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Linear Correlation of the Uterine Artery Pulsatility Index (PI) in the Mid Trimester in a Pregnant Female with Foetal Birth Weight

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Abstract:-

❖ ***Background***

For the placenta to mature, trophoblasts must infiltrate the uterine decidua and decidual arteries. Placental anomalies are the cause of small for gestational-age (SGA) newborns, fetal growth restriction (FGR), and preeclampsia (PE). From the time of the implantation to the conclusion of the pregnancy, changes in the placental and uterine blood vessels is discovered to be a useful diagnostic tool for problems related to pregnancy. The aims of this review is to compile studies on the roles of uterine artery PI in pregnancy issues. We have considered all the relevant English-language articles published between January 1, 1982, and October 29, 2021. Predicting the pregnancy problems ahead of the time allows health care providers to take timely action to prevent or lessen harm to expectant mothers and their babies. Taking a low-dose aspirin tablet daily before 16 weeks of pregnancy can help to significantly reduce the risk of pregnancy complications. From the start of pregnancy to the end, high-risk populations can be identified using UAD in conjunction with few other maternal characteristics, fetal measurement data, and biochemical indicators. Identifying populations at high risk can aid in the decrease of maternal mortality. Furthermore, modest risk stratification could be used to follow high-risk pregnant women closely, which lowers the incidence of unfavorable events.

❖ ***Methods***

A prospective study was carried out on 110 patients with elevated uterine PI out of the 631 patients who visited SKNMC & GH, Pune, on a regular prenatal visit between January 2022 and November 2023.

Observation

In comparison to a normal newborn after birth, patients with elevated uterine artery PI had lower birth weights, according to our analysis of 110 patients.

❖ ***Conclusion***

We come to the conclusion that mid-trimester uterine artery pulsatility index (PI) along with other biochemical markers aids practitioners in anticipating the early-onset fetal growth restriction. Determining delivery technique and lowering risks can both be aided by monitoring the uterine artery PI, in the mid-trimester in the high-risk pregnancies.

Keywords:- *uterine artery Doppler (UTD), fetal birth weight (FBW), and pulsatility index (PI). Small for Gestational Age, or SMA.*

I. INTRODUCTION

The increased uterine artery pulsatility index (UtA-PI) in the midtrimester has been found to be a common finding that has been demonstrated to be sensitive in predicting instances of intrauterine growth restriction (IUGR) and/or severe pre-eclampsia, particularly those occurring before 34 weeks' gestation(1-3). Despite its wide usage, UtA Doppler's specificity among the unselected women is limited because abnormal results that were discovered at 20 weeks might occasionally lead to a smooth pregnancy (1, 4). For the placenta to mature, trophoblasts must infiltrate the uterine decidua and decidual arteries. Normal blood flow in the mother's uterine artery supports the placental function and a healthy intrauterine environment, which also aids in the fetus's development.

The primary causes are two considerations. Maternal blood first carries nutrition and eliminates waste. Secondly, the uterine artery blood flow also affects the transport of oxygen to the maternal-fetal interface.

The uterine artery predicting the vascular events that are significant during pregnancy is possible with uterine artery doppler (UAD). From the time of the implantation until the conclusion of the pregnancy, identifying changes in the placental and uterine blood vessels can be a useful diagnostic tool for pregnancy-related problems (5). Aberrant uterine artery recasting and decreased uterine artery blood flow, as well as high-risk pregnant women who are likely to have unfavorable pregnancy outcomes can be identified by quantitative parameters. The utero-placental vascular impedance lowers during angiogenesis gradually and stabilization occurs at about 24 weeks of pregnancy (2). The placental blood perfusion may drop again in later pregnancies (6). The pulsatility index (PI), systolic/diastolic (S/D) ratio, resistance index (RI), and the existence of an early diastolic notch are common indicators used for evaluation of uterine artery blood flow (1, 7).

Indeed, the irregularities in the uterine artery blood flow and the development of pregnancy issues have been linked in certain research (2, 8). Further investigation, however, refutes this association (9, 10). This review aims at the compilation of studies on the roles of UAD in pregnancy issues.

The objectives of this paper are to evaluate the uterine artery Doppler in mid-trimester pregnancies and explore its limits and clinical consequences in connection to fetal birth weight.

II. METHOD

A prospective study was carried out in between January 2022 and November 2023 in the SKNMC, Pune, fetal medicine department. 110 of the 651 women who were screened for prenatal visits at this time were chosen.

❖ *Inclusion criteria* -

- Pregnant women with 18-24 weeks of gestation.
- Those women who are willing to perform the Doppler study(written informed consent taken).

❖ *Exclusion criteria* -

- Pregnant women with less than17 weeks and more than 25 weeks of gestation.
- Multifetal pregnancies, abnormal karyotype, and sonographic suspicion of fetal anomaly.

During the visit, the mother's characteristics and medical history were recorded. The fetal size was estimated using trans abdominal ultrasonography measurements of the femur length, the biparietal diameter, the fetal head circumference, and the abdominal circumference. Fetal head circumference, femur length at 19–24 weeks, and menstruation history were used to calculate gestational age.

