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ROLE OF UTERINE ARTERY DOPPLER IN THE PREDICTION OF PRE-ECLAMPSIA AND INTRA UTERINE GROWTH RESTRICTION IN FIRST & SECOND TRIMESTERS OF PREGNANCY: AN OBSERVATIONAL STUDY AT A TERTIARY HOSPITAL IN RAJASTHAN

Radio-Diagnosis

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ABSTRACT

AIMS & OBJECTIVES: To evaluate the usefulness of uterine artery Doppler USG screening in first and mid trimester to predict the risk for preeclampsia and IUGR. Also, to determine the sensitivity and specificity of uterine artery Doppler indices [Pulsatility index (PI) and diastolic notching] in prediction of preeclampsia in pregnant women & to know the outcome of pregnancy and its relation with the uterine artery Doppler indices.**MATERIALS & METHODS:** The study began after approval from the Research Review Board and Institutional Ethics Committee. The study was carried out in the Department of Radiodiagnosis & Modern Imaging, S.P.M.C., Bikaner (Rajasthan). After obtaining approval from the Institutional Ethics Committee, eligible pregnant women fulfilling the inclusion criteria were enrolled. Written informed consent was obtained prior to participation. Relevant clinical history and examination findings were recorded in a predesigned proforma. Uterine artery Doppler examinations were performed as per standard departmental protocol, and participants were followed up till delivery for documentation of maternal and fetal outcomes. **RESULTS:** The findings of this study indicate that abnormal uterine artery Doppler parameters are associated with a higher likelihood of adverse maternal and fetal outcomes, particularly hypertensive disorders of pregnancy. However, a consistent trend toward elevated Doppler indices in affected pregnancies was observed. This suggests that altered uteroplacental circulation precedes the clinical onset of disease and may reflect early placental insufficiency. Thus, second-trimester Doppler assessment appears to have stronger predictive value compared to first-trimester screening alone.

KEYWORDS

Uterine; Doppler; Notching; Fetal; Iugr; Outcome; Pregnancy.

INTRODUCTION:

Hypertensive disorders of pregnancy are among the most common medical complications encountered during gestation and remain a major cause of maternal and perinatal morbidity and mortality worldwide[1]. These disorders include chronic hypertension, gestational hypertension, preeclampsia, and eclampsia, with preeclampsia accounting for the majority of severe complications.[2] Globally, hypertensive disorders complicate approximately 5–10% of all pregnancies and contribute substantially to adverse maternal and fetal outcomes, particularly in low- and middle-income countries where access to early antenatal care and advanced monitoring facilities may be limited.[3]

In the Indian context, hypertensive disorders of pregnancy represent a significant public health concern[4]. They are consistently reported as one of the leading causes of maternal mortality, contributing to nearly 10–15% of maternal deaths nationwide. Apart from mortality, these conditions are associated with considerable maternal morbidity, including acute complications such as eclampsia, cerebrovascular accidents, pulmonary edema, hepatic dysfunction, acute renal failure, and disseminated intravascular coagulation[5]. The burden extends beyond the antenatal period, as women who experience hypertensive disorders during pregnancy have an increased risk of developing chronic hypertension and cardiovascular disease later in life.

The fetal and neonatal consequences of hypertensive disorders are equally serious. Impaired uteroplacental perfusion can lead to placental insufficiency, resulting in intrauterine growth restriction, preterm birth, low birth weight, placental abruption, stillbirth, and increased rates of neonatal intensive care unit admission.[6-7] These adverse outcomes contribute significantly to perinatal morbidity and mortality and have long-term implications for child health and development.

