disorders frequently affect pregnancy and are a key factor in maternal morbidity and mortality, along with bleeding and infection. Worldwide, the prevalence of various pregnancy-related hypertension disorders ranges from 5 to 15%. It is responsible for 7−10% of perinatal mortality globally, compared with 20% in poorer nations. Perinatal mortality ranges from 5% for mild pregnancy induced hypertension (PIH) to 15−25% for severe PIH.[1]

The placenta vascularizes throughout a typical pregnancy to allow for blood flow between the mother and foetus. 2 For a normal pregnancy to proceed, the uteroplacental and fetoplacental circulation must develop satisfactorily. The alternative in its development may be linked to pregnancy-related hypertension, which can compromise circulation and result in prematurity, subnormal growth, or foetal death.[1] The placenta of preeclampsia patients exhibits abnormalities, including inadequate trophoblastic invasion, which results in poor placental perfusion.[2] Hypoxia, oxidative stress, and the production of chemicals that could trigger subsequent reactions including inflammation and endothelial dysfunction are all thought to be caused by this.[3] This pathologic process is further influenced by an excessive inflammatory status, an

Accepted 19 March 2023.
Available online 30 December 2023

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https://doi.org/10.58675/2682-339X.2004

exaggerated immunological response from the mother to this chronic inflammatory status, and an imbalance between pro and antiangiogenic molecules.[4] Even before the condition manifests clinically, preeclamptic pregnancies cause structural and circulatory abnormalities in the placenta.[5] Satomura showed for the first time that the Doppler method could assess blood flow.[6]

However, recent studies have revealed that middle cerebral artery (MCA) Doppler testing is similarly beneficial and strongly encourage it. Doppler ultrasonography is frequently used to assess umbilical arteries (UA).[7]

Doppler imaging of the MCA is a well-known method for identifying foetal impairment.[8]

Doppler velocimetry enables immediate intervention to improve the neonatal prognosis by properly identifying a compromised intrauterine growth restriction (IUGR) foetus.[9] Numerous studies have demonstrated that the MCA and UA pulsatility index (PI) ratio has higher sensitivities and specificities for the prediction of foetal prognosis than the UA alone.[10] The PI ratio between the MCA and the UA exhibits both the umbilical velocimetry of the placenta's circulatory insufficiency and the adaptive modifications that cause the PI ratio to change. This investigation looked at how effectively a newborn's prognosis in a Primi Gravida with hypertension patient might be predicted using the ratio of MCA to UA pulsatility.

2. Patients and methods

In this cohort study, women with Primi Gravida with Hypertension took part. During the months of December 2021 and November 2022, 100 cases of severe preeclampsia at 34–40 weeks of gestation were seen at Alhussien University Hospital's prenatal clinic and emergency room at the university of medical, ultrasound was performed by staff at fetal care unit at Alhussien University Hospital and emergency team staff.

2.1. Member

2.1.1. Inclusion criteria

Primi Gravida women at 34–40 weeks of gestation, age from 25 to 35 years old and pregnant women with induced hypertension.

2.1.2. Exclusion criteria

The exclusion criteria included: multi pregnancy, twins, hydramnios, pregnancy complicated with other medical disorders (chronic hypertension, diabetes mellitus, cardiac disorders ….etc.) and congenital fetal malformation.

2.2. Methodology

2.2.1. All women were subjected to

Complete history to rule out any possible maternal sickness or pregnancy complication: personal history, which includes name, age, profession, marital status, place of residence, and any distinctive medical practices, present history figuring out the gestational age in weeks is also included, any complaints during pregnancy, the warning symptoms and all investigations she had done in that pregnancy, menstrual history: including LMP, obstetric history, contraceptive history, past history for the presence of any medical disorders and family history for any medical disorders in the family especially hypertension.

