

The Applicability and Use of Doppler Ultrasonography in The First Trimester

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In contemporary obstetrics, the idea of "the pathological processes which are apt to cause complications or diseases at the later stages of pregnancy or even at the postnatal period could be revealed in early pregnancy weeks is spreading. Most researchers are readily willing to use all available means of technology to detect the pathologies which could develop in the early weeks of pregnancy. Along with the first trimester screening tests, the importance and application fields of the first trimester doppler ultrasonography is frequently discussed.

This review will discuss shortly the first trimester screening tests and then will focus on the advantages and applicability of the first trimester doppler ultrasound as mentioned in the current literature.

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The prenatal/early detection of pathologies of pregnancy such as disease processes, infections, genetic disorders etc. and taking the necessary precautions to prevent and overcome those is now the main aim of maternal fetal medicine.

Screening tests are being developed on those pathologies, along with first trimester screening tests and diagnostic methods. Biochemical tests (free β -HCG, PAPP-A), ultrasonographic markers (nuchal translucency, nasal bone screening), and serologic markers (TORCH) are among the first trimester screening tests.

Invasive procedures such as amniocentesis, chorion villus sampling, and non-invasive approaches as fetal cell screening in maternal blood are commonly mentioned first trimester diagnostic tests.

Recently, along with all of those, the applicability and advantages of first trimester doppler applications are frequently mentioned as a non-invasive screening and diagnostic test.

First Trimester Fetal Hemodynamics

Fitzgerald and Drumm¹ are the first researchers who used doppler ultrasound to detect umbilical artery blood flow spectrum in obstetric diagnosis. Later, many researchers investigated the fetal arterial and venous systems to detect physiological and pathological blood flow patterns.

a) Umbilical Artery and Fetal Descending Aorta:

First trimester work-up revealed the absent end diastolic

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flow along with high pulsatility index in both umbilical artery and fetal descending aorta between the 6th and 13th weeks of pregnancy.^{2,3,4}

Incidental finding of reverse end diastolic flow in umbilical artery at the late first trimester has been found to be associated with fetal loss in later pregnancy in a study,⁵ and with chromosomal abnormalities in another.⁶

b) Middle Cerebral Artery:

In the late first trimester it is hard to differentiate the blood flow of carotid artery, and especially the middle and anterior cerebral branches of the carotid artery. At this period, middle cerebral artery pulsatility index, when compared, is 1.4 and 2.0 times more than the descending aorta and the umbilical artery respectively, and this has been linked to the more rapid growth of fetal head in the early pregnancy.³

c) Umbilical Vein:

The fetal blood flow in the umbilical vein is a constant forward flow. Rarely, a pulsatile pattern synchronized with fetal heart beat is observed in early pregnancy weeks, but this disappears between the 9th and 12th weeks of pregnancy.⁷ Abnormal umbilical vein pulsatile pattern has also been observed in normal cases with a real knot on the umbilical cord.

d) Ductus Venosus:

Ductus venosus blood flow is pulsatile and has 3 components, (systolic, atrial and diastolic). Blood flow rate in the ductus venosus is high. Systol/diastole ratio in ductus venosus has been reported to be constant during the pregnancy.⁸

To date, late diastolic back flow of ductus venosus has been only reported in cases with cardiac defects,⁹ and again with seriously intrauterine growth restricted (IUGR) fetuses with disturbed cardiac functions.¹⁰ As a proof of in vivo heart failure, 10 to 14 week old fetuses who have increased nuchal

translucencies as a result of chromosomal abnormalities, also have an abnormal blood flow synchronized with fetal atrial contractions.¹¹ Again, the absence of a wave or a reversed blood flow, has been reported at normal karyotyped fetuses with increased nuchal translucency and cardiac defects.¹² These results indicate that the evaluation of ductus venosus blood flow is helpful to select 1) the high risk fetuses with abnormal screening test results who would eventually proceed to invasive testing and 2) chromosomally normal fetuses carrying a higher risk for cardiac abnormalities.

Physiological Pregnancy:

Chorionic vessels blood flow is best shown with doppler ultrasound after the second trimester. In the first trimester, a real intervillous blood flow presence is not clear. Jauniaux was first to say that blood flow in intervillous space could not be detected with doppler ultrasound before 11th and 12th weeks.¹³

Uterine perfusion increases with the first trimester of pregnancy, and doppler ultrasound is quite effective to detect this, even in the early stages of pregnancy.

Most of the articles reported an early diastolic notch in uterine artery doppler waveforms in early pregnancy, which is generally accepted to indicate a high vascular resistance, and which generally disappears as the pregnancy advances, as a response to decreased vascular resistance in time. The persistence of the uterine artery notch in one or both uterine arteries after the 24th week of pregnancy is shown to be associated with complications such as preeclampsia and/or IUGR at later pregnancy.¹⁴

Dickey et al.,¹⁵ in their study on first trimester pregnant women after an infertile period, detected a reverse correlation between crown to rump length (CRL) and pulsatility index and resistance index.

Abnormal Pregnancy:

Placental abnormalities:

Two recent studies mention the useful application of doppler ultrasonography on detecting placenta accreta in the 8th and 9th weeks of pregnancy, respectively.^{16,17} In these studies, demonstration of the subplacental vessels extending into the lower uterine segment and the loss of subplacental hypoechoic zone have been explained as the diagnostic determinants of placenta accreta.

Abortions:

With doppler ultrasonography, missed abortion cases have been linked to the increased subplacental vascularity, which was mentioned to be related to the loss of pregnancy within a week.¹⁸

Jaffe et al.¹⁹ prospectively studied the trophoblastic blood flow waveforms and concluded that a finding of intervillous blood flow or an increased resistance index in spiral arteries

indicated to an expected pregnancy loss with 80% sensitivity and 86% specificity.

Kurjak et al.²⁰ reported that a low pulsatility index in intervillous space to be related to unembryonic pregnancies and missed abortions, and that no change of resistance index was seen compared to normal pregnancies.

On the contrary, there are four separate studies concluding that doppler findings could not be used to detect which threatened abortions would end up with real pregnancy losses.²¹⁻²⁴ They reported that the size and the central location of hematomas are more conclusive of prognosis.

When all those studies are considered, if a pregnancy is to end up in abortion, the doppler investigation of uterine blood circulation is not considered as a dependable predictor of outcome.

The Prediction of Preeclampsia and IUGR:

Even though the doppler ultrasonography is an efficient way of screening for preeclampsia and IUGR in the second trimester, there are limited and conflicting data on the first trimester use.

Martin et al.²⁵ reported that a uterine artery pulsatility index of 2.35 or more in the 11th-14th weeks of pregnancy had low sensitivity in relation to preeclampsia and IUGR development.

A more recent study showed that a uterine artery resistance index value over 75 percentile at the 10th to 14th weeks of pregnancy indicated to a 66% risk of IUGR development in the second and third trimesters.²⁶

Even though the high resistance indices of spiral arteries in the early pregnancy showed a defective trophoblastic invasion, those changes do not have prognostic value as long as they are not permanent.

A first trimester IUGR is diagnosed when more than a 7 days of difference between the measured and expected CRL is encountered. Although the real cause is not usually detected, the blamed factors are generally chromosomal abnormalities, other congenital abnormalities, TORCH infections, alcohol and substance, diabetes, placental insufficiency, and delayed implantation.

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