Umbilical Cord Morphology and Umbilical Artery Doppler in Intrauterine Growth-Restricted Fetuses

Essay

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«رَبَّنَا عَلَيْكَ تَوَكَّلْنَا وَإِلَيْكَ أَنَبْنَا وَإِلَيْكَ الْمَصِيرُ»

(الممتحنة: من الآية٤)

Abstract

Intra uterine growth restriction (IUGR) results in a wide spectrum of complications including perinatal death and prematurity as well as short and long term sequelae. Correct identification of IUGR is crucial as appropriate management can result in a better outcome. Diagnosis of IUGR often depends on a combination of tests including accurate early pregnancy dating, serial ultrasound examinations and Doppler velocimetry studies. The ultimate goal is to distinguish between IUGR and small for gestational age fetus (SGA) to avoid over treatment & to detect the IUGR fetus at risk early by monitoring the morphometric changes (diameter & area) of the umbilical cord .

Key words

Umbilical - intrauterine growth-restriction - morphometry - Doppler

Dedication

To my parents, my sisters, and
my friends, with love,
for their love.
To my father, for your never-ending
support.

Sarah

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First and foremost, thanks to Allah

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Sarah

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List of Abbreviations

A/REDF	Absent /reversed end diastolic flow.
AC	Abdominal circumference.
AFI	Amniotic fluid index.
AGA	Appropriate for gestational age.
ALARA	As low as reasonably achievable.
BPD	Bi-parietal diameter.
cBPD	Corrected bi-parietal diameter
CDS	Color Doppler sonography.
CRL	Crown-rump length.
CTG	Cardiotocography.
CW	Continuous wave.
d & ds	Day & days.
DV	Ductus venosus.
EDV	End diastolic volume.
EFW	Estimated fetal weight.
FL	Femur length.
FVW	Flow velocity waveform.
GA	Gestational age.
GRIT	Growth restriction intervention trial.
HC	Head circumference.
HC/AC ratio	Head circumference / abdominal circumference ratio.
IUGR	Intra-uterine growth restriction.
LMP	Last menstrual period.
MCA	Middle cerebral artery.
MSD	Mean sac diameter.
NST	Non stress test.
OFD	Occipito-frontal diameter.
PI	Pulsatility index.
PW	Pulsed wave.
RI	Resistance index.
S/D ratio	Systolic /diastolic ratio.

SD	Standard deviation.
SGA	Small for gestational age.
UA	Umbilical artery.
UV	Umbilical vein.
wks	Weeks.

Introduction

Prenatal evaluation of the umbilical cord is usually performed to assess the impedance of the umbilical arteries to blood flow in fetuses with or at risk for growth and developmental abnormalities (*Lin & Santolaya-Forgas, 1998).*

Recently, some studies have investigated the sonographic morphologic and morphometric characteristics of the umbilical cord components in relation to fetal and maternal diseases *(Di Naro et al, 2002).*

Intrauterine growth-restriction (IUGR) is defined by the presence of abnormal sonographic biometry (abdominal circumference below the 5th percentile for gestational age at the time of sonography and a birth weight below the 10th percentile) *(Raio et al,2003).*

IUGR is associated with an increased risk of perinatal mortality, morbidity, and impaired neurodevelopment *(Kok et al, 1988).*

Ultrasonographic biometry helps to identify a heterogenous group of small for gestational age fetuses that include fetuses with IUGR and fetuses with small constitution. The correct detection of the compromised IUGR fetus, to allow for timely intervention, is a main objective of antenatal care. Umbilical artery Doppler velocimetry is the most rigorously evaluated test among noninvasive tests of fetal well being *(Neilson & Alfirevic, 1998).*

Small for gestational age babies with normal umbilical artery Doppler studies are unlikely to be stillborn or to experience major complications during pregnancy or the neonatal period *(McCowan et al, 2000).*

It has been shown that a lean umbilical cord (its cross-sectional area is below 10th percentile for gestational age) on prenatal sonography poses

a risk that the fetus will be small for gestational age at delivery and will have distress during labour *(Raio et al, 1998).*

Lean umbilical cords with reduced vein caliber and blood flow have been found in IUGR fetuses with normal umbilical artery Doppler parameters *(Bruch et al,1997).*

When IUGR fetuses with normal umbilical artery Doppler parameters were compared with those with abnormal Doppler parameters, a further decrease of the total vessel area was observed, which was mainly due to a reduction of the vessel wall thickness *(Di Naro et al, 2002).*

The proportion of lean umbilical cords was higher in IUGR fetuses than in appropriate-for-gestational age fetuses. Umbilical vein caliber decreases significantly with worsening of umbilical artery parameters *(Raio et al, 2003).*

Histologic studies, conducted by computerized microscopic morphometric analysis, showed that umbilical cords of IUGR fetuses were significantly smaller and characterized by reduced umbilical vein cross-sectional areas compared with those of healthy fetuses. Similar findings in umbilical cords of pregnant women with hypertensive disorders were reported *(Bruch et al, 1997).*

Aim of work

To identify the intra-uterine growth restricted fetuses & to assess their sonographic morphological and morphometrical characteristics of the umbilical cord as well as the degree of umbilical artery Doppler parameters abnormalities.