Despite advances in obstetric care, the clinical presentation of hypertensive disorders, particularly preeclampsia, often occurs late in the disease process, when placental pathology is already well established. Conventional screening methods based on maternal history and blood pressure measurement alone have limited predictive value for identifying women who will subsequently develop severe disease. This limitation has driven ongoing research into early, non-invasive screening modalities that can identify high-risk pregnancies before the onset of clinical manifestations, thereby allowing closer surveillance and timely intervention to improve maternal and fetal outcomes.[8]

Preeclampsia: Definition, Pathophysiology, and Maternal–Fetal Impact Preeclampsia is a pregnancy-specific, multi-system disorder characterized by the new onset of hypertension after 20 weeks of gestation, often accompanied by proteinuria or evidence of maternal end-organ dysfunction. It remains one of the most serious complications of pregnancy and is responsible for a substantial proportion of maternal and perinatal morbidity and mortality worldwide. The clinical presentation of preeclampsia is heterogeneous, ranging from mild hypertension to severe disease complicated by eclampsia, HELLP syndrome, pulmonary edema, renal failure, and cerebrovascular accidents.[9]

The underlying pathophysiology of preeclampsia is complex and begins early in pregnancy, long before clinical manifestations become apparent. Abnormal placentation plays a central role, particularly inadequate invasion of the maternal spiral arteries by trophoblastic cells. Failure of physiological transformation of these vessels results in persistently high-resistance uteroplacental circulation. This leads to reduced placental perfusion, chronic placental hypoxia, and oxidative stress. In response, the placenta releases anti-angiogenic factors such as soluble fms-like tyrosine kinase-1 and endoglin into the maternal circulation, causing widespread endothelial dysfunction.

Maternal endothelial dysfunction is responsible for the systemic features of preeclampsia, including hypertension, proteinuria, and multi-system involvement affecting the liver, kidneys, brain, and coagulation system. Beyond the immediate pregnancy-related complications, women who develop preeclampsia are now recognized to have a significantly increased long-term risk of cardiovascular disease, including chronic hypertension, ischemic heart disease, heart failure, and stroke[10].

From a fetal perspective, preeclampsia is closely associated with placental insufficiency. Reduced uteroplacental blood flow compromises oxygen and nutrient transfer to the fetus, resulting in intrauterine growth restriction, oligohydramnios, preterm delivery, stillbirth, and increased neonatal morbidity[11]. Early-onset preeclampsia, in particular, is associated with more severe placental

pathology and poorer perinatal outcomes compared to late-onset disease. Given its early placental origin and significant maternal-fetal impact, preeclampsia represents an ideal target for early prediction using uteroplacental Doppler assessment.[12-13]

MATERIALS & METHODS:

The study population comprised pregnant women attending the antenatal clinic and obstetric services of S.P. Medical College & Associated Group of P.B.M. Hospitals, Bikaner (Rajasthan), who were referred to the Department of Radiodiagnosis & Modern Imaging for ultrasonography and Doppler evaluation during the study period. Eligible participants fulfilling the inclusion criteria were enrolled after obtaining informed consent and were followed up with scheduled Doppler examinations to assess uterine artery indices and pregnancy outcomes.

Inclusion criteria

1. Pregnant women with singleton or multiple gestation who were willing to participate in the study and provided written informed consent.

2. Participants undergoing first Doppler assessment between 12–14 weeks of gestation and second Doppler assessment between 20–26 weeks of gestation.

3. Pregnant women attending the antenatal clinic/obstetric services or referred cases to the Department of Radiodiagnosis & Modern Imaging for Doppler evaluation during the study period.

4. Participants who could be followed up till delivery for assessment of maternal and fetal outcomes (preeclampsia and IUGR).

Exclusion criteria

1. Pregnant women who do not have any pre-existing Hypertension.

2. Pregnant women who did not provide informed written consent for participation in the study.

3. Participants with gestational age outside the defined Doppler assessment periods (12–14 weeks for Scan 1 and 20–26 weeks for Scan 2).

4. Pregnant women with confirmed major fetal congenital anomalies detected on ultrasonography.

5. Cases with intrauterine fetal demise at the time of enrolment or during the follow-up period.

6. Participants who were lost to follow-up or in whom pregnancy outcome could not be recorded till delivery.

7. Poor Doppler window/inadequate study due to technical limitations, preventing reliable measurement of uterine artery indices.