All the doppler studies were performed using the Seimens Acuson X300 Ultrasound machine by a single Fetal medicine specialist using a 5-MHz sector transducer with spatial peak temporal average intensities below 50 mW/cm square and the high-pass filterat 50–100 Hzs. All the images obtained during the ultrasound scan have been saved and uploaded to IMPACS.

Doppler imaging was used to photograph the whole diameter of the Uterine artery at a distance of 1 cm from the crossing point, with the 2 mm sampling gate. The quality of the flow-velocity waveform was maximized using the smallest angle of insonation and by being careful to create a good waveform with a sharp and defined contour. The mean PI for every UtA was calculated by averaging the values of three consecutive measurements. The mean PI of the left and right uterine artery was then calculated.

When evaluated transvaginally, uterine artery PI in the first trimester is lesser than in the second (EVIDENCE LEVEL:- 2++). At 23 weeks, the transabdominal approach's mean uterine artery PI is 1.44, while with the transvaginal approach is 1.58 (EVIDENCE LEVEL:- 2+). Between 20 and 24 weeks, there is a 15% decrease in the 95th centile of the mean uterine artery PI, and between 22 and 24 weeks, there is a 10% decrease (EVIDENCE LEVEL:- 2++).

Following a thorough postpartum examination of each patient, the following parameters were recorded: birth weight, gestational hypertension or occurrence of late-onset pre-eclampsia, gestational age at delivery, small for gestational age (SGA) infants (birth weight 10th centile), rate of the labor induction, rate of the cesarean section due to foetal distress, and the rate of perinatal death, Gestational hypertension was defined as having a diastolic blood pressure of at least 90 mmHg or the systolic blood pressure of at least two distinct events spaced at least six hours apart.

III. RESULT

During our study period, 110 women had increased UtA-PI at 20 weeks of gestation. Out of which, 50 (45.5%) were normotensive women who were prospectively selected and had foetuses that were developing normally and chronically increased UtA-PI after giving birth. In the control group, 50 patients were prospectively enrolled. Table 1 presents details on the patient and the pregnancy, whereas Table 2 contrasts the outcomes of the cases' and controls' pregnancies.

Table 1. Maternal and pregnancy characteristics of the study groups

Parameter	Abnormal Doppler group (*n* = 50)	Control group (*n* = 50)	P value
Maternal age (in years)	34.15 ± 4.71	34.443± 4.022	0.744
Mean uterine artery pulsatility index (at 20weeks)	1.68 ± 0.21	0.80 ± 0.25	<0.0001

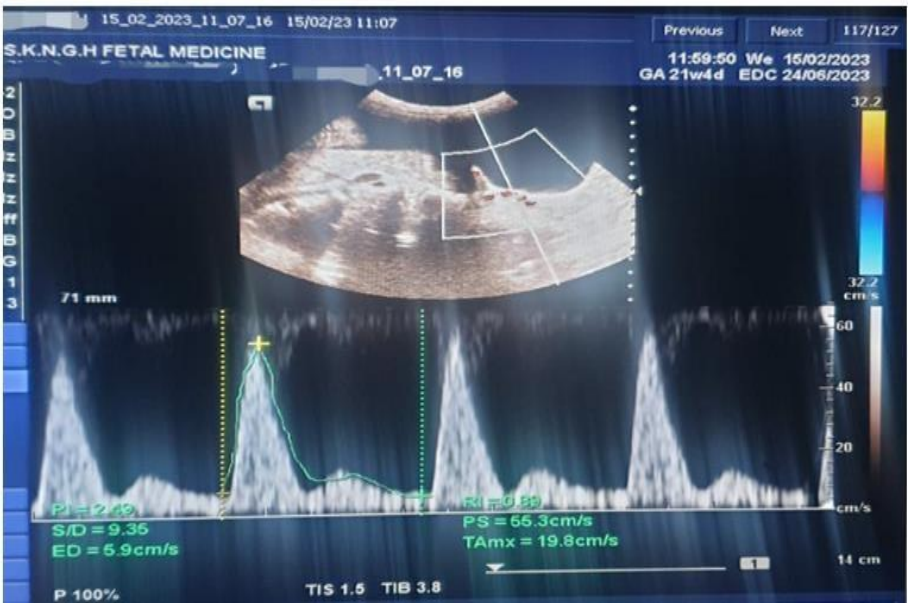

Fig. 1. Increased uterine artery pulsatility index with a diastolic notch.

