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

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Abstract:-

➢ *Background*

The uterine decidua and decidual arteries must be invaded by trophoblasts in order for the plcenta to develop. Preeclampsia (PE), foetal growth restriction (FGR), and small-for gestationalage (SGA) infants are all caused by abnormalities of the placenta. Uterine artery Doppler allows for the prediction of important vascular events during pregnancy (UAD). Finding alterations in uterine and placental blood vessels can be a helpful diagnostic tool for pregnancy issues from the implantation stage through the end of the pregnancy. The purpose of thisreview is to assemble research on the functions of Uterine artery PI in pregnancy problems. From January 1, 1983, until October 30, 2021, we take into account all pertinent English-language articles. The ability to foresee pregnancy issues in advance enables medical professionals to implement prompt measures to prevent or decrease harm to mothers and newborns. Before 16 weeks of pregnancy, using low-dose aspirin every day can greatly lower the likelihood of pregnancy problems. UAD can be combined with other maternal variables, biochemical indicators, and foetal measurement data to identify high-risk populations from the beginning through the end of pregnancy. Determining high-risk populations can help reduce maternal mortality. Additionally, strict monitoring for high-risk pregnant women can be conducted by moderate risk stratification, reducing the frequency of adverse events.

➢ *Methods*

Prospective study was conducted in 110 patient with raised uterine PI out of 631 came for routine antenatal visit from January 2021 to November 2022 in SKNMC & GH, Pune.

➢ *Observation*

In our study of 110 patients, we observed that pateints with raised Uterine artery PI showed low birth weight which was decreased as compared to normal neonate after birth.

➢ *Conclusion*

We conclude that uterine artery pulsatility index (PI) with additional biochemical markers in mid trimester helps the practioner in prediction for early-onset fetal growth restriction. Monitoring uterine artery PI in mid-trimester in high-risk pregnancies can also aid in determining the method of delivery and reduces risks.

Keywords:- Pulsatility Index (PI), Fetal Birth Weight (FBW), UTD- uterine artery Doppler. SMA- Small for Gestational Age.

I. INTRODUCTION

A common finding that has been demonstrated to be sensitive in predicting cases of severe pre-eclampsia and/or intrauterine growth restriction (IUGR), particularly those occurring before 34 weeks' gestation, is increased uterine artery pulsatility index (UtA-PI) in the midtrimester(1-3). Although UtA Doppler is frequently used, its specificity among unselected women is limited because aberrant results found at 20 weeks sometimes result in an uneventful pregnancy(1, 4). The uterine decidua and decidual arteries must be invaded by trophoblasts in order for the placenta to develop. The placenta's functionality and a healthy intrauterine environment are both supported by normal blood flow in the maternal uterine artery, which also promotes the development of the foetus. Two factors are the main causes. First, maternal blood transports nutrients and removes waste. Second, oxygen delivery to the maternal-fetal interface is impacted by uterine artery blood flow. There are two key phases in the development of uteroplacental blood arteries. In the first stage happening before 12 weeks after fertilisation,

spiral arteries invade the barrier between the decidua and myometrium (1).

Uterine artery Doppler allows for the prediction of important vascular events during pregnancy (UAD). Finding alterations in uterine and placental blood vessels can be a helpful diagnostic tool for pregnancy issues from the implantation stage through the end of the pregnancy (5). Quantitative parameters can discover high-risk pregnant women who are likely to experience negative pregnancy outcomes, as well as abnormal uterine artery recasting and decreased uterine artery blood flow. During angiogenesis, the uterine placental vascular impedance steadily decreases and stabilises at 24 weeks of pregnancy (2). In subsequent pregnancies, the placental blood perfusion may once again decrease (6). Common indications to assess uterine artery blood flow include the pulsatility index (PI), resistance index (RI), systolic/diastolic (S/D) ratio, and the presence of an early diastolic notch (1, 7).

Undoubtedly, some research has indicated a connection between the development of pregnancy difficulties and irregular uterine artery blood flow (2, 8). However, additional research does not support this connection (9, 10). The purpose of this review is to assemble research on the functions of UAD in pregnancy problems.

The purpose of this paper is to assess the uterine artery Doppler in mid-trimester pregnacies in correlation with fetal birth weight and as well as to discuss its clinical implications and limitations.