Embryology

Major events occurring in the first weeks of pregnancy

The zygote migrates into the fallopian tube within 3-5 days, during which it changes into a blastocyst. The syncitiotrophoblast (outer sheet of syncitium, outside the cytotrophoblast giving irregular projections presenting early chorionic villi) has the power to erode the endometrium until the blastocyst reaches the stratum spongiosum of the endometrium *(Sadler, 1995).*

A blood clot is formed at the opening and the surface epithelium grows over it. Now the blastocyst is embedded in the endometrium which is now called decidua. The process of embedding of the blastocyst in the endometrium of the uterus is called implantation**.** Starting from the pole opposite the inner cell mass called embryonic pole and ends at the 2^{nd} pole which called abembryonic pole. It occurs about one week after fertilization and completed at 11^{th} day. The normal site of implantation is in the upper part of the posterior wall of the uterus near its fundus *(Di Slavo, 1998).*

At the 9^{th} day a layer of cells separates, forming a membrane called exocoelomic (Heuser`s) membrane, creating the primary yolk sac. Simultaneously, the amniotic cavity forms. The embryonic disc lies between the yolk sac and the amniotic sac *(Sadler, 1995).*

At the 11^{th} and 12^{th} days, a new tissue called extra-embryonic mesoderm appears, in which multiple small cavities begin to appear. These cavities enlarge and unite together to form a single cavity which is called extra-embryonic coelom. The cavity of the extra-embryonic coelom does not surround the blastocyst completely because part of the extra-embryonic mesoderm, called connecting stalk (fig.1), has no cavities (future umbilical cord) connecting the embryo with the

trophoblast (outer cell mass of the blastocyst). The primary yolk sac is now converted into the secondary yolk sac and sends a finger like diverticulum into the substance of the connecting stalk known as allantois (fig. 2), *(Sachs & Fourcroy, 1982).*

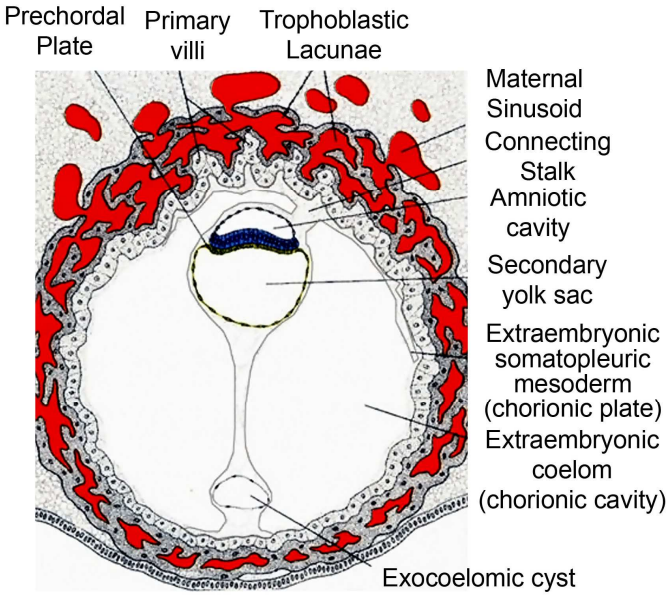

Fig. 1. Drawing of a 13-day human blastocyst *(Sadler, 1995).*

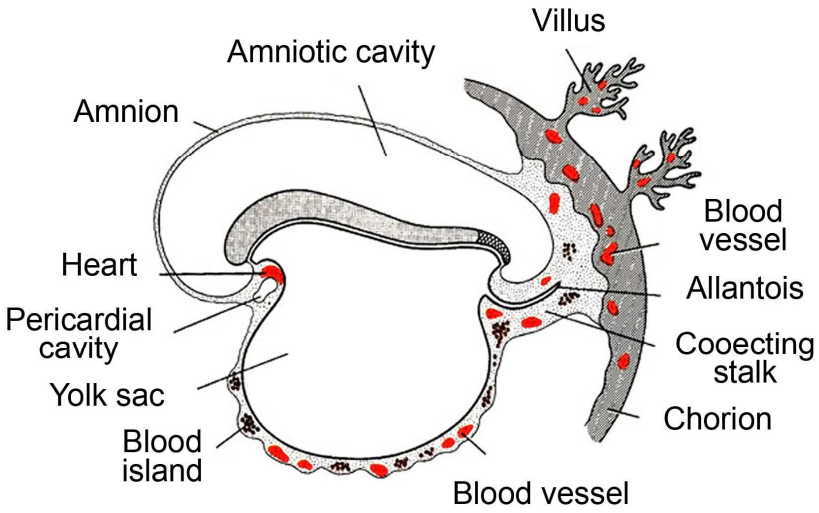

Fig.2. Human embryo at 19 days *(Sadler, 1995).*

The chorionic villi begin to enlarge opposite the connecting stalk forming chorion frondosum and degenerate on the opposite side forming