REPRESENTATIVE CASES:

FIG 1: SHOWS RIGHT UTERINE ARTERY SPECTRAL IMAGING WITH NOTCHING

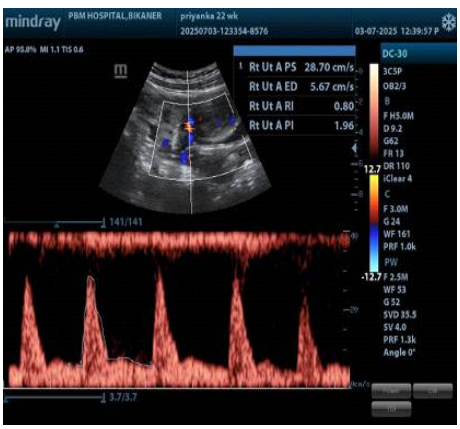
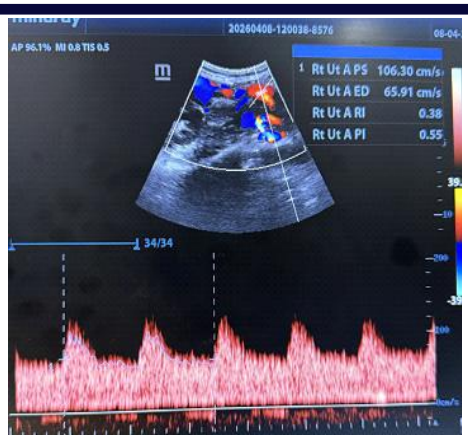


FIG 2: SHOWS NORMAL UETRINE ARTERY SPECTRAL FLOW PATTERN



RESULTS:

While sensitivity and specificity were not sufficiently high to recommend Doppler as a standalone diagnostic test, its high negative predictive value suggests usefulness in identifying women at lower risk, thereby helping in risk stratification and focused antenatal surveillance.

The study also demonstrated an association between elevated second-trimester uterine artery pulsatility index and increased likelihood of operative delivery, further reflecting the relationship between abnormal uteroplacental perfusion and adverse obstetric outcomes.

Overall, uterine artery Doppler sonography emerges as a valuable, non-invasive, and easily reproducible modality for early identification of pregnancies at increased risk of preeclampsia and fetal growth restriction. While it should not replace clinical evaluation and routine antenatal care, it can serve as an important adjunct in comprehensive risk assessment, particularly in tertiary care settings. Early identification of high-risk women allows closer monitoring and timely intervention, thereby contributing to improved maternal and perinatal outcomes.

LIMITATIONS:

- The sample size, although adequate for preliminary evaluation, was relatively small and may have limited the statistical power to detect stronger associations.
- The study was conducted at a single tertiary care centre, which may limit generalizability of results to community or rural healthcare settings.
- The proportion of high-risk pregnancies was relatively higher compared to general population screening cohorts, which may influence predictive estimates.
- Doppler assessment was operator-dependent, and although performed as per protocol, subtle inter-observer variability cannot be completely excluded.
- Only uterine artery Doppler parameters were primarily emphasized; biochemical markers and combined predictive models were not incorporated.
- The follow-up period was limited to delivery, and long-term maternal cardiovascular outcomes were not evaluated.
- Sensitivity and specificity values observed were moderate, indicating that uterine artery Doppler alone cannot function as a definitive predictive tool.

RECOMMENDATIONS:

- Uterine artery Doppler examination should be incorporated as a part of routine mid-trimester anomaly scan, particularly in women with identifiable clinical risk factors for preeclampsia and fetal growth restriction.
- Second-trimester Doppler assessment appears to have greater predictive value compared to first-trimester assessment alone; therefore, careful evaluation at 20–26 weeks should be emphasized in antenatal imaging protocols.

- Persistent bilateral uterine artery notching in the second trimester should alert clinicians to the possibility of impending hypertensive disorders, warranting closer antenatal surveillance and blood pressure monitoring.

- Uterine artery Doppler findings should always be interpreted in conjunction with clinical parameters such as maternal age, baseline blood pressure, and past obstetric history, rather than in isolation.

- Larger multicentric studies with inclusion of biochemical markers and combined predictive models are recommended to enhance diagnostic accuracy and develop validated screening algorithms.

- Early identification of high-risk pregnancies through Doppler screening should be integrated with institutional protocols for timely referral, appropriate obstetric management, and neonatal preparedness to reduce maternal and perinatal morbidity.

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