



Impact of Lung Imaging on Clinical Decision Making in Critically ill Patients

An Essay

Submitted for partial fulfillment of the Master Degree
in intensive care medicine

Submitted by

Ahmed Abdelnaby Elsaid Raby

M.B.B.Ch,

Supervised by

Prof. Dr. Sherif Farouk Ibrahim

*Professor of Anesthesia, Intensive care and Pain Management
Faculty of medicine – Ain Shams University.*

Prof. Dr. Sahar Kamal Hasanin

*Professor of Anesthesia, Intensive care and Pain Management
Faculty of medicine – Ain Shams University.*

Dr. Rasha Mahmoud Hassan

*lecturer of Anesthesia, Intensive care and Pain Management
Faculty of medicine – Ain Shams University.*

**Faculty of Medicine
Ain Shams University**

2016

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

[وَقُلْ رَبِّ زِدْنِي عِلْمًا]

سورة طه الآية رقم 114



Acknowledgement

First of all, all gratitude is due to **Allah** almighty for blessing this work, until it has reached its end, as a part of his generous help, throughout my life.

Really I can hardly find the words to express my gratitude to **Prof.Dr. Sherif Farouk Ibrahim**, Professor of Anesthesia, Intensive Care and Pain Management, faculty of medicine, Ain Shams University, for his supervision, continuous help, encouragement throughout this work and tremendous effort he has done in the meticulous revision of the whole work. It is a great honor to work under his guidance and supervision.

I would like also to express my sincere appreciation and gratitude to **Prof.Dr. Sahar Kamal Hasanin**, Professor of Anesthesia, Intensive Care and Pain Management, faculty of medicine, Ain Shams University, for her continuous directions and support throughout the whole work.

Really I can hardly find the words to express my gratitude to **Dr.Rasha Mahmoud Hassan**, Lecturer of Anesthesia, Intensive Care and Pain Management, Faculty of Medicine, Ain Shams University for her continuous directions and meticulous revision throughout the whole work. I really appreciate their patience and support.

Last but not least, I dedicate this work to my family, whom without their sincere emotional support, pushing me forward this work would not have ever been completed.



Ahmed AbdelnabyElsaidRaby

Contents

List of Abbreviations	i
List of Figures	ii
Introduction and Aim of the Essay.....	1
Review of Literature	5
* Chapter 1: Anatomy of chest and pathogenesis in respiratory failure	5
* Chapter 2: Chest x-ray in critically ill patients.....	17
* Chapter 3: Ultrasound chest in critically ill patients...40	
* Chapter 4: Computed Tomography chest and Magnetic Resonance Imaging (MRI) in critically patients.....	55
Summary.....	73
References.....	75
Arabic Summary.....	--

List of Abbreviations

AP	: Antero-Posterior
ARDS	: Acute respiratory distress syndrome
BLUE	: Bedside Lung Ultrasonography in Emergency
CAP	: Community acquired pneumonia
CT	: Computed tomography
CTA	: Computed tomography angiography
HRCT	: High-resolution CT
CXR	: Chest X-Ray
CPE	: Cardiogenic pulmonary edema
CO ₂	: Carbon dioxide
COPD	: Chronic obstructive pulmonary disease
HCAP	: Healthcare-associated pneumonia
ICU	: Intensive care unit
MRI	: Magnetic resonance imaging
MRA	: Magnetic resonance angiography
NPE	: Non-Cardiogenic pulmonary edema
O ₂	: Oxygen
PA	: Postero-anterior
Pco ₂	: Partial pressure of carbon dioxide
PE	: Pulmonary embolism
Po ₂	: Partial pressure of oxygen
US	: Ultrasound
VPW	: Vascular pedicle width

List of Figures

<i>Fig.</i>	<i>Title</i>	<i>Page</i>
1.1	Topography of lungs	7
1.2	Intrapulmonary blood circulation	10
1.3	Oxygen cascade	13
1.4	Relationship of ventilation and PaCO ₂	15
2.1	CXR of normal supine and normal lateral view	19
2.2	CXR of normal radiographic anatomy	20
2.3	CXR showing intubation and overdistended tracheostomy tube cuff	21
2.4	CXR showing correct position of the central venous catheter	23
2.5	CXR showing chest tube	24
2.6	CXR showing malpositioned nasogastric tube	25
2.7	CXR showing total lung collapse	26
2.8	CXR showing rt side lobar pneumonia	27
2.9	CXR showing aspiration pneumonia.	28
2.10	CXR showing ARDS progression.	30
2.11	CXR showing pulmonary embolism	31

List of Figures(Cont.)

Fig.	Title	Page
2.12	CXR showing chronic obstructive pulmonary disease	32
2.13	CXR showing pulmonary edema.	33
2.14	CXR showing tension pneumothorax	34
2.15	CXR showing pneumomediastinum	35
2.16	CXR showing subcutaneous emphysema	36
2.17	CXR showing peural effusion	37
2.18	CXR showing how to measure vpw	38
2.19	Algorithm suggested fluid management for acute lung injure (ALI) patients using the vascular pedicle width (VWP)	39
3.1	Lung us image showing normal lung surface (Bat sign & Sliding) and M-mode show Seashore sign	34
3.2	Lung us image showing quad sign and sinusoid sign of pleural effusion	44
3.3	Lung us image showing pleural effusion	45
3.4	Lung us image showing consolidated lung	46
3.5	Lung us image showing alveolar interstitial syndrome	47

List of Figures(Cont.)