General examination: using a normal mercury sphygmomanometer, blood pressure was measured while the subject was semi-recumbent with their head and chest slightly elevated. 2 blood pressure recordings 6 h apart as recommended by the American College of Obstetricians and Gynecologists. Chest and heart examination and edema was tested for pitting in the lower limbs, ankles and shin of the tibia, checking for edema of the lower abdomen and testing for ascites.

Abdominal examination: for edema and loin exam.

Laboratory investigations: comprehensive urine analysis, fasting and postprandial blood sugar readings, and complete blood picture, liver function test, renal profile, blood coagulation profile, prothrombin time.

Ultrasonography: pertaining to the placenta's position, the amount of alcohol consumed, the number of foetuses, the presence or absence of foetal cardiac activity, and the foetal biometry. The four fundamental biometric measurements—biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length—are frequently used to estimate gestational age and/or birth weight in the second and third trimesters (FL). Intervention: Values below the fifth percentile in MCA pulsatility index (PI) Doppler investigations among pregnant hypertensive women are regarded as abnormal.

Foetal middle cerebral artery and umbilical artery Pulsatility Index (PI): The recipe PI=(PSV-EDV)/TAV can be utilized to work out PI by separating the time found the middle value of (mean) speed (TAV) toward the end diastolic speed (EDV), which is deducted from the pinnacle systolic speed (PSV).[11]

Every Primi Gravida with hypertension had their fetal center cerebral course/umbilical conduit pulsatility record proportion estimated exclusively to decide the cerebroplacental proportion. The MCA was immediately perceived as a huge branch going anterolaterally from the circle of Willis toward the horizontal boundary of the circle. It began inside 1 cm of a Doppler test volume. The Willis circle and normal pulsatility record were then used to imagine the MCA at the level of the cerebral peduncles. Afterward, more center cerebral corridors were likewise gained. An example was taken from an umbilical rope circle that was drifting uninhibitedly after the UA Doppler test was done, and the PI was gotten. The point between the blood stream heading and the ultrasonographic pillar is generally 30°. Baschat and Gembruch's nomogram characterizes a CPR of under 1 or beneath the fifth percentile for gestational age as strange.[12]

All sonographic assessments were performed *trans*-centrally at the tertiary consideration focus of the Alhussien College Medical clinic using Medison × 4 ultrasound innovation and a 4.0 MHz test.

Mode of delivery: vaginal delivery: induction of labor and spontaneous vaginal delivery and cesarean section (CS): Elective C.S and Urgent C.S.

Neonatal assessment by Apgar score: The Apgar score system is a useful clinical tool for identifying newborns who require resuscitation and for gauging the effectiveness of any such efforts. The five immediately observable characteristics that are evaluated and assigned a number between 0 and 2 are heart rate, respiratory effort, muscular tone, reflex irritation, and colour. Five minutes after delivery, the overall score—which is based on the sum of the five components—is calculated. The effectiveness of resuscitative measures can be determined by looking at the 5 min score. The 5 min Apgar score and the newborn's condition in the delivery room have a strong correlation with the likelihood of survival.[13]

According to the study done in the emergency room on 100 pregnant women who are at 34–40 weeks of gestation with severe preeclampsia, the majority of them were admitted to the labor room and delivery room where they spent few days till delivery.

A minor portion of those cases were admitted for immediate delivery. All measurements of the pH of the foetal blood were made within 5 min of delivery. The Apgar score was determined five minutes after the baby was born. It was deemed evidence of neonatal morbidity if the new born was admitted to the neonatal intensive care unit (NICU) and had an Apgar score of 7 at 5 min or above, pH 7.2, or both NICU. Before the study began, the protocol and other pertinent documents were submitted to the council of the OB/GYN Department for ethical and research permission in line with the local regulations that were followed, AAl-Azhar University.

Table 1. Attributes of the review populace.

Age (y)	
Range	20–35
Mean ± SD	28.620 ± 4.273
Gestational age (weeks)	
Range	34–40
Mean ± SD	36.240 ± 1.664
Parity	
P0	24 (24.00%)
P1	28 (28.00%)
P2	26 (26.00%)
P3	20 (20.00%)
P4	2 (2.00%)
Previous abortions	
Nil	64 (64.00%)
One abortion	24 (24.00%)
Two abortions	12 (12.00%)
Mode of delivery	
CS delivery	86 (86.00%)
Normal vaginal delivery	14 (14.00%)
Indication of CS	
Urgent	30 (34.88%)
Elective	56 (65.12%)

Data are presented as mean (SD) or number (%).

2.3. Statistical analysis

Measurable social examination programming was utilized to survey, code, classify, and input the gained information into a PC (SPSS 20 for windows; SPSS Inc, Chicago, IL, 2001). The quantitative factors are communicated as the middle and interquartile range for nonparametric information and as the mean and standard deviation (SD) for parametric information (IQR). A subjective variable could be communicated utilizing frequencies and rates. The Understudy *t*-test and the Mann Whitney test were utilized to look at a nonstop factor between two exploration gatherings. To analyze the connection

Table 2. Doppler records in the review populace.

MCA_PI	
Range	0.5–2.67
Mean ± SD	1.224 ± 0.520
UA_PI	
Range	0.4–1.91
Mean ± SD	0.801 ± 0.285
CPR	
Range	0.6–3.18
Mean ± SD	1.600 ± 0.611
CPR	
Normal	84 (84.00%)
Low	16 (16.00%)

CPR, cerebroplacental ratio PI pulsatility index; **MCA**, middle cerebral artery; **UA**, umbilical artery.

Table 3. Prevalence of low (<1.0) cerebroplacental ratio in the study population.

Variable	*n* (%)
CPR	
Normal (≥1.0)	84 (84.0%)
Low (<1.0)	16 (16.0%)

between straight out factors, Fisher's careful tests and the χ^2 were utilized. The edge for measurable importance was a *P*-worth of 0.05.

3. Results

The MCA/UA resistance index ratio in women with severe preeclampsia was investigated as a potential predictor of neonatal outcome in this observational cross-sectional study. The study enrolled 100 pregnant participants who had severe preeclampsia.

Table 4. Low (7.2) umbilical artery pH, low (7) Apgar score at 5 min, and intensive care unit confirmation rates in the review population.

Variable	*N* (%)
Apgar score at 5 min	
Normal (≥7)	82 (82.0%)
Low (<7)	18 (18.0%)
UA pH	
Normal (≥7.2)	67 (67.0%)
Low (<7.2)	33 (33.0%)
NICU admission	
No NICU admission	66 (66.0%)
NICU admission	34 (34.0%)

Our review includes a subjective analysis of newborn outcome measurements with regard to Apgar rating at five minutes 82 cases (82%) had umbilical cord pressure readings of 7 or higher, while 12 cases (12%) had readings of 7 or lower. As for umbilical cord pressure, 67% of patients had readings of 7 or higher, while 33% had readings of 7 or lower.

Table 1 lists the initial traits of the ladies who were included.

As respect the graphic information of the patients qualities; mean (SD) old enough was 28.620 (4.273), as respects the equality of patients 24 (24%) were P0, 28 (28.0%) were P1, 26 (26%) were P2, 20 (20%) were P3, 2 (2%) P4, 64 of cases had no past foetus removal, and mean SD of gestational age 36.240 (1.664) weeks (Table 2).

As far as the Doppler records, the MCA PI had a mean (SD) of 1.224 (0.520), the UA PI had a mean (SD) of 0.801 (0.285), and the MCA/UA PI proportion had a mean (SD) of 1.600. (0.611) (Tables 3–6).

There was positive relationship between cerebroplacental ratio proportion and low Apgar score at 5 min as responsiveness half and 88.10% particularity, assessed positive prescient worth = 44.44 and negative prescient worth = 90.24.

The MCA/UA PI proportion had superb prescient worth of NICU as *P* esteem = 0.009, 62.5% awareness, 71.43% explicitness, 29.41 assessed positive prescient worth, and negative prescient worth = 90.91 as displayed in Table 7, Fig. 1.

