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REVIEW

Recommendations for Prenatal Doppler in Daily Obstetric Practice - A Review

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Abstract

Doppler fluximetry in obstetrics refers to the use of Doppler ultrasound technology to assess blood flow patterns and velocities in the maternal and fetal circulations during pregnancy. It provides valuable information about the vascular dynamics in the placenta, umbilical cord, and fetal organs, aiding in the evaluation of fetal well-being and the identification of potential complications. The umbilical artery, middle cerebral artery, and uterine artery are the blood vessels used in Doppler fluximetry to measure blood flow patterns and velocities. The parameters commonly assessed in Doppler fluximetry include: Systolic/Diastolic Ratios: The ratio of peak systolic velocity to end-diastolic velocity, providing information about the resistance to blood flow. Pulsatility Index (PI): Calculated as the difference between peak systolic and end-diastolic velocities divided by the mean velocity, reflecting the resistance and compliance of the vessel. Resistance Index (RI): Calculated as the difference between peak systolic and end-diastolic velocities divided by the peak systolic velocity, assessing vascular resistance. By evaluating these parameters, Doppler fluximetry can provide insights into the uteroplacental and fetal circulations. Abnormal findings, such as increased resistance or altered blood flow patterns, may indicate placental insufficiency, fetal growth restriction, fetal anemia, or other complications. These findings can guide clinical management and help in making decisions regarding the timing and mode of delivery or further interventions. It's essential to note that the interpretation of Doppler findings should always be done in conjunction with other clinical data, such as fetal growth assessment, maternal health, and fetal well-being. Doppler flowmetry should always be performed and interpreted by qualified healthcare professionals, such as obstetricians, perinatologists, or sonographers, who can integrate the Doppler findings with other clinical data to provide appropriate care for pregnant women.

Keywords: Doppler fluximetry; Obstetrics; Systolic/Diastolic Ratios; Pulsatility Index; Resistance Index.

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INTRODUCTION

Doppler fluximetry in obstetrics refers to the use of Doppler ultrasound technology to assess blood flow patterns and velocities in the maternal and fetal circulations during pregnancy. It provides valuable information about the vascular dynamics in the placenta, umbilical cord, and fetal organs, aiding in the evaluation of fetal well-being and the identification of potential complications[1].

The Doppler Effect, named after the Austrian physicist Christian Doppler, is a phenomenon that describes the change in frequency of sound or light waves as they are reflected by a moving object[2]. In obstetrics, Doppler ultrasound uses this principle to measure the velocity of blood flow in specific vessels.

Doppler fluximetry involves placing the ultrasound probe over the target blood vessel, such as the umbilical artery, middle cerebral artery, or uterine artery[3]. The Doppler ultrasound emits high-frequency sound waves that bounce off the red blood cells within the vessel. The returning waves are then analyzed to determine the velocity and waveform characteristics of the blood flow.

The parameters commonly assessed in Doppler fluximetry include:

- Systolic/Diastolic Ratios: The ratio of peak systolic velocity to end-diastolic velocity, providing information about the resistance to blood flow.
- Pulsatility Index (PI): Calculated as the difference between peak systolic and end-diastolic velocities divided by the mean velocity, reflecting the resistance and compliance of the vessel.
- Resistance Index (RI): Similar to PI, the difference between peak systolic and end-diastolic velocities divided by the peak systolic velocity, assessing vascular resistance.

By evaluating these parameters, Doppler fluximetry can provide insights into the uteroplacental and fetal circulations. Abnormal findings, such as increased resistance or altered blood flow patterns, may indicate placental insufficiency, fetal growth restriction, fetal anemia, or other complications. These findings can guide clinical management and help in making decisions regarding the timing and mode of delivery or further interventions[4,5]:

It's essencial to note that the interpretation of Doppler findings should always be done in conjunction with other clinical data, such as fetal growth assessment, maternal health, and fetal well-being.

MEASUREMENT TECHNIQUES TO DOPPLER FLOWMETRY IN OBSTETRICS

There are several measurement techniques used in Doppler flowmetry in obstetrics to assess blood flow velocities and patterns. These techniques involve placing the Doppler ultrasound probe on specific blood vessels and obtaining measurements using various parameters. Here are some commonly used measurement techniques in obstetric Doppler flowmetry[6,7]:

- Pulsed Wave Doppler (PW Doppler): This technique uses short bursts or pulses of ultrasound waves to assess blood flow. The Doppler probe emits and receives ultrasound signals at specific sampling sites within the vessel of interest. PW Doppler allows for precise localization of the sample volume and provides information about the velocity and waveform characteristics of blood flow.
- Continuous Wave Doppler (CW Doppler): CW Doppler uses continuous transmission and reception of ultrasound waves. It allows for the assessment of high-velocity blood flow, such as in cases of fetal cardiac evaluation. Unlike PW Doppler, CW Doppler does not provide spatial resolution or depth information, but it is useful for assessing blood flow in vessels where PW Doppler may be limited due to high velocity or deep location.
- Color Doppler: Color Doppler combines real-time imaging with Doppler flow information. It assigns colors to different blood flow velocities, allowing for visualization of blood flow patterns. Color Doppler is often used to guide the placement of the sample volume in PW Doppler or to provide a qualitative assessment of blood flow distribution and direction.
- Spectral Doppler Analysis: Spectral Doppler analysis involves the interpretation of the Doppler waveform obtained from PW Doppler or CW Doppler. The waveform reflects the changes in blood flow velocity over time. Spectral Doppler analysis includes measuring parameters such as peak systolic velocity, end-diastolic velocity, and calculating indices like the pulsatility index (PI) or resistance index (RI). These measurements help in assessing the resistance to blood flow and identifying abnormalities in the vascular dynamics.

The choice of measurement technique depends on the specific blood vessel being evaluated, the clinical question, and the expertise of the operator. Different techniques may be used for assessing blood flow in vessels like the umbilical artery, middle cerebral artery, uterine artery, or ductus venosus.

The interpretation of Doppler flowmetry measurements should always be done in conjunction with other clinical information to obtain a comprehensive assessment of fetal well-being and placental function.

INTERPRETATION OF DOPPLER FLOWMETRY IN OBSTETRICS

Interpretation of Doppler flowmetry in obstetrics involves analyzing the parameters obtained from Doppler ultrasound measurements to assess blood flow velocities and patterns. The interpretation aims to evaluate the vascular dynamics in the maternal and fetal circulations, identify potential abnormalities, and provide information about fetal well-being and placental function. Are some interpretations of Doppler flowmetry in obstetrics[8-10]:

Umbilical Artery Doppler:

- Normal: A normal umbilical artery Doppler waveform is characterized by a forward flow throughout the cardiac cycle, with a low-resistance pattern. The waveform shows smooth deceleration during diastole.
- Abnormal: Abnormal umbilical artery Doppler findings may include absent or reversed end-diastolic flow (ARED), increased pulsatility index (PI), increased resistance index (RI), or abnormal waveform patterns. These findings can indicate placental insufficiency, fetal growth restriction, or other complications.

Middle Cerebral Artery (MCA) Doppler:

- Normal: A normal MCA Doppler waveform typically demonstrates a low-resistance pattern with antegrade flow throughout the cardiac cycle.
- Abnormal: Abnormal MCA Doppler findings, such as increased pulsatility or resistance indices, may indicate fetal anemia or cerebral circulatory redistribution. These findings can be associated with conditions like fetal hypoxia, fetal anemia, or other abnormalities.

Ductus Venosus Doppler:

- Normal: A normal ductus venosus Doppler waveform shows continuous forward flow throughout the cardiac cycle, reflecting normal cardiac function and placental circulation.
- Abnormal: Abnormal ductus venosus Doppler findings, such as reversed a-wave or altered pulsatility indices, may suggest cardiac dysfunction, chromosomal abnormalities, or adverse pregnancy outcomes.

Uterine Artery Doppler:

- Normal: A normal uterine artery Doppler waveform demonstrates a low-resistance pattern with forward flow.
- Abnormal: Abnormal uterine artery Doppler findings, such as increased pulsatility or resistance indices, may indicate impaired uteroplacental circulation, placental insufficiency, or a higher risk of preeclampsia.

The interpretation of Doppler flowmetry in obstetrics should always be done in conjunction with other clinical data, such as fetal growth assessment, maternal health, and fetal well-being. The combination of Doppler findings with other parameters, such as biophysical profile (BPP) scores, non-stress tests (NSTs), or additional imaging studies, helps provide a comprehensive evaluation and guide clinical management decisions.

PARAMETRES DURING INTERPRETATION OF DOPPLER FLOWMETRY IN OBSTETRICS

Interpretation of Doppler flowmetry in obstetrics involves analyzing the parameters obtained from Doppler ultrasound measurements to assess blood flow velocities and patterns. These values help evaluate the vascular dynamics and provide information about fetal well-being and placental function. These parametres are:

- Pulsatility Index (PI): The pulsatility index is a numeric value calculated as the difference between the peak systolic velocity and the end-diastolic velocity, divided by the mean velocity. It reflects the resistance and compliance of the vessel being assessed. Higher PI values indicate increased resistance to blood flow.
- Resistance Index (RI): The resistance index is another numeric value calculated as the difference between the peak systolic velocity and the

end-diastolic velocity, divided by the peak systolic velocity. It also provides information about vascular resistance. Higher RI values suggest increased resistance to blood flow.
- Systolic/Diastolic (S/D) Ratio: The S/D ratio is calculated by dividing the peak systolic velocity by the end-diastolic velocity. It indicates the relationship between the systolic and diastolic components of the waveform. An elevated S/D ratio may indicate increased resistance or altered blood flow patterns.

Mean Arterial Blood Velocity: This value represents the average velocity of blood flow within the vessel being assessed. It provides information about the overall blood flow characteristics in the region of interest.

INTERPRETATION OF DOPPLER FLOWMETRY IN OBSTETRICS, BASED ON GESTATION AGE, AND CORRESPONDING VALUES

Interpretation of Doppler flowmetry in obstetrics, based on gestational age, involves assessing the blood flow velocities and patterns in various vessels and comparing them to reference ranges specific to each gestational age[11-15].

Umbilical Artery Doppler:
- Normal interpretation: In early to mid-gestation, the umbilical artery Doppler waveform typically shows a low-resistance pattern with forward flow throughout the cardiac cycle. As gestation progresses, there is an increasing diastolic component. Normal values for pulsatility index (PI) and resistance index (RI) generally decrease with advancing gestational age.
- Abnormal interpretation: Abnormal umbilical artery Doppler findings may include absent or reversed end-diastolic flow (ARED), increased PI, increased RI, or abnormal waveform patterns. These abnormal findings may indicate placental insufficiency, fetal growth restriction, or other complications.

Middle Cerebral Artery (MCA) Doppler:
- Normal interpretation: Normal MCA Doppler waveforms typically exhibit a low-resistance pattern with antegrade flow throughout the cardiac cycle. The pulsatility index (PI) and resistance index (RI) values are generally within specific reference ranges for each gestational age.
- Abnormal interpretation: Abnormal MCA Doppler findings may include increased PI or RI values, indicating altered blood flow patterns or potential fetal anemia. These findings may require further evaluation and intervention.

Ductus Venosus Doppler:
- Normal interpretation: Normal ductus venosus Doppler waveforms demonstrate continuous forward flow throughout the cardiac cycle, indicating normal cardiac function and placental circulation. The pulsatility index for veins (PIV) and the S/D ratio are typically within reference ranges specific to each gestational age.
- Abnormal interpretation: Abnormal ductus venosus Doppler findings, such as reversed a-wave or altered pulsatility indices, may suggest cardiac dysfunction, chromosomal abnormalities, or adverse pregnancy outcomes.

Uterine Artery Doppler:
- Normal interpretation: Normal uterine artery Doppler waveforms show a low-resistance pattern with forward flow. The pulsatility index (PI) and resistance index (RI) values are typically within specific reference ranges based on gestational age.
- Abnormal interpretation: Abnormal uterine artery Doppler findings may include increased PI or RI values, suggesting impaired uteroplacental circulation and a higher risk of preeclampsia or other placenta-related complications.

It's important to emphasize that these interpretations are general guidelines, and specific reference ranges and interpretations may differ. They consider individual patient factors and integrate Doppler findings with other clinical information to provide accurate and personalized care.