Fig.	Title	Page
3.6	Flow-chart showing the procedure for the sonographic diagnosis ofpneumothorax	48
3.7	Lung ultrasound image showing abolition of lung sliding and the stratosphere sign	49
3.8	Lung ultrasound image showing the lung point	49
3.9	Ultrasound guided percutaneous dilatational tracheostomy	50
3.10	Algorithm for the evaluation and management of a hypotensive patient.	52
3.11	The BLUE-protocol	53
3.12	Algorithm for ultrasonography assessment of respiratory failure	54
4.1	Window levels in CT chest	57
4.2	CT chest showing right-sided pulmonary contusion and hemothorax	52
4.3	CT chest showing multiple small lung lacerations	59
4.4	CT chest showing tracheal rupture	60
4.5	CT chest showing area of right lower-lobe consolidation	61

List of Figures(Cont.)

Fig.	Title	Page
4.6	CT chest showing large empyema	62
4.7	CT chest showing acute pulmonary embolism	56
4.8	CT chest showing acute respiratory distress syndrome	66
4.9	CT chest showing large left-sided hemothorax	67
4.10	CT chest showing left-sided tension pneumothorax	68

Introduction

Lung imaging plays a central role in the management of critically ill patients with respiratory problems as acute respiratory failure, ARDS, traumatized patient and hemodynamic therapy in shocked patient. Bedside chest radiography, ultrasonography, computed tomography (CT) and magnetic resonance imaging (MRI) are essential aids in both diagnosis and evaluation of responses to therapy (*Morris et al.2013*).

The role of chest X-Ray is very useful in the management of patients with respiratory failure and in detecting a lot of respiratory problems associated like pneumothorax and pleural effusion. Chest radiography findings are an integral part of the diagnosis, follow up and positioning of tubes and lines (*Rubinowitz et al., 2007*).

Lung ultrasound (LU) has emerged in recent years as a powerful diagnostic tool, and as such it is increasingly used in patients managed in intensive care units (ICUs) as a bedside non-invasive test with an excellent safety profile so can be performed repeatedly. Lung ultrasound identifies (with high diagnostic accuracy) the most common pathological abnormalities of the respiratory system

encountered in these patients. Indeed, this technique has a diagnostic accuracy in identifying pneumothorax, consolidation, interstitial syndrome, and pleural effusion. So therefore, it may be considered an alternative to bed side CXR and thoracic CT for critically ill patients .In addition, it has been shown that on appropriate clinical grounds, LU may be of help in the diagnosis of pneumonia and in the follow up its course (*Lichtenstein et al., 2008*).

Computed tomography (CT) chest is widely used to clarify radiographic abnormalities detected by CXR. Advantages of chest CT compared with CXR are the ability to distinguish superimposed structures due to cross sectional imaging with superior assessment of tissue density, permitting accurate assessment of the size and density of pulmonary nodules and improved identification of abnormalities adjacent to the chest wall, such as pleural disease. The use of IV contrasts helps to distinguish vascular from nonvascular structures, which is especially useful in assessing hilar and mediastinal abnormalities. Also CT angiography helps to detect pulmonary emboli (*Longo et al., 2013*).

A variety of other imaging techniques like Magnetic Resonance Imaging (MRI) of the chest are used less commonly to assess respiratory diseases (*Longo et al., 2013*).

Aim of the Essay

This essay aims to highlight the different types of lung imaging studies in critically ill patients and their importance in diagnosis and clinical decision making in ICU.

Chapter One

Anatomy of Chest and Pathogenesis in Respiratory Failure

Good knowledge of lung anatomy is mandatory to understand the features of lung diseases because it permits a better understanding of distribution of the diseases in the lung. Differential diagnosis of lung disease can indeed be narrowed when one is able to decide whether the disease very likely is located in or around the airways, the blood vessels, the lymphatics or the lung interstitium. The anatomical organization of lung consists of the bronchial tree, the pulmonary blood vessels, the lymphatics and the interstitium. It is important in using and interpreting different methods of scanning the lungs (*Verschakelen and Wever, 2007*).

The thoracic cage

The thoracic cage is formed by the sternum and costal cartilages in front, the vertebral column behind and the ribs and intercostal spaces laterally. It is separated from the abdominal cavity by the diaphragm and communicates superiorly with the root of the neck through the thoracic outlet (*Faiz and Moffat, 2002*).

The airways

The trachea is 10-20 cm length . It lies slightly to the right of the midline and divides at the carina into right and left main bronchi. The carina lies under the junction of the manubrium sterni and the second right costal cartilage. The right main bronchus is more vertical than the left. The right main bronchus divides into the upper lobe bronchus and the intermediate bronchus, which further subdivides into the middle and lower lobe bronchi. However, the left main bronchus divides into upper and lower lobe bronchi only. Each lobar bronchus further divides into segmental and subsegmental bronchi. There are about 25 divisions in all between the trachea and the alveoli. There are approximately 300 million alveoli in each lung (*Faiz and Moffat, 2002*).