As respects the Doppler records in connection with cerebroplacental proportion the mean (SD) of the MCA PI was 1.318 (0.512), mean (SD) of UA PI was 0.767 (0.278) (Fig. 2, Table 8).

Table 5. Legitimacy of cerebroplacental ratio as indicator of Apgar score less than 7 at 5 moment.

Low- Apgar 5	CPR			Chi-Square	
	Normal (≥1.0) *N* (%)	Low (<1.0) *N* (%)	Total *N* (%)	X2	*P*-value
Normal (≥7)	74 (88.10)	8 (50.00)	82 (82.00)	13.215	<0.001*
Low (<7)	10 (11.90)	8 (50.00)	18 (18.00)		
Total	84 (100.00)	16 (100.00)	100 (100.00)		
Roc					
Sens	**Spec.**	**PPV**	**NPV**	**Accuracy**	
50.0	88.10	44.44	90.24	82	

NPV, negative predictive value; PPV, positive predictive value.

Table 6. Validity of cerebroplacental ratio as predictor of neonatal intensive care unit admission.

NICU	CPR			Chi-Square	
	Normal (≥1.0) *N* (%)	Low (<1.0) *N* (%)	Total *N* (%)	χ^2	*P*-value
No NICU admission	60 (71.43)	6 (37.50)	66 (66.00)	6.895	0.009*
NICU admission	24 (28.57)	10 (62.50)	34 (34.00)		
Total	84 (100.00)	16 (100.00)	100 (100.00)		
Roc					
Sens.	**Spec.**	**PPV**	**NPV**	**Accuracy**	
62.5	71.43	29.41	90.91	70	

There was a significant association between middle cerebral artery pulsatility index/umbilical artery pulsatility index ratio less than 1 and neonatal intensive care unit admission as the *P* value = 0.009. NPV, negative predictive value; PPV, positive predictive value.

Table 7. The correlation between middle cerebral artery Doppler ultrasound indices in included women and the cerebroplacental ratio.

MCA-PI	CPR		t	T-Test
	Normal (≥1.0)	Low (<1.0)		*P*-value
Range	0.6–2.67	0.5–1.2	4.530	<0.001*
Mean ± SD	1.318 ± 0.512	0.731 ± 0.163		

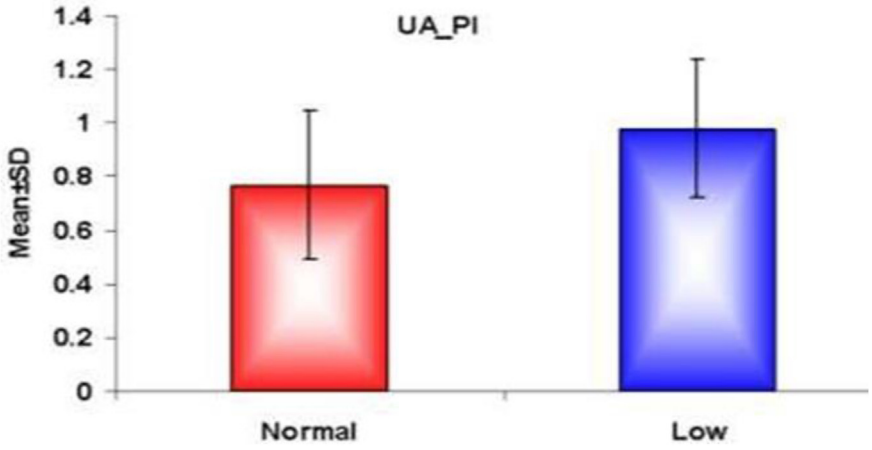

Fig. 1. The relationship between umbilical artery pulsatility index files in included ladies and the cerebroplacental ratio.

