



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

∞∞∞∞

تم رفع هذه الرسالة بواسطة /صفاء محمود عبد الشافي

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون

أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات: لا يوجد



# **The Role of Fetal Pulmonary Artery Doppler in Prediction of Fetal Lung Maturity**

*A Thesis*

Submitted for partial fulfillment of Master degree  
in Radio diagnosis

*By*

**Nardeen Boshra Atta**

M.B.B.Ch, Menofeya University (2014)

*Under Supervision of*

**Prof. Dr. Mounir Sobhy Guirguis**

Professor of Radio diagnosis  
Faculty of Medicine, Ain Shams University

**Dr. Suzan Farouk Ibrahim**

Lecturer of Radio diagnosis  
Faculty of Medicine, Ain Shams University

**Faculty of Medicine  
Ain Shams University  
2022**



## Acknowledgments

*First and foremost, I feel always indebted to **Allah**, the Most Beneficent and Merciful who gave me the strength to accomplish this work,*

*My deepest gratitude to my supervisor, **Prof. Dr. Mounir Sobhy Guirguis**, Professor of Radiology, Faculty of Medicine, Ain Shams University, for his valuable guidance and expert supervision, in addition to his great deal of support and encouragement. I really have the honor to complete this work under his supervision.*

*I would like to express my great and deep appreciation and thanks to **Dr. Suzan Farouk Ibrahim**, Lecturer of Radiology, Faculty of Medicine, Ain Shams University, for her meticulous supervision, and her patience in reviewing and correcting this work,*

*Special thanks to my **Parents**, my **Husband** and all my **Family** members for their continuous encouragement, enduring me and standing by me.*

* **Mardeen Boshra Atta***

## **List of Contents**

<i>Subject</i>	<i>Page No.</i>
<b>List of Abbreviations.....</b>	<b>i</b>
<b>List of Tables.....</b>	<b>vi</b>
<b>List of Figures .....</b>	<b>viii</b>
<b>List of Cases .....</b>	<b>xvi</b>
<b>Introduction .....</b>	<b>1</b>
<b>Aim of the Work.....</b>	<b>2</b>
<b>Review of Literature</b>	
Anatomy of the Fetal Chest by Ultrasound.....	3
Respiratory Distress Syndrome.....	12
Scanning Technique of Fetal Pulmonary Artery Doppler .....	25
<b>Patients and Methods.....</b>	<b>48</b>
<b>Results.....</b>	<b>55</b>
<b>Case Presentation .....</b>	<b>72</b>
<b>Discussion .....</b>	<b>102</b>
<b>Limitations of the study .....</b>	<b>111</b>
<b>Summary .....</b>	<b>112</b>
<b>Conclusions .....</b>	<b>115</b>
<b>Recommendations .....</b>	<b>116</b>
<b>References .....</b>	<b>117</b>
<b>Arabic Summary .....</b>	<b>—</b>

## List of Abbreviations

<i>Abbreviation</i>	<i>Explanation</i>
AAO.....	the ascending aorta
AC.....	abdominal circumference
AFI.....	fluid index
Ao.....	Aorta
AT.....	acceleration time
AT/ET ratio.....	the acceleration/ejection time
BP.....	biparietal diameter
BPD.....	bronchopulmonary dysplasia
CHD.....	congenital heart disease
CPAP.....	continuous positive airway pressure
CS.....	caesarean section
CT.....	computed tomography
DAo.....	descending aorta
EDV.....	end diastolic volume
EFW.....	expected fetal weight