II. METHOD

Prospective study was conducted in Fetal Medicine Department, SKNMC, Pune, from from January 2021 to november 2022. Total 651 women were screened antenatal visit during this period, out of which 110 were selected.

➤ *Inclusion criteria -*
- Pregnant women 18-24 weeks of gestation.
- Women who are willing to perform the Doppler study (written informed consent taken).

➤ *Exclusion criteria -*
- Pregnant women who are less than17 weeks and more than 25 weeks of gestation.
- Multifetal pregnancies, sonographic suspicion of fetal anomaly, abnormal karyotype.

This visit included recording of maternal characteristics and medical history, and estimation of fetal size from trans abdominal ultrasound measurement of biparietal diameter, fetal head circumference, abdominal circumference and femur length. Determination of gestational age was done from menstrual history the fetal head circumference and femur length at 19–24 weeks.

Doppler studies were performed using Seimens Acuson X300 Ultrasound machine by single Fetal medicine specialist using 5-MHz sector transducers with spatial peak temporal average intensities below 50 mW/cm2 and the high-pass filter at 50–100 Hz. All images have been saved and uploaded to IMPACS.

The whole diameter of the UtA and a distance of 1 cm from the crossing point were imaged using doppler imaging with the sampling gate set at 2 mm. The flow-velocity waveform's quality was maximised by employing the shortest angle of insonation and taking care to produce a good waveform with a distinct and sharp contour. The value of the average of three successive measurements was used to determine the mean PI for each UtA. Then, the left and right UtAs' mean PI was determined.

As in the first trimester, uterine artery PI in the s ec-ond trimester is higher when measured transvaginally(EVIDENCE LEVEL: 2++). The 95thcentile for mean uterine artery PI is 1.44 for thetransabdominal approach and 1.58 for the transvaginal approach at 23 weeks (EVIDENCE LEVEL: 2+).The 95thcentile of the mean uterine artery PI decreasesby about 15% between 20 and 24 weeks, and by<10%between 22 and 24 weeks (EVIDENCE LEVEL: 2++).

All patients underwent a thorough postpartum checkup, and the following factors were noted: gestational age at delivery, birth weight, small for gestational age (SGA) infant (birth weight 10th centile), occurrence of late-onset pre-eclampsia or gestational hypertension, rate of labour induction, rate of Cesarean section due to foetal distress, and rate of perinatal death. Systolic blood pressure of at least two separate occurrences that were at least six hours apart and/or diastolic blood pressure of at least 90 mmHg were considered to be signs of gestational hypertension.

III. RESULT

110 women had elevated UtA-PI at 20 weeks' gestation during the research period. Among these, 50 (45.5%) prospectively chosen normotensive women with properly developing foetuses and persistently elevated UtA-PI attended after birth. 50 patients were prospectively included in the control group. Table 1 provides information about the patient and the pregnancy, and Table 2 compares the results of the pregnancies of cases and controls.

Table 1. Maternal and pregnancy characteristics of the study groups

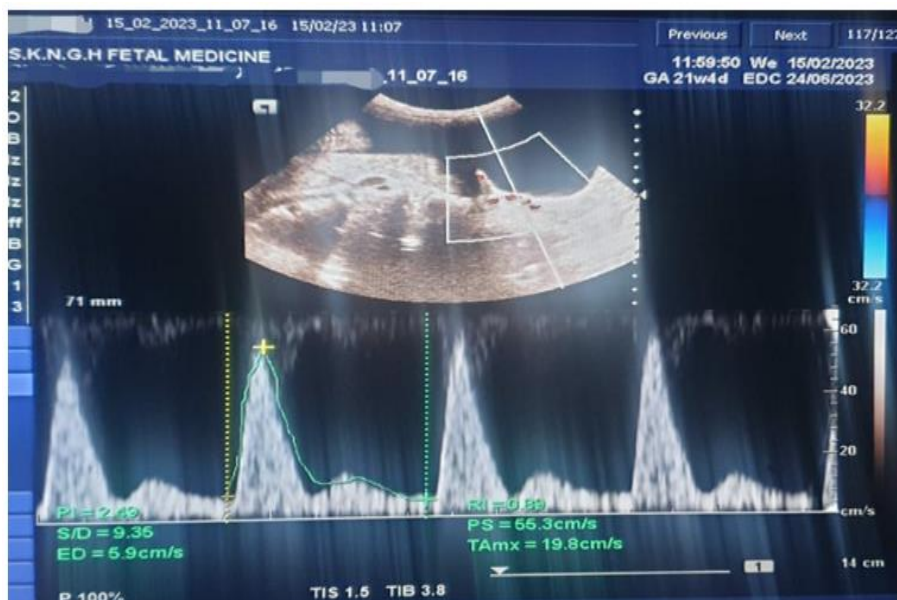| Parameter	Abnormal Doppler group (*n* = 50)	Control group (*n* = 50)	P value
Maternal age (years)	34.15 ± 4.7	34.44 ± 4.02	0.74
Mean uterine artery pulsatility index at 20 weeks	1.68 ± 0.20	0.80 ± 0.25	<0.0001

Fig. 1. Illustrate raised uterine artery PI.

Table 2. Comparison of pregnancy outcomes between 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
Fetal demise	0(0)	0(0)	---
NICU admission	7 (14)	2 (4)	
Cesarean section	16 (32)	18 (36)	
Cesarean section due to fetal distress	9 (18)	5 (10)	
Birth weight (g)	2890±623	3390±425	<0.0001
Small-for-gestational-age neonate	10 (20)	0 (0)	---

Birth weight (2890±623 vs. 3390±425, P value -<0.0001) and gestational age at delivery (37.5±1.58 vs. 38.8±1.4 weeks, P value -<0.0001) were considerably lower in women with aberrant Doppler findings compared to controls, and the chance of giving birth to an SGA infant was higher (10/50 vs. 0/50). Both groups had similar rates of caesarean section performed due to foetal distress (9/50 vs. 5/50) and hospitalisation to the neonatal intensive care unit (NICU) (7/50 vs. 2/50).

IV. DISCUSSION

In a high-risk group, screening for UAD in the second trimester might be advantageous. Reportedly, at 23-24 weeks, the detection rate of aberrant uterine artery blood flow to PE was 45% in high-risk pregnant women. For pregnant women with a moderate risk of UtA- RI more than the 90th percentile is a potential sign of prenatal hypertension or FGR after 20 gestational weeks. When high-risk multiparous pregnant women have bilateral notches with RI 0.55 and unilateral notches with RI 0.65 at 20 weeks, the majority of them will have unfavourable pregnancy outcomes because of inadequate placentation. UAD had a higher prognostic impact

on SGA neonates among high-risk females at 22–24 weeks compared to clinical high-risk variables.

In the second trimester, uterine artery monitoring among low-risk pregnant women is also beneficial. In low-risk pregnant women, a UtA-PI larger than 1.45 in the second trimester was a crucial predictor for predicting FGR. The identification of uterine artery Doppler waveform and the formation of a notch in the second trimester can be utilised to monitor pregnant women who may have unfavourable pregnancy outcomes(16). In a retrospective research, 1,472 pregnant women between weeks 19 and 22 were examined for uterine artery blood flow. A higher rate of caesarean sections, spontaneous preterm birth, placental abruption, and FGR were all associated with high UtA-RI, PI or the development of a diastolic notch in pregnant women (P 0.05)(16). The presence of diastolic notch dramatically elevated the incidence of severe PE, HELLP syndrome and oligohydramnios. According to reports, the development of uterine artery notches indicates poor endothelial function. In contrast to late-onset PE, most early-onset PE could be predicted by uterine artery testing at 22–24 weeks in 30,639 pregnant women who weren't randomly selected .

Additionally, it's important to check for uterine artery notches in the second trimester. When at least three similar consecutive wave-forms are obtained, PI is measured, and the presence orabsence of early diastolic notching is recorded(19). When UAD was detected in 652 pregnant women between weeks 12 and 16, it was discovered that the presence of bilateral notches increased the risk of PE, spontaneous PTB, and SGA infants. One further study found that the positive likelihood ratios of the mean notch depth index (mNDI) and mean pulsatility index (mPI) for predicting early-onset PE had a medium predictive impact. This study involved 1,536 pregnant women between 16 and 23 weeks of gestation . It implies that mNDI or mPI in the second trimester can aid in the identification of high-risk people who may have early-onset PE. The combination of NDI and UtA-PI has also been demonstrated in previous studies to be able to predict a variety of unfavourable pregnancy outcomes, including placental abruption, FGR, stillbirth, and spontaneous PTB before 32 weeks.

A few research with significant sample sizes have produced useful findings. At 23 weeks gestation, a multicenter investigation found UtA-PI in 7,851 pregnant women. For predicting PE (with or without FGR) and FGR (with or without PE), the percentage of UtA-PI larger than the 95th percentile was 41 and 16%, respectively . Additionally, the sensitivity of UtA-PI was 93, 80, and 56%, respectively, for women who lost their pregnancies before 32 weeks due to PE with FGR, PE without FGR, or FGR without PE . UtA-PI alone identified 25-77% SGA (less than the 5th quantile) who had births at different gestational weeks in a retrospective analysis involving 23,894 pregnancies at 19–24 gestational weeks, with a false positive rate (FPR) of 10%. (16).

The positive likelihood ratio of elevated UtA-PI and the presence of notch to predict PE was highest in a meta-analysis with 79,547 PE patients and 41,131 FGR pregnancies (21 in a high-risk group and 7.5 in a low-risk population).

However, the outcomes of a study performed in low-risk primiparas revealed that UAD in the second trimester had a small prognostic influence on FGR. Similar to this study, another one at 22 weeks looked at 2,489 low-risk pregnant women's uterine artery blood flow. The outcomes of the logistic regression model demonstrated that SGA had only 44.8% and 28.1%, respectively, predictive sensitivity.

V. CONCLUSION

Published research have shown that UAD can be used to predict pregnancy-related problems including FGR. The accuracy of prediction for early-onset FGR brought on by inadequate placentation was better than 90% when UAD was supplemented with additional biochemical indicators. Monitoring UAD in high-risk mid-trimester pregnancies can also help with predicting early onset FGR and choosing the delivery strategy. One of the most important aspects of obstetric practise is the identification of high-risk individuals who could have early pregnancy outcomes that are not favourable. It is difficult to assess pregnancy risk in primiparas since they lack obstetric history. Due to the fact that UAD is a non-invasive screening, it can help clinical practitioners identify high-risk patients and implement specific detection and prevention interventions. It is possible to lower maternal mortality by identifying high-risk populations. Future studies must use standardised detection techniques to evaluate the parameter choice and UAD evaluation procedure in order to develop better prediction algorithms. The development of cutting-edge screening methods and preventative measures can also be aided by raising awareness of the causes of pregnancy difficulties.

REFERENCES

[1]. Cnossen JS, Morris RK, ter Riet G, Mol BW, van der Post JA, Coomarasamy A, Zwinderman AH, Robson SC, Bindels PJ, Kleijnen J, Khan KS. Use of uterine artery Doppler ultrasonography to predict pre-eclampsia and intrauterine growth restriction: a systematic review and bivariable meta-analysis. *CMAJ* 2008; **178**: 701– 711.

[2]. 2Yu CK, Smith GC, Papageorghiou AT, Cacho AM, Nicolaides KH. An integrated model for the prediction of pre-eclampsia using maternal factors and uterine artery Doppler velocimetry in unselected low-risk women. *Am J Obstet Gynecol* 2005; **193**: 429– 436.

[3]. 3Papageorghiou AT, Roberts N. Uterine artery Doppler screening for adverse pregnancy outcome. *Curr Opin Obstet Gynecol* 2005; **17**: 584– 590.

[4]. 4Papageorghiou AT, Yu CK, Cicero S, Bower S, Nicolaides KH. Second-trimester uterine artery Doppler screening in unselected populations: a review. *J Matern Fetal Neonatal Med* 2002; **12**: 78– 88.

[5]. 5Ghi T, Contro E, Youssef A, Giorgetta F, Farina A, Pilu G, Pelusi G. Persistence of increased uterine artery resistance in the third trimester and pregnancy outcome. *Ultrasound Obstet Gynecol* 2010; **36**: 577– 581.

