ROLE OF ULTRASOUND IN EVALUATION OF CHEST DISEASES

ESSAY

Submitted for Fulfillment of Master Degree in Radiodiagnosis

By

Nixon Barnaba Balli Yakram

MB BS

College of Medicine - University of Juba

Supervised by

Dr. Youssriah Yahia Sabri

Professor of Radiodiagnosis

Faculty of Medicine – Cairo University

Dr. Mona Foad Ahmed

Lecturer of Radiodiagnosis

Faculty of Medicine – Cairo University

Dr. HibatAllah Hany Mohamed Asal

Lecturer of Pulmonolgy

Faculty of Medicine – Cairo University

Faculty of Medicine – Cairo University

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Abstract

Keywords

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The static analysis of a combination of sonographic artifacts and real images makes accurate diagnosis of many lung disorders possible.
And Ultrasonography allows immediate diagnosis of pleural effusion, pneumothorax, pulmonary embolism, pneumonia, as well as rib fracture, helps in staging of lung cancer, and it provides a basis for further diagnostic-and treatment-related decisions. Appropriate training on chest ultrasonography is needed to ensure proper application and interpretation of this technique .While application of ultrasound for the detection of pleural and peripheral lung lesions is well established, the sonographic assessment of the lung parenchyma is relatively new. Nevertheless, there are some limitations to the use of chest ultrasonography including subcutaneous emphysema deeper lung disorders, obesity, and operator dependency.

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Dedication

This research is dedicated to my wife, daughters, and parents whose unconditional affection, love, and encouragement have enabled me face this challenge with zeal and passion

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LIST OF ABBREVIATIONS

ARDS	Acute respiratory distress syndrome
B-mode	Brightness mode
BSLUS	Bed side lung ultrasonography
CDUS	Color Doppler Ultrasound
CT	Computed tomography
DTF	Diaphragm thickness fraction
EBUS-TBNA	Endobronchial ultrasound guided transbronchial needle aspiration
EUS-FNA	Endoscopic ultrasound fine needle aspiration
FNA	Fine needle aspiration
ICU	Intensive care unit
LUS	Lung ultrasound
MHz	Mega Hertz
M-mode	Motion Mode
PAVM	Pulmonary arteriovenous malformation
PE	Pleural effusion
PE	pulmonary embolism
PTX	pneumothorax
RV	Residual volume
TLC	Total lung capacity
US	Ultrasound

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Introduction and Aim of the Work

Traditionally, air has been considered the enemy of ultrasound and the lung has been considered an organ not amenable to ultrasonography examination. Chest X-Ray and CT scan have been the routine chest tests. However, there are some difficulties as in ICU where various positions are not feasible. Computed tomography chest exposure gives the patient an effective dose of eight msv, equivalent to four hundred chests x-rays. Thus, repeated follow -up examinations are not advisable **(Prithviraj and Suresh, (2014).**

Ultrasound (US) has been proved to be valuable for the evaluation of a wide variety of chest diseases, particularly when the pleural cavity is involved. The advantages of US are that it is a relatively inexpensive, widely available, mobile form of multi-planar imaging free from ionizing radiation. Chest US can supplement other imaging modalities of the chest and guides a variety of diagnostic and therapeutic procedures **(Liao et al, 2013).**

Ultrasonography of lung is based on the principle that every acute disease reduces lung aeration, changing the lung surface and generating distinct, predictable patterns. This allows the diagnosis of various conditions and the monitoring of therapeutic interventions **(Karim and Arora, 2014).**

With a sensitivity of 100% and a specificity of 99.7%, sonography is more accurate than conventional radiography in the detection of pleural effusion because as little as 5 ml of fluid can be visualized. By contrast, the minimum volume detectable in a posteroanterior radiograph is 150 ml **(Vollmer and Gayete, 2010).**

Ultrasonography allows characterization of the size of a pleural effusion. The size of a pbleural effusion may be estimated qualitatively as small, moderate, or large. Ultrasound is superior to standard radiography and chest CT scan to characterize the internal complexity of an effusion, such as septation **(Koenig et al, 2011)**

US-guided transthoracic biopsy allows needle placement and biopsy taking during a single breath hold, which decreases the time the needle stays across the pleura. Real-time US visualization allows accurate needle placement, shorter

procedure time, and better performance in debilitated and less cooperative patients **(Bahr et al, 2013).**

High-frequency ultrasound can detect soft-tissue masses arising from the chest wall as well as bony metastases to the ribs. It also differentiates pulmonary consolidation from interstitial syndrome **(Groote-Bidlingmaier and Stellenbosch, 2012).**

The principal limitation of chest ultrasound is the presence of subcutaneous emphysema that impedes the petenetration in depth of the ultrasound beam; other factors such as obesity, presence of chest wall hematomas or well developed musculature can create varying degrees of obstacle but they never impede the study of the lung **(Zanforlin et al, 2013).**

Ultrasound machines with two-dimensional scanning capability are used for pleural ultrasonography and associated procedures. A 3.5 to 5.0 MHz transducer with a convex sector design is used in most instances. Once an abnormality has been identified, a 7.5 to 10 MHz linear transducer can be used if needed to obtain more detailed images **(Sikora et al, 2012).**

A particular remarkable usefulness of thoracic ultrasound is in the emergency department, in cases of acute respiratory illness **(Sperandeo et al, 2014).**

Aim of the work

The aim of this work is to evaluate the role of ultrasound as a bed-side, safe, available, and affordable technique in management of some chest diseases.

NORMAL SONOGRAPHIC ANATOMY OF THE CHEST

In the typical appearance of a normal chest on US, the chest wall is visualized as multiple layers of echogenicity representing muscles and fascia. Reverberation artefacts beneath the pleural lines imply an underlying air-filled lung (Fig.1) (Bolliger et al, 2009).

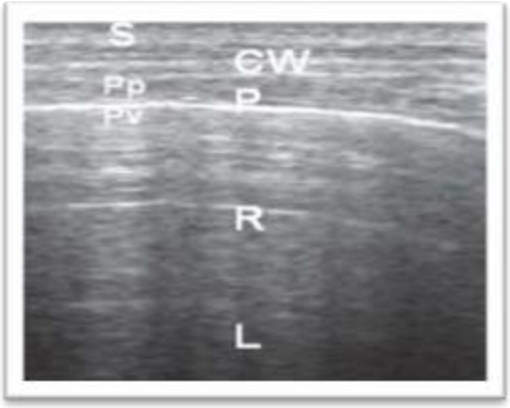

Fig.1 The typical appearance of a normal chest on US by transverse image through the intercostal space with high frequency probe.: S_Skin; CW_chest wall; P_pleura; Pp_parietal pleura; Pv_visceral pleura; L_lung; R_reverberation artifact (Bolliger et al, 2009).

The pleura situated posterior (below) to the ribs appear as white curved lines with a dark shadow behind. This is known as the "Bat sign" (Fig.2). In a longitudinal view the bat sign identifies the upper and lower ribs (the wings of the bat) and, a little deeper, the pleural line (the back of the bat) (**Prithviