

**Uterine arteries Doppler in the early second trimester
in correlation to fetal birth weight**

Thesis

*Submitted for complete fulfillment for the M. Sc. degree
in Obstetrics and Gynaecology*

By

Amr Cherif Hamza

(M.B.B.Ch, Cairo University)

Supervised by

Professor Dr. Omar Abd El Aziz Mohamed

Professor of Obstetrics and Gynecology

Faculty of Medicine

Cairo University

Dr. Hisham Saeed Isamel El Shaer

Lecturer of Obstetrics and Gynecology

Faculty of Medicine

Cairo University

Faculty of Medicine

Cairo University

2010

Acknowledgement

I would like to thank all those who helped me in my research for this thesis and the patient who participated in the study.

Moreover, I would like to thank the investigators for their patience and understanding. A special gratitude and respect goes to Prof. Dr. Omar Abd El Aziz and Dr. Hisham El Shaer for their supervision and thoughtful insight.

I also thank the discussing committee Prof. Dr. Omar Abd El Aziz, Prof. Dr. Omayma Idris and Prof. Dr. Ahmed Mansour for attending the discussion to give their suggestions and expert opinion for refining this thesis.

The whole work would have never been accomplished if I did not have a patient and understanding family. I would like to thank on this occasion my wife for her support. Also, I would like to praise and thank my parents, my father who made me love medicine and my mother who offered all her love and comfort to achieve what I want.

Cairo, March 23rd 2010

Amr Hamza

جامعة القاهرة / كلية الطب
الدراسات العليا

محضر
اجتماع لجنة الحكم على الرسالة المقدمة من
الطبيب / عمرو شريف محمد عبد القادر
توظلة للحصول على درجة الماجستير / الدكتوراه
فى

تحت عنوان : باللغة الانجليزية :
Uterine artery Doppler in the early
second trimester in correlation to fetal birth weight.

: باللغة العربية :
دور الـ uterine artery Doppler
المتردد فى الحمل وعلاقته بوزن الجنين

بناء على موافقة الجامعة بتاريخ ١٢ / ١ / ٢٠١٠ تم تشكيل لجنة الفحص والمناقشة
للمرسالة المذكورة أعلاه على النحو التالى :-
١. د. عبد الباقى محمد كبر عبد الباقى عن المشرفين
٢. د. سعيدة الشويخ ممتحن داخلى
٣. د. أحمد محمد منصور ممتحن خارجى

بعد فحص الرسالة بواسطة كل عضو منفردا وكتابة تقارير منفردة لكل منهم انعقدت اللجنة
مجتمعة فى يوم : الاربعاء ٢٢ / ٣ / ٢٠١٠ بقسم النساء مدرج
بكلية الطب - جامعة القاهرة وذلك لاستماع الطالب فى جلسة علنية فى موضوع الرسالة والنتائج
التي توصل اليها وكذلك الاسس العلمية التي قام عليها البحث .
قرار اللجنة

تم قبول الرسالة

توقيع أعضاء اللجنة :-
المشرف الممتحن

الممتحن الخارجى

الممتحن الداخلى

محمد منصور

أحمد

عصام

Index

Introduction	1
Aim of work	3
Review of literature	
Chapter 1: The world of Doppler	5
History of Doppler	6
Clinical applications of Doppler in obstetrics and gynecology	15
Doppler Velocimetry	18
Doppler velocimetry of the uteroplacental circulation	29
Chapter 2	58
Fetal Growth and Development	59
Chapter 3	84
Fetal and Maternal Circulations	85
Acute Hypoxia	101
Chronic Stress	102
Practical work	104
Patients and Methods	105
Results	110
Discussion	121
Conclusion	128
Summary	130
Reference	135
Arabic summary and abstract	171

List of tables:

#	Title	Page
1-1	History of introduction of Doppler into the field of obstetrics	14
1-2	Pregnant women included in this study.	111
2-2	Maternal heights in cm at registration of the pregnant women included in this study..	111
3-2	Maternal weights at registration in kg of the pregnant women included in this study.	111
4-2	Parity of the pregnant women included in this study.	112
5-2	Resistance index of the uterine artery Doppler between the 16 th and 22 nd week of gestation.	112
6-2	Pulsatility index of the uterine artery Doppler between the 16 th and 22 nd week of gestation.	112
7-2	Rattoo of maximal systolic and minimal diastolic flow of the uterine artery Doppler between the 16 th and 22 nd week of gestation.	112
8-2	Birth weight of newborns included in this study in kg.	113
9-2	Birth weight percentile corrected by the Gardosi's customized growth curve of newborns included in this study in %.	113
10-2	First APGAR scores of newborns included in this study in %.	113
11-2	Second APGAR scores of newborns included in this study in %.	113
12-2	Pearson product-moment correlation coefficients in evaluating the Pulsatility Indices (PI), Resistance Indices (RI) and Systolic flow over diastolic flow ration (S/D) of uterine artery Doppler	114

	<p>between the 16th and 22nd weeks of gestation. R(%) stands for the Pearson product-moment correlation coefficients when percentiles of the neonatal weight are studied. P(wt) stands for the Pearson product-moment correlation coefficients when the actual weights in grams are used.</p>	
--	---	--

List of Figures:

#	Title	Page
1-1	Example of mirror imaging of the Doppler waveform obtained from the uterine artery.	27
2-1	Anatomy of arcuate, radial and spiral arteries	30
3-1	Normal pregnancy. Spiral artery at the myometrial junction show extensive structural alterations (physiologic changes)	31
4-1	Fully developed physiologic changes in the uteroplacental arteries during normal pregnancy.	32
5-1	Difference between normal and preeclamptic pregnancies regarding the extent of physiologic changes in the uteroplacental arteries.	34
6-1	Preeclampsia. Myometrial spiral artery is unaffected by physiologic changes and retains a normal internal elastic lamina.	35
7-1	Preeclampsia.	36
8-1	Preeclampsia complicating essential hypertension.	37
9-1	Uterine artery compliance during the menstrual cycle and throughout pregnancy.	41
10-1	Subplacental (top), right uterine (bottom left), and left uterine (bottom right) waveforms in a chronically hypertensive woman at 22 weeks' gestation.	48
11-1	Absent early-diastolic velocities in the uterine artery wave with pulsed Doppler	50
12-1	Reverse flow of the uterine artery of a severely preeclamptic	50

	woman.	
13-1	Reference ranges of the uterine and arcuate resistance index, demonstrating the effect of placental site. (<i>Bower et al., 1993</i>)	52
14-1	Flow velocity waveforms (FVW) obtained from both placental circulations at 8 and 16 weeks of gestation, respectively. Note the progressive increase in diastolic flow of the uteroplacental waveforms from the uterine artery to the spiral artery and as gestational age advances. (<i>Jauniaux et al., 1992</i>)	53
15-1	Transverse image of the embryo at 12 weeks and 1 day of gestational age depicting the crown–rump length measurement of 5.43mm. (<i>Kremkau et al., 2002</i>)	63
16-1	Transverse ultrasound image at the level of the biparietal diameter, demonstrating thalami (T) and septum cavum pellucidum (SCP). (<i>Kieler et al., 1998</i>)	68
17-1	Posterior fossa with cerebellar diameter, fourth ventricle, and cisterna magna. (<i>Kieler et al., 1998</i>)	68
18-1	Longitudinal image of the fetal spine. (<i>Kieler et al., 1997</i>)	69
19-1	This figure shows the fully developed changes in the uteroplacental arteries of normal pregnancy. The <i>hatched portions</i> of the wall of the spiral arteries indicate the extent of the physiologic changes. IVS = intervillous space. (<i>Pijnenborg et al., 1983</i>)	87
20-1	Diagram showing the Starling Resistor (<i>Konrad et al., 2004</i>)	94
21-1	Fetal heart showing the percentages of combined ventricular output by each ventricle and traversing the major vascular	97

	pathways.	
1-2	Birth-weight expressed in percentiles plotted against the uterine artery resistance index values in 32 pregnancies assessed at 16 – 22 weeks of gestation.	115
2-2	Birth-weight expressed in percentiles plotted against the uterine artery pulsatility index values in 32 pregnancies assessed at 16 – 22 weeks of gestation.	116
3-2	Birth-weight expressed in percentiles plotted against the uterine artery systolic over diastolic ratio values in 32 pregnancies assessed at 16 – 22 weeks of gestation.	117
4-2	Birth-weight expressed grams plotted against the uterine artery resistance index values in 32 pregnancies assessed at 16 – 22 weeks of gestation.	118
5-2	Birth-weight expressed grams plotted against the uterine artery resistance index values in 32 pregnancies assessed at 16 – 22 weeks of gestation.	119
6-2	Birth-weight expressed in percentiles plotted against the uterine artery systolic over diastolic ratio values in 32 pregnancies assessed at 16 – 22 weeks of gestation.	120

