THE VALUE OF EARLY PREGNANCY ULTRASOUND PARAMETERS IN THE PREDICTION OF FIRST TRIMESTER OUTCOME

Thesis

Submitted In partial Fulfillment of the MD Degree
In obstetrics and gynecology

By

Heba Mahmoud Ibrahim Marie
(M.B.Pch. M.S.C)
Obstetrics and gynecology Department
Cairo University Hospitals

Supervised by

Prof. Dr. Mohamed Momtaz Awad
Professor of obstetrics and gynecology
Faculty of Medicine - Cairo University

Prof. Dr. Mona Mohamed Abou El Ghar
Professor of obstetrics and gynecology
Faculty of Medicine - Cairo University

Prof. Dr. Sherief Mohamed Negm
Assistant Professor of obstetrics and gynecology
Faculty of Medicine - Cairo University

Faculty of Medicine
Cairo University
2012

Abstract

Objectives: The primary outcome was to evaluate: the correlation between the ultrasound parameters assessed in the first trimester (Crown- rump length, Fetal heart rate, Uterine artery Doppler assessment and Fetal volume measurement) and silent miscarriage, the correlation between different ultrasound parameters and the correlation between the patient clinical characteristics and early pregnancy loss.

Methodology: This was a prospective study that included two hundred pregnant women in the first trimester. Each pregnant women was submitted to three ultrasound scans during the first trimester where (Crown- rump length, Fetal heart rate, Uterine artery Doppler assessment and Fetal volume measurement) were assessed. Complete questionnaire was performed including: obstetric history, and symptoms of the current pregnancy

Results:In the first scan 33.3% of fetuses with a CRL below the 5^{th} centile for gestational age miscarried compared to 8.1% of those with normal CRL (p = 0.008). (Odds Ratio: 5.7, 95% Confidence Interval: 1.7-19.2).In the second scan15.6% of fetuses with a CRL below the 5^{th} centile for gestational age miscarried compared to 3.9% of those with normal CRL (p = 0.020). (Odds Ratio: 4.6, 95% Confidence Interval: 1.2-18.3).There was a positive correlation between CRL and fetal volume during the first scan, follow up scan and the final scan (r= 0.933, 0.900, 0.547 respectively). Two factors were associated with significantly higher

frequency of miscarriage; history of previous miscarriages (p=0.008) (Odds Ratio: 5.1, 95% confidence interval 1.4-18.7) and threatened miscarriage during the current pregnancy (p = 0.003 (Odds Ratio: 5.3, 95% confidence interval 1.8-15.9).

Conclusion:CRL below 5th centile for the gestational age in the first trimester was associated with increased risk of first trimester silent miscarriage. There was a positive correlation between CRL and fetal volume measurement in the first trimester. History of previous miscarriage and threatened miscarriage in the current pregnancy were associated with increased risk of silent miscarriage in the ongoing pregnancy.

Key words: (Crow- rump length, fetal heart rate, Doppler indices, VOCAL, miscarriage)

Acknowledgement

Firstly and lastly thanks to Allah the most merciful for his help.

I would like to express my deepest gratitude to Prof. Mohamed Momtaz Professor of Obstetrics & Gynecology Faculty of Medicine, Cairo University, for his help in choosing the subject of this thesis. I'm greatly thankful to him for his support, enthusiastic encouragement and sincere appreciation.

Also I would like to thank Prof. Mona Abou EL Ghar Professor of Obstetrics & Gynecology Faculty of Medicine, Cairo University, for her sincere supervision and the great efforts that she had offered throughout the period of making and revising this thesis.

Also I would like to thank Prof. Sherif Negm assistant Professor of Obstetrics & Gynecology Faculty of Medicine, Cairo University for his sincere advice, and supervision which helped to simplify my task of preparing this work.

I'm grateful to all my professors, staff and colleagues of the Obstetrics & Gynecology department Cairo University who helped me throughout this work.

Many grateful thanks to my family especially my parents for their continuing care, strong support and patience which guided me throughout my whole life.

Finally, I'm grateful to the patients for whom all our efforts are devoted.