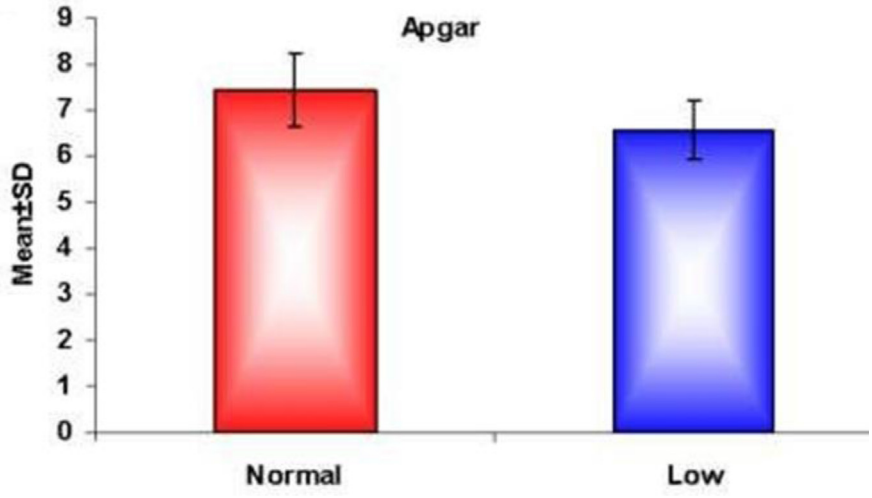

Fig. 2. The connection between ladies with ordinary cerebroplacental ratio and ladies with low cerebroplacental ratio in regards to Apgar score at 5 min.

Table 8. Chances proportion and 95% coefficient stretch for low (<7) Apgar score, low (<7.2) UA pH, and neonatal intensive care unit affirmation.

	Odds ratio*	95% CI	Lower upper	*P*-value
Low-Apgar 5	5.728	1.609	20.389	0.007*
Low-UA-pH	1.469	0.421	5.126	0.547
NICU	2.373	0.668	8.429	0.181

There was positive connection between middle cerebral artery/umbilical artery pulsatility index proportion and neonatal intensive care unit affirmation as relationship coefficient = p esteem = 0.181, as Apgar score at 5 min there was unfortunate relationship with p esteem = 0.181 yet there was negative connection with umbilical line PH with *P* esteem = 0.547.

Fig. 3.

4. Discussion

The current investigation was conducted at Alhussin University Hospital as a prospective observational study. The objective is to determine how well the MCA/UA PI ratio for individuals with severe third-trimester preeclampsia predicts a poor neonatal outcome. The average age (SD) and gestational age (SD) of the 100 Primi Gravia with Hypertension participants in this study, respectively,

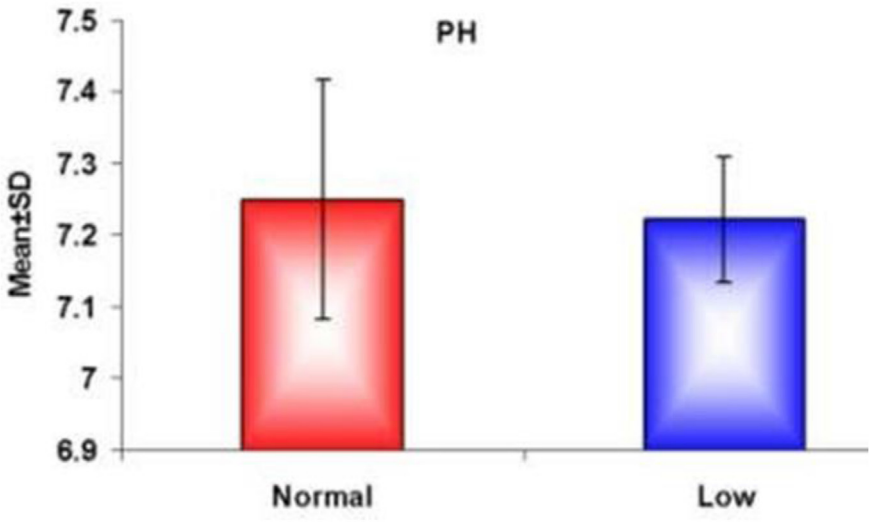

Fig. 3. The correlation between women with normal cerebroplacental ratio and women with low cerebroplacental ratio as regarding the umbilical artery PH.