List of abbreviations:

Abbrev.	Abbreviations
%	Percentile
2D	Two Dimensional
AC	Abdominal Circumference
Ao	Aorta
BPD	Biparietal Diameter
BW	Body weight
Cm	Centimeter
Cm/s	Centimeter per second
CRL	Crown-Rump Length
CTG	Cardiotocogram
Cu ²⁺	Ionized copper
CW	continuous wave
DA	ductus arteriosus
FHR	fetal heart rate
FL	Femur Length
FP	Fetoplacental
FVW	Flow velocity waveforms
G	Gram
GLUT	glucose transport proteins
hCG	human chorionic gonadotropin
hPL	Human placental lactogen
I.V.S.	intervillous space
IgG	immunoglobulin G
IUGR	intrauterine growth restricted
Kg	Kilogram
l/min	Liter per minute
LA	left atrium
LDL	low-density lipoprotein
LV	Left ventricle
Max	Maximum
Min	Minimum
ml/min	Milliliter pro minute
Mm	Millimeter

mmHg	Millimeter Mercury
MPT	Main pulmonary trunk
PA	pulmonary artery
PI	Pulsatility Index
PIH	Pregnancy induced hypertension
PO2	oxygen partial pressure
PTH-rP	Parathyroid hormone-related protein
PW	Pulsed wave
RI	Resistance Index
RV	right ventricle
S/D	Systolic over Diastolic ratio
SD	Standard Deviation
UP	Uteroplacental
US	Ultrasound
Wt	Weight

Keywords:

uterine artery Doppler, birth weight, normal pregnancy, prediction, Pulsatility index, resistance index, systolic over diastolic ratio, early second trimester.

Abstract:

Objective: To establish whether uterine artery resistance index (RI), Pulsatility index (PI) and systolic over diastolic ratio (S/D) in healthy pregnant women in early second-trimester has a relation with birth weight.

Methods: This was a cross-sectional study of 32 pregnant women attending routine ultrasound examination at 16 – 22 weeks' gestation. Uterine artery RI, PI and S/D were measured. Birth weight and customized centiles, calculated by centile calculator version 5.12.1 of birth weights were plotted against Doppler value using Pearson product-moment correlation coefficient.

Results: The Pearson product-moment correlation coefficients in evaluating the Pulsatility Indices (PI), Resistance Indices (RI) and Systolic flow over diastolic flow ration (S/D) were , 0.05, -0.07 and 0.02 for absolute weights and -0,21, -0.09 and -0.06 for customized percentiles respectively.

Conclusion: A non significant correlation exists between birth weight, customized percentiles and first-trimester uterine artery Doppler parameters.

Introduction

In a pregnancy, a fetus grows inside the maternal uterus depending on many interacting factors. The result of these factors is represented by the fetal weight and well being. *Kaufmann and associates 2003*

The neonatal weight should be inside a certain range, where we can say that this weight is normal. Growth curves have been established to set limits to the lower and upper ranges of the neonatal weight. If this weight is normal, we can then conclude that the intrauterine environment was suitable for normal fetal growth. The proper neonatal weight is therefore one of the signs of normal placental functions. *Audibert F et al 2005*.

Measuring the uterine artery flow can give us an idea about the speed velocity of the uterine artery blood flow. Measurement of the uterine artery flow velocity can give us an idea about the blood flow to the uterus and therefore to the fetus. This can give us an idea about the amount of nutrients that reach the fetus during the antenatal period. *Assali et al 1953*

The perfusion of the placenta and therefore the fetus depends on the uterine supply of blood to the uterus. Therefore, the growth of the fetus in utero should depend on it as it determines the placental sufficiency as well. As an outcome, the neonatal weight reflects the normality of this system, and hence the normality of the placental functions. *Campbell et al 1983*

The first Doppler velocimetry in the analysis of human fetal blood flow was published in 1977 by Fitzgerald and Drumm.

Aim of work