Table of contents

Contents	Page
List of abbreviations	i
List of tables	iii
List of figures	v
Introduction and aim of work	1
Review of literatures	3
• *Chapter one: Introduction to ultrasound*	3
• *Chapter two: Sono- embryology*	14
• *Chapter three :Ultrasound evaluation of abnormal early pregnancy*	25
• *Chapter four: Role of Doppler imaging in the evaluation of early pregnancy*	44
• *Chapter five: First trimester screening for congenital anomalies*	54
• *Chapter six: The Fetus in the 3D ultrasound*	67
Patients and methods	81
Results	86
• *Pictures from the study*	102
Discussion	115
Conclusion and recommendations	129
Summary	131
References	135

List of Abbreviations

2 D	Two dimentional ultrasound
3D	Three dimentional ultrasound
4D	Four dimentinal
AIUM	The American Institute of Ultrasound in Medicine
ALARA	(As Low As Reasonably Achievable) principle.
A-mode	Amplitude mode
B-mode	Brightness mode
BPM	Beat per minute
CRL	crown rump length
EV	Embryonic volume
GA	Gestational age
HCG	Human chorionic gonadotrophin
ISUOG	The International Society of Ultrasound in Obstetrics and Gynecology
IUGR	Intrauterine growth restiction
IUP	Intrauterine pregnancy
M-mode	Motion mode
MoM	multiples of the medium
MSAFP	maternal serum alpha fetoprotein
MSD	Mean sac diameter
NT	Nucal translucency
NTD	Neural tube defects
PAPP-A	pregnancy associated plasma protein-A
PI	pulsatility index
PSV	Peak systolic velocity

RI	resistance index
ROI	region of interest
S/D Ratio	Systolic / Diastolic Ratio
SCH	Subchorionic hematoma
SD	Standard deviation
SONAR	Sound Navigation and Ranging
STIC	*Spatiotemporal image correlation*
TGC	Time gain control
TM-mode	Time motion mode
TUI	*Tomographic ultrasound imaging*
TVS	Transvaginal sonography
US	ultrasound
VCI	*Volume contrast imaging*
VOCAL	virtual organ computer aided analysis
WFUMB	World Federation of Ultrasound in Medicine and Biology
YS	Yolk sac

List of Tables

Table 1	The anatomical structure with relation to the gestational age
Table 2	Ultrasound based terminology used in the diagnosis of miscarriage
Table 3	First trimester fetal heart rate
Table 4	Relation between nuchal translucency thickness and prevalence of chromosomal defects, miscarriage or fetal death and major fetal abnormalities.
Table 5	Conditions associated with increased NT
Table 6	Database of CRL and fetal volume measurements
Table 7	Descriptive analysis of fetal volume from7 to 10 weeks
Table 8	Clinical characteristics of the studied group
Table 9	Results of baseline ultrasound examination of the studied group
Table 10	Results of second ultrasound examination of the studied group
Table 11	Results of final ultrasound examination of the studied group
Table 12	Results of first ultrasound examination of the viable and miscarriage groups
Table 13	Relation between crown-rump length normality during first examination and frequency of silent miscarriage in the current pregnancy in the studied group
Table 14	Results of second ultrasound examination of the viable and miscarriage groups

Table 15	Relation between crown-rump length normality during second examination and frequency of silent miscarriage in the current pregnancy in the studied group
Table 16	Results of final ultrasound examination of the viable and miscarriage groups
Table 17	Relation between clinical characteristics and outcome of pregnancy at the end of first trimester

List of Figures

Figure 1	Sagittal view of the uterus showing the gestational sac
Figure 2	The yolk sac
Figure 3	The embryo & yolk sac at 6 weeks of gestation
Figure 4	the embryo at the seventh week postmenstrual
Figure 5	An embryo of eight weeks postmenstrual
Figure 6	A fetus at 10 weeks postmenstrual
Figure 7	A fetus at 11 weeks postmenstrual
Figure 8	Structural evaluation of the fetus at 12 weeks
Figure 9	A fetus at 13 weeks postmenstrual
Figure 10	intrauterine blood in various locations
Figure 11	a small sac at 8.3 weeks gestation with subsequent normal delivery
Figure 12	Comparison of new CRL curves with Robinson & Hadlock curves
Figure 13	Anembryonic sac with a large yolk sac
Figure 14	An embryo at 6.5 weeks with echogenic yolk sac
Figure 15	Uterine artery indices
Figure 16	Ultrasound image with color Doppler showing the uterine &external iliac arteries
Figure 17	Anatomy of arcuate, radial and spiral arteries.
Figure 18	Normal uterine artery wave forms for gestation
Figure 19	Normal and abnormal uterine artery wave forms
Figure 20	Measurement of nuchal translucency thickness