ET.....ejection time

FiO2 .....fraction of inspired oxygen

FL..... femur length

FLM.....fetal lung maturity

GA..... gestational age

GI..... Gastrointestinal

HMD .....hyaline membrane disease

IVC.....inferior vena cava

IVS.....interventricular septum

L..... left

LA..... left atrium

LBC.....lamellar body count

LMP.....last menstrual period

LPA..... left pulmonary arteries

L/S ratio.....l.ecithin/sphingomyelin ratio

LV..... left ventricle

MG.....multigravida

MPA.....main pulmonary artery

MR..... magnetic resonance

MV.....main volume

NBW.....New born weight

NEC.....Necrotizing enterocolitis

NICU.....neonatal intensive care unit

NPV .....negative predictive value

PA.....the pulmonary artery

PDA..... patent ductus arteriosus

PEEP.....Positive end-expiratory pressure

PG..... phosphatidylglycerol

PI.....pulsatile index

PVL.....periventricular leukomalacia

PPV.....positive predictive value

PS.....portal sinus

PSV.....peak systolic velocity

PSV.....peak systolic volume

PV.....pulmonary veins

R.....right

RA..... right atrium

RDS.....respiratory distress syndrome

RI.....resistance index

ROC.....Receiver operating characteristics

ROP.....Retinopathy of prematurity

RPA.....right pulmonary arteries

RV.....right ventricle

SD.....standard deviation

St..... stomach

SVC.....superior vena cava

TV.....tricuspid valve

TVI.....time velocity integral

US.....Ultrasound

UV..... umbilical vein

V/Q .....ventilation perfusion

WBC.....white blood cell

3VV.....three vessel view



## List of Tables

	<i>Title</i>	<i>Page No.</i>
<b>Table (5:1):</b>	GA “wks.” Descriptive among study group (n=60). <b>Error! Bookmark not defined.</b>	
<b>Table (5:2):</b>	Placental grading distribution among study group (n=60).....	55
<b>Table (5:3):</b>	AF free particles distribution among study group (n=60).....	56
<b>Table (5:4):</b>	Fetal lung to liver echogenicity distribution among study group (n=60).....	57
<b>Table (5:5):</b>	Resistance index (RI), Pulsatile index (PI) and AT/Et ratio descriptive among study group (n=60). ....	58
<b>Table (5:6):</b>	Neonatal respiratory distress syndrome distribution among study group (n=60). ....	59
<b>Table (5:7):</b>	The percentage of RDS +ve neonates were admitted to NICU and RDS –ve group admitted and who were not admitted. (n=60). ....	60
<b>Table (5:8):</b>	Comparison between RDS Group and No-RDS Group according to GA.....	60
<b>Table (5:9):</b>	Comparison between RDS Group and No-RDS Group according to placental grading.....	62
<b>Table (5:10):</b>	Comparison between RDS Group and No-RDS Group according to AF free particles. ....	63

<b>Table (5:11):</b> Comparison between RDS Group and No-RDS Group according to fetal lung to liver echogenicity.....	65
<b>Table (5:12):</b> Comparison between RDS Group and No-RDS Group according to Resistance index (RI) and Pulsatile index (PI).....	66
<b>Table (5:13):</b> Comparison between RDS Group and No-RDS Group according to AT/ET ratio.....	67
<b>Table (5:14):</b> The best cutoff, sensitivity, specificity, PPV, NPV and accuracy according to AT/ET ratio. ....	69
<b>Table (5:15):</b> Sen., Spe., PPV, NPV and accuracy when combining one parameter with AT/ET ratio and when combing all parameters with AT/ET ratio in prediction of fetal lung maturity. ....	70

## List of Figures

<i>Figure No.</i>	<i>Title</i>	<i>Page No.</i>
<b>Figure (1:1):</b>	Transverse US image of a normal fetal thorax demonstrates homogeneous and symmetric intermediate echogenicity of the lungs.....	4
<b>Figure (1:2):</b>	(a) Transverse view showing the fetal lung was the same intensity of the liver (curved arrow) at 32+2 weeks. (b) Intensity of the fetal lung (straight arrow) was higher than that of fetal liver in the left occipital posterior view at 38+5 weeks.....	5
<b>Figure (1:3):</b>	Schematic drawing of a cross section of the thorax at the level of the four-chamber view in a fetus with situs solitus.....	7
<b>Figure (1:4):</b>	Schematic drawing of the four-chamber view showing the normal anatomic structures in the posterior region between the spine and heart, called the area behind the heart. ....	8
<b>Figure (1:5):</b>	Schematic drawing of the three-vessel view of the fetal heart demonstrating the pulmonary artery (PA), the ascending aorta (AAo), and the superior vena cava (SVC) in the upper chest arranged in an oblique line with the PA most anterior, SVC most posterior, and AAo in between.....	10