were 28.620 (4.273) years and 36.240 (1.664) weeks, respectively. Prior to the Doppler test, all subjects got a standard ultrasonographic scan that confirmed the gestational age and ruled out any foetal anomalies. Our research on Apgar scores at five minutes revealed that 34% of infants were admitted to the NICU, and that 33% of those hospitalizations were due to neonatal acidemia, leaving 18% of infants with scores below 7.2. We found that the cutoff value for the positive and negative predictive values of the MCA/UA PI ratio was 29.41, NICU admission was predicted with 71.43% accuracy and 62.5% sensitivity. 90.91. A strong association between the umbilical artery's PH of 7.2/7 (43%) and the study's findings was found and the 5 min Apgar score of 8 (50%) as well as a higher rate of new born ICU 10 (62.5%) in the MCA/UA PI ratio group. This was supported by the prospective observational study conducted by Shahinaj et al.[14] with 738 preeclampsia patients. It was found that the rates of NICU admissions were considerably higher in the group of aberrant MCA/UA PI, with 202 (77.6%) and 161 (61.9%) Apgar scores below 7 at 5 min. With a 77.6% positive and 52.5% negative predictive value, the MCA/UA PI ratio indicated a requirement for NICU admission with a 50.1% sensitivity and 79.3% specificity. The area under the curve for predicting the chance of NICU admission has a value of 0.714 with a 95% confidence interval (0.609–0.819). The ideal end esteem was 0.8, with 100% awareness, 100% negative worth, 97.96% explicitness, and an expected 75% positive prescient worth. The aftereffects of this examination concurred with those of Adiga et al.[15]

In a planned observational evaluation involving 100 pregnant women with toxemia and gestational hypertension, the ability of the cerebro-umbilical pulsatility record proportion to predict infant results was investigated (birth weight, perinatal demise, APGAR score at 5 min, respiratory issues, acidemia, and seizure).

Poor perinatal results were anticipated with a general particularity of 87.5% and a negative prescient worth of 75.5%, showing a diminished probability of such occasions in the event that CPR is typical greater than 1.08. El-Sokarry et al.[16] found that their planned case control investigation of 100 ladies upheld the discoveries of the ongoing request. They found that an Apgar score of 7 and a MCA/UA PI Proportion of 1 were connected with higher paces of NICU confirmation (p 0.05). MCA PI/UA PI proportion showed a 73.7% responsiveness, 68.3% particularity, 52% positive prescient worth, and 85% negative prescient worth while foreseeing pre-birth result (Apgar score 7). (*P* 0.05). As per El-Sokarry et al.,[16] MCA/UA RI proportion displays prevalent demonstrative exactness, responsiveness, and particularity in the forecast of NICU affirmation than MCA/UA PI proportion, which is reliable with the ongoing investigation's discovering that MCA/UA PI proportion shows 62.5% awareness and 71.43% explicitness. The ongoing examination exhibited a feeble association (p worth of 0.396) between umbilical pH 7.2 and MCA/UA PI proportion under 1. (low symptomatic exactness). In foreseeing umbilical pH 7.2, the MCA/UA PI proportion exhibited 43.75% responsiveness, 69.05% explicitness, a 21.21% positive predictive value (PPV), and 86.57% negative predictive value (NPV).