GENERAL AND SPECIFIC INDICATIONS FOR DOPPLER FLOWMETRY IN OBSTETRICS

Doppler flowmetry in obstetrics provides valuable information about fetal well-being, placental function, and the uteroplacental circulation. Are described below some general and specific indications for Doppler flowmetry in obstetrics[16-18]:

General Indications:

1. High-risk Pregnancies: Doppler flowmetry is often recommended in high-risk pregnancies, including those with conditions such as gestational hypertension, preeclampsia, diabetes, maternal cardiovascular disease, multiple pregnancies (twins, triplets), or a history of fetal growth restriction.
2. Fetal Growth Restriction (FGR) or Small for Gestational Age (SGA): Doppler flowmetry is commonly used to assess fetal well-being and detect placental insufficiency in cases of suspected fetal growth restriction or when the fetus is measuring small for gestational age.
3. Decreased Fetal Movements: If a pregnant person report decreased fetal movements or a change in fetal activity, Doppler flowmetry may be used to assess fetal well-being and evaluate the uteroplacental circulation.

Specific Indications[19-24]:

1. Umbilical Artery Doppler: Umbilical artery Doppler is indicated in cases of suspected placental insufficiency, fetal growth restriction, or abnormal fetal biophysical profile. It helps assess the uteroplacental circulation and predict adverse pregnancy outcomes.
2. Middle Cerebral Artery (MCA) Doppler: MCA Doppler is useful in cases of suspected fetal anemia, such as in isoimmunization (Rh factor incompatibility), to evaluate fetal cerebral circulatory redistribution and assess the need for intrauterine transfusion.
3. Ductus Venosus Doppler: Ductus venosus Doppler is employed to assess cardiac function and predict adverse pregnancy outcomes, particularly in cases of chromosomal abnormalities or cardiac dysfunction.
4. Uterine Artery Doppler: Uterine artery Doppler is used to evaluate uteroplacental circulation and assess the risk of developing preeclampsia or other placenta-related complications, especially in pregnancies at high risk for these conditions.

It's important to note that these indications are not exhaustive, and specific recommendations may vary based on individual patient factors, local protocols, and the expertise of the healthcare provider.

DISCUSSION AND CONCLUSIONS

The Doppler ultrasound is a technique that evaluates blood flow velocity and patterns, through these parameters:

Umbilical Artery Doppler: Measures blood flow in the umbilical artery, providing information about fetal-placental circulation.

Middle Cerebral Artery (MCA) Doppler: Assesses blood flow in the fetal brain, which can be useful for monitoring fetal anemia or assessing cerebral circulatory redistribution.

Ductus Venosus Doppler: Evaluates blood flow in the ductus venosus, aiding in assessing cardiac function and potential chromosomal abnormalities.

Uterine Artery Doppler: Assesses blood flow to the uterus, helping to identify placental insufficiency or predict preeclampsia.

Doppler waveforms are assessed by examining the velocity and resistance of blood flow. Various indices, such as the pulsatility index (PI), resistance index (RI), and systolic/diastolic (S/D) ratios, may be used for interpretation. Abnormal Doppler findings may suggest placental insufficiency, fetal hypoxia, or other complications, and further management or interventions may be required.

Specific recommendations for Doppler flowmetry in obstetrics can vary depending on individual patient factors, local protocols, and the expertise of the healthcare provider. It is recommended to perform regular Doppler assessments to monitor the uteroplacental and fetal circulations. Doppler flowmetry is particularly valuable in high-risk pregnancies. High-risk conditions may include gestational hypertension, preeclampsia, diabetes, maternal cardiovascular disease, multiple pregnancies (twins, triplets), suspected fetal anomalies, decreased fetal movements, a history of fetal growth restriction (FGR) or Small for Gestational Age (SGA). The timing and frequency of Doppler assessments may vary depending on the specific indication, gestational age, and clinical context. Doppler flowmetry should be interpreted in conjunction with other clinical findings, including fetal growth assessment, maternal health, and fetal well-being. Combining Doppler results with biophysical profile (BPP) scores, non-stress tests (NSTs), or additional imaging studies provides a more comprehensive evaluation.

We have come to the conclusion that regular Doppler assessments can help assess fetal well-being, detect

placental insufficiency, and guide management decisions regarding timing of delivery or interventions.

It's important to note that recommendations need to be determined are general in nature, and specific recommendations, which may vary based on individual circumstances. The use of Doppler flowmetry and interpretation of results should be performed by qualified healthcare professionals, such as obstetricians, perinatologists, or sonographers, who are trained in obstetric Doppler ultrasound and can consider the unique needs of each patient.

Ethics approval and consent to participate

This study is literature review. It was conducted using only aggregated data in literature. Institutional review board approval was not required.

Conflict of Interest

The author declares that there is no financial interest or conflict of interest.

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