<b>Figure (1:6):</b>	Transverse views (A and B) of the chest showing the oesophagus as an echogenic circular structure in the space between the descending aorta (Ao) and left atrium (LA) in A and a dilated oesophagus in B during fetal swallowing. ....	11
<b>Figure (2:1):</b>	Schematic outlines the pathology of RDS. ....	13
<b>Figure (2:2):</b>	Bottom curve reflects findings from lungs obtained at postmortem from an infant with hyaline membrane disease (HMD).....	15
<b>Figure (2:3):</b>	Chest radiographs in a premature infant with respiratory distress syndrome .....	23
<b>Figure (2:4):</b>	Ultrasound appearance of neonatal respiratory distress syndrome .....	24
<b>Figure (3:1):</b>	Four-chamber view of the fetal heart obtained without image optimization. the depth is high.....	27
<b>Figure (3:2):</b>	Four-chamber view of the fetal heart in the same fetus following image optimization.....	27
<b>Figure (3:3):</b>	Four-chamber views of the fetal heart in the same fetus, imaged in A through the ribs .....	28
<b>Figure (3:4):</b>	Determining fetal situs in longitudinal lie.....	31

<b>Figure (3:5):</b>	Axial view of the fetal abdomen in a fetus with situs solitus. ....	33
<b>Figure (3:6):</b>	Determining fetal situs: A diagram of the fetus is presented in back posterior (1 and 3) and back anterior (2 and 4) positions.....	34
<b>Figure (3:7):</b>	Apical four-chamber view of the fetal heart showing the right atrium (RA), left atrium (LA), right ventricle (RV), left ventricle (LV), and interventricular septum (IVS). ....	35
<b>Figure (3:8):</b>	A: Transverse view of the fetal abdomen at the level of the stomach. A significant portion of one rib at each lateral abdominal wall is present .....	36
<b>Figure (3:9):</b>	Schematic drawings and corresponding ultrasound images of four chamber views in four fetuses.....	38
<b>Figure (3:10):</b>	Four-chamber view in gray scale in A and B (same fetus) showing the anatomic position of the heart in the chest. ....	39
<b>Figure (3:11):</b>	Schematic drawing showing the anatomic relationship of the diagnostic transverse planes of the fetal heart. ....	41
<b>Figure (3:12):</b>	Ultrasound image of the three-vessel view of the fetal heart demonstrating the main pulmonary artery .....	43
<b>Figure (3:13):</b>	Transverse section of the fetal chest showing the short axis from the right side. ....	45

**Figure (3:14):** Blood flow velocity waveforms (a) recorded from a main right pulmonary artery at 22 weeks' gestation. Schematic presentation (b) of a Doppler flow velocity waveform with the measured parameters..... 46

**Figure (3:15):** Doppler wave forms in the fetal ductus arteriosus showing normal wave form ..... 46

**Figure (5:1):** Pie chart placental grading distribution among study group. .... 56

**Figure (5:2):** Pie chart AF free particles distribution among study group. .... 57

**Figure (5:3):** Pie chart fetal lung to liver echogenicity distribution among study group. .... 58

**Figure (5:4):** Pie chart Neonatal respiratory distress syndrome distribution among study group. .... 59

**Figure (5:5):** Comparison between RDS Group and No-RDS Group according to GA. .... 61

**Figure (5:6):** Comparison between RDS Group and No-RDS Group according to placental grading. .... 62

**Figure (5:7):** Comparison between RDS Group and No-RDS Group according to AF free particles. .... 64

**Figure (5:8):** Comparison between RDS Group and No-RDS Group according to fetal lung to liver echogenicity. .... 65

<b>Figure (5:9):</b>	Comparison between RDS Group and No-RDS Group according to Resistance index (RI) and Pulsatile index (PI).....	67
<b>Figure (5:10):</b>	ROC for AT/ET ratio in prediction of fetal lung maturity. ....	68
<b>Figure (5:11):</b>	Comparison between RDS Group and No-RDS Group according to At/Et ratio. ....	69
<b>Figure (5:12):</b>	ROC curve, sensitivity, specificity, positive predictive value, negative predictive value, and accuracy for factors combination .....	71
<b>Figure (6:1):</b>	2D ultrasound showing posterior placenta grade II and clear amniotic fluid with absence of free floating particles.....	73
<b>Figure (6:2):</b>	2D ultrasound showing hypoechogenicity of fetal lung to liver.....	73
<b>Figure (6:3):</b>	Measurements of the MPA AT, ET and AT/ ET ratio using pulsed wave Doppler .....	74
<b>Figure (6:4):</b>	2D ultrasound showing amniotic fluid with presence of free floating particles .....	76
<b>Figure 6:5:</b>	2D ultrasound showing anterior placenta with calcifications and lacunar changes grade III.....	76
<b>Figure (6:6):</b>	2D ultrasound showing hyperechogenicity of fetal lung to liver... ..	77