Regan et al.[17] They detached the 270 preeclamptic pregnant women they surveyed into three get-

togethers considering their Doppler results. Foetal MCA/UA PI 1 is accessible in just 40 models. They guessed an association among CPR and the later start of serious blood poisoning. Interestingly, with patients with a commonplace UA Doppler or those with an uncommon UA Doppler yet a normal CPR, patients with a bizarre CPR have earlier gestational ages after entering the world and more unmistakable speeds of baby dismalness. We tracked down a weak connection (relationship coefficient = 1.469, *P* regard = 0.318) between the MCA/UA PI extent and line PH. While Ebrashy et al.[18] saw that preeclamptic pregnancies with MCA/UA RI1 conveyed a general bet of 1.4 (95% conviction range, 1.2–1.7) of new born child acidemia (pH 7.2) in their impending case control research that included 50 pregnant women with blood poisoning. Rehana et al.[19] saw that the MCA/UA PI extent had 52.63% positive and 96.97% negative perceptive characteristics and had 90.91% responsiveness and 78.04% distinction to break down children at risk for acidemia in their audit assessment of 150 patients some place in the scope of 28 and 40 weeks of improvement. In our survey, we tracked down that the MCA/UA PI extent 1 had remarkable relationship judicious impetus for expecting the recurrence of neonatal ICU confirmation as affirmed by 95% sureness extends (0.668–8.429), with a normal positive farsighted worth of 29.41%, 71.43% unequivocally, with a negative prescient worth of 90,91%. In their forthcoming case control study, Alkolekar et al.[20] observed that 6178 pregnant ladies were screened regularly somewhere in the range of 35 and 37 weeks of pregnancy for a poor neonatal result, the exhibition of screening by CPR at 36 weeks might be better than that at 90 days. As indicated by their exploration, it is ideal for troublesome results to be anticipated by low CPR when there is a more limited period between the assessment and conveyance not exactly or equivalent to about 14 days instead of a more drawn out time span. The information was just assembled during the third trimester of pregnancy, which is the review's fundamental imperfection.

Karlsen et al.,[21] in their planned longitudinal that included 220 ladies with high gamble pregnancy, they found positive prescient incentive for CPR less than 1 in the anticipating any neonatal result was CI 95% (4.7–14.4), relative gamble 8.3% for NICU affirmation, and CI 95% (3.2–8.3), relative gamble 5.1% for foetal pain.

The flow concentrate additionally concurred with Allam and Maarouf,[22] in their 201 pregnant ladies accomplice observational examination, shifting in gestational age from 31 to 40 weeks.

A measurably critical association was found between the strange cerebro/umbilical RI proportion and PIH and IUGR foetal occasions (p esteem 0.05). Moreover, foetal inconvenience, IUGR, unfortunate birth weight, and an unusual cerebro/umbilical PI proportion are related with cesarean segments, low 5 min Apgar score and neonatal ICU confirmation cases (*P* value < 0.05). The MCA/UA PI 1 and Apgar score at 5 min showed a positive association, with a p worth of 0.040. In their investigation of 50 preeclamptic pregnant ladies isolated into two gatherings in light of CPR proportion, Yalti et al.[23] tracked down concurrence with this. Foetal MCA/UA proportion was under 1 in only 16 occurrences. The responsiveness and positive prescient upsides of the UA Doppler lists alone in foreseeing a poor neonatal result were 30 and half, separately, as per the people who found that the Apgar score was diminished with CPR proportion 1(*P* 0.05). Likewise, they found that MCA Doppler records alone had a responsiveness and PPV of 50 and 46.7%, separately.[24] Asma and Co. They concurred with the findings of their review partner research, which covered 9772 singleton pregnancies, that flow request when Doppler CPR was substantially lower in pregnancy requiring an activity or admission to the NICU (P.01). Despite the fact that MCA PI and CPR in pregnancies when the infant was owned up to the NNU were practically diminished, UA PI was observably higher in those cases (P 05). The general infant confirmation rate for the review companion was 3.9%. As indicated by this review, lower foetal CPR was related with term neonatal unit (NNU) confirmation and the requirement for an activity to convey the new born child due to thought foetal split the difference.

4.1. Conclusion

Doppler information, which includes cerebral and umbilical velocimetry, it can be helpful in the treatment of preeclamptic patients and in deciding when to deliver the patient in order to rescue the foetus because it provides information on the impact of the placental anomaly.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Sources of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest

The authors declared that there were NO conflicts of Interest.

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