[6]. Parry S, Sciscione A, Haas DM, Grobman WA, Iams JD, Mercer BM, et al. Role of early second-trimester uterine artery Doppler screening to predict small-for-gestational-age babies in nulliparous women. *Am J Obstet Gynecol.* (2017). 217:594. doi: 10.1016/j.ajog.2017.06.013

[7]. 6Gómez O, Figueras F, Fernández S, Bennasar M, Martínez JM, Puerto B, Gratacós E. Reference ranges for uterine artery mean pulsatility index at 11–41 weeks of gestation. *Ultrasound Obstet Gynecol* 2008; **32**: 128– 132.

[8]. 7Salomon LJ, Bernard JP, Ville Y. Estimation of fetal weight: reference range at 20–36 weeks' gestation and comparison with actual birth-weight reference range. *Ultrasound Obstet Gynecol* 2007; **29**: 550– 555.

[9]. 8Kurmanavicius J, Wright EM, Royston P, Zimmermann R, Huch R, Huch A, Wisser J. Fetal ultrasound biometry: 2. Abdomen and femur length reference values. *Br J Obstet Gynaecol* 1999; **106**: 136– 143.

[10]. 9Hadlock FP, Harrist RB, Sharman RS, Deter RL, Park SK. Estimation of fetal weight with the use of head, body, and femur measurements—a prospective study. *Am J Obstet Gynecol* 1985; **151**: 333– 337.

[11]. 10Jauniaux E, Farquharson RG, Christiansen OB, Exalto N. Evidence-based guidelines for the investigation and medical treatment of recurrent miscarriage. *Hum Reprod* 2006; **21**: 2216– 2222.

[12]. Brodszki J, Länne T, Stale H, Batra S, Marsál K. Altered vascular function in healthy normotensive pregnant women with bilateral uterine artery notches. *Bjog.* (2002) 109:546–52. doi: 10.1111/j.1471-0528.2002.01315.x

[13]. Takahashi K, Ohkuchi A, Hirashima C, Matsubara S, Suzuki M. Establishing reference values for mean notch depth index, pulsatility index and resistance index in the uterine artery at 16–23 weeks' gestation. *J Obstet Gynaecol Res.* (2012) 38:1275–85. doi: 10.1111/j.1447-0756.2012.01864.x

[14]. Becker R, Vonk R, Vollert W, Entezami M. Doppler sonography of uterine arteries at 20–23 weeks: risk assessment of adverse pregnancy outcome by quantification of impedance and notch. *J Perinat Med.* (2002) 30:388– 94. doi: 10.1515/jpm.2002.060

[15]. Becker R, Vonk R. Doppler sonography of uterine arteries at 20–23 weeks: depth of notch gives information on probability of adverse pregnancy outcome and degree of fetal growth restriction in a low-risk population. *Fetal Diagn Ther.* (2010) 27:78–86. doi: 10.1159/000274377

[16]. atiu D, Hide-Moser K, Morgenstern B, Gottschalk I, Eichler C, Ludwig S, et al. Doppler indices and notching assessment of uterine artery between the 19th and 22nd week of pregnancy in the prediction of pregnancy outcome. *In Vivo.* (2019) 33:2199–204. doi: 10.21873/invivo.11722

[17]. Familiari A, Bhide A, Morlando M, Scala C, Khalil A, Thilaganathan B. Mid-pregnancy fetal biometry, uterine artery Doppler indices and maternal demographic characteristics: role in prediction of small-for-gestational-age birth. *Acta Obstet Gynecol Scand.* (2016) 95:238–44. doi: 10.1111/aogs.12804

[18]. Severi FM, Bocchi C, Visentin A, Falco P, Cobellis L, Florio P, et al. Uterine and fetal cerebral Doppler predict the outcome of third-trimester small-for-gestational age fetuses with normal umbilical artery Doppler. *Ultrasound Obstet Gynecol.* (2002) 19:225–8. doi: 10.1046/j.1469-0705.2002. 00652.x

[19]. Albaiges G, Missfelder-Lobos H, Lees C, Parra M, Nicolaides KH. One-stagescreening for pregnancy complications by color Doppler assessment of the uterinearteries at 23 weeks' gestation.Obstet Gynecol2000;96: 559 – 564

[20]. Vergani P, Roncaglia N, Andreotti C, Arreghini A, Teruzzi M, Pezzullo JC, et al. Prognostic value of uterine artery Doppler velocimetry in growth- restricted fetuses delivered near term. *Am J Obstet Gynecol.* (2002) 187:932– 6. doi: 10.1067/mob.2002.127137