Figure 21	2D Ultrasound pictures of normal, small and absent nasal bone
Figure 22	Ultrasound picture showing cardiac echogenic focus
Figure 23	Abnormal ductus venosus Doppler of trisomy21
Figure 24	Multiplaner image of twins at 16 weeks of gestation
Figure 25	3D surface rendering of normal fetal appearance
Figure 26	3D appearance of increased NT thickness
Figure 27	3D trunk and head volume of the fetus using the VOCAL technique
Figure 28	Distribution of parity in the studied group
Figure 29	Previous miscarriages in the studied group
Figure 30	Frequency of threatened miscarriage in the studied group
Figure 31	the correlation between CRL and fetal volume in the first scan
Figure 32	the correlation between fetal volume and Doppler indices (RI and PI) in the first scan
Figure 33	the correlation between CRL and fetal volume in the second scan
Figure 34	the correlation between CRL and fetal volume in the final scan
Figure 35	CRL in miscarriage and viable groups in the first scan
Figure 36	CRL in miscarriage and viable groups in the second scan
Figure 37	Normal ultrasound parameters at 7 weeks of gestation

Figure 38	Normal ultrasound parameters at 8 weeks of gestation
Figure 39	CRL below5th centile for gestational age that ended into miscarriage.
Figure 40	CRL below5th centile for gestational age that ended into miscarriage
Figure 41	Normal ultrasound parameters at 9 weeks of gestation
Figure 42	Normal ultrasound parameters at 10 weeks of gestation
Figure 43	Normal ultrasound parameters at 11 weeks of gestation
Figure 44	Normal ultrasound parameters at 12 weeks of gestation
Figure 45	Normal ultrasound parameters at 13 weeks of gestation
Figure 46	Normal appearance of the nasal bone and normal nuchal translucency thickness at 13weeks of gestation
Figure 47	Abnormal ultrasound findings at 13 week scan
Figure 48	A picture of nuchal cord with normal umbilical artery wave form.
Figure 49	A picture of subchorionic hematoma in a case presented with threatened miscarriage.

INTRODUCTION

Two dimensional ultrasound is a commonly performed investigation in the first trimester of pregnancy to confirm the pregnancy location, viability and gestational age. Measurement of the embryonic and fetal crown – rump length (CRL) is conventionally performed to confirm the gestational age. Smaller than expected fetal crown – rump length has been associated with subsequent pregnancy loss in studies that involved women with threatened miscarriage. Moreover some chromosomal defects are not only associated with high intrauterine lethality but also associated with fetal growth restriction in the first trimester of pregnancy evidenced by smaller than normal fetal crown-rump length. ***(Choong et al, 2003)***

Other ultrasound findings that could be associated with subsequent miscarriage include slower embryonic heart rate and abnormal uterine artery Doppler. Presence of poor obstetric history is reflected in the Doppler velocimetry markers of increased uterine artery resistance during the first trimester of subsequent pregnancy. Recent studies confirm the presence of abnormal uterine artery Doppler finding is association with uteroplacental insufficiency. ***(Hichey et al, 2005)***

Three dimensional ultrasound evaluation of the human fetus could be used to monitor the fetal development in the various stages of gestation including the first trimester. It is possible that estimation of the fetal volume using 3D volume measurements could be

superior to 2D ultrasound parameters in predicting the pregnancy outcome and fetal volume data base in the first trimester may be a reference table for diagnosing early pregnancy failure. ***(Aviram et al, 2003)***

The diagnosis of miscarriage is made in at least 10-20% of pregnancies in the first trimester. However, in pregnancies where fetal viability is demonstrated, the rate of subsequent miscarriage is decreased to 2-16%. ***(Mukri et al, 2008)***

The aim of work:

The primary outcome is to evaluate the correlation between each of the ultrasound parameters that were assessed in the first trimester (crown rump length, fetal heart rate, uterine artery Doppler and fetal volume measurement) and early pregnancy loss (e.g. silent miscarriage). And the correlation between different ultrasound parameter to each other. Our aim also was to evaluate the correlation between the patient clinical characteristics and early pregnancy loss.

INTRODUCTION TO ULTRASOUND

History:

The introduction of sonography to obstetrics by Donald and colleagues in 1958 is now regarded as one of the major milestones of modern medicine ***(Dunstand and Nix, 1998).***

The story of the development of ultrasound applications in medicine should probably start with the history of measuring distance under water using sound waves. The term SONAR refers to Sound Navigation and Ranging ***(Donald, 1974).***

It became possible to obtain information about the fetus and its environment directly with a non-invasive diagnostic procedure considered safe even when used repeatedly. Initially, acceptance of the technique was slow because it was new and unfamiliar and because the equipment was large and cumbersome to use. With the advent of small, mobile, high-resolution, real-time scanners in the mid to late 1970s, the ease of use together with increased physician awareness of the capabilities of ultrasound accelerated its application to an ever-expanding number of pregnancies. In addition, more recent advances in technology and expertise have enhanced image quality and allowed for considerable insight into fetal physiology ***(Johnson et al., 1992).***