Table 2. Comparison of pregnancy outcomes between the study groups

Parameter	Abnormal Doppler group (*n* = 50)	Control group (*n* = 50)	P value
Gestational age at delivery (weeks)	37.5±1.58	38.8±1.4	<0.0001
NICU admission	7 (14)	2 (4)	
Small-for-gestational-age neonate	10 (20)	0 (0)	---
Cesarean section	16 (32)	18 (36)	
Cesarean section due to fetal distress	9 (18)	5 (10)	
Fetal demise	0(0)	0(0)	---
Birth weight (g)	2891±622	3391±424	<0.0001

In comparison to controls, women with aberrant Doppler findings had significantly lower birth weights (2891±622 vs. 3391±424, P value -<0.0001) and gestational ages at delivery (37.5±1.58 vs. 38.8±1.4 weeks, P value -<0.0001), as well as higher odds of having an SGA baby (10/50 vs. 0/50). Similar numbers of caesarean sections (9/50 vs. 5/50) and hospitalizations to the neonatal intensive care unit (NICU) (7/50 vs. 2/50) were done for fetal distress in both groups.

DISCUSSION

It may be helpful to screen for UAD abnormalities in the second trimester in a high-risk group. According to reports, in high-risk pregnant women, the rate of detection of abnormal uterine artery blood flow to pre-eclampsia at 23–24 weeks was 45%. After 20 weeks of gestation, RI greater than the 90th percentile in expectant mothers at moderate risk of prenatal hypertension or fetal growth restriction may be an indication. Most multiparous pregnant women who are at high-risk will have unfavorable pregnancy outcomes due to insufficient placentation if they have bilateral uterine artery Doppler notches with RI 0.55 and unilateral uterine artery Doppler notches with RI 0.65 at 20 weeks of pregnancy. When compared to clinical high-risk factors, UAD showed a greater predictive effect on SGA neonates among high-risk females at 22–24 weeks.

Monitoring the uterine artery using Doppler studies during the second trimester is advantageous for low-risk expectant mothers as well a UtA-PI greater than 1.45 in the second trimester was a critical predictor of FGR in low-risk pregnant mothers. Monitoring pregnant women who may have negative pregnancy outcomes can be done with the use of the identification of uterine artery Doppler waveform and the establishment of a notch in the second trimester (16). Measurement of uterine artery blood flow was done in 1,472 pregnant women between 19 and 22 weeks of gestation as a part of a retrospective study.Formation of a diastolic notch, or High UtA-RI and PI in pregnant women were linked to have a greater incidence of cesarean sections, placental abruption spontaneous preterm birth, and FGR (P value- 0.05)(16). The incidence of oligohydramnios, HELLP syndrome, and severe PE was significantly increased in the presence of diastolic notch. Uterine artery notches are thought to be a sign of impaired endothelial function. Unlike late-onset PE, uterine artery testing at 22–24 weeks may predict the majority of early-onset PE in 30,639 pregnant women who were not chosen at random.

In the second trimester, it's also critical to look for uterine artery notches. The PI measurement and the presence or absence of the early diastolic notch is noted when at least three comparable consecutive wave-forms are observed (19). Bilateral notches were associated with increased incidence of PE, spontaneous PTB, and SGA babies when UAD was found in 652 pregnant women between 12 and 16 weeks of gestation. An additional investigation revealed that the medium predictive influence was attributed to the positive likelihood ratios of the mean notch depth index (mNDI) and mean pulsatility index (mPI) for early-onset PE prediction. 1,536 pregnant women between the ages of 16 and 23 weeks participated in this study. It suggested that mPI or mNDI during the second trimester can be helpful to identify individuals who are at high risk of developing early-onset pre-eclampsia. Prior researches have also showed that the combination of UtA-PI and NDI can predict a range of unfavorable pregnancy outcomes, such as spontaneous PTB before 32 weeks, FGR, stillbirth, and placental abruption.

In a meta-analysis involving 79,547 pre- eclampsia patients and 41,131 patients with fetal growth restriction pregnancies (21 in a high-risk group and 7.5 in a low-risk population), the positive likelihood ratio of raised UtA-PI and the presence of notch to predict pre- eclampsia was the highest.

Nonetheless, the results of a study conducted in primiparas at minimal risk showed that uterine artery Doppler in the second trimester had a negligible predictive impact on fetal growth restriction. An another study,one conducted at 22 weeks of gestation examined the uterine artery blood flow of 2,489 low-risk pregnant women and compared with this study. The results of the logistic regression model showed that SGA's predictive sensitivity was only 28.1% and 44.8%, respectively.

IV. CONCLUSION

According to published studies, FGR and other pregnancy-related issues can be predicted using UAD. When more biochemical indications were added to UAD, the prediction accuracy for early-onset FGR caused by insufficient placentation exceeded 90%. In high-risk mid-trimester pregnancies, tracking UAD can aid in early onset FGR prediction and delivery method selection. Identification of the high-risk people who may have unfavorable early pregnancy outcomes is a crucial component of obstetric practise. Due to their lack of obstetric history, primiparas make it challenging to determine their pregnancy risk. Since UAD is a very useful non-invasive screening tool. It can assist medical professionals in identifying patients who are at a higher risk and implementing targeted interventions for detection and prevention. Maternal mortality can be reduced by identifying people at high risk. To improve prediction algorithms, future research must assess parameter selection and UAD evaluation process using standardized detection approaches. Increasing knowledge of the reasons behind pregnancy problems can also help with the development of innovative screening techniques and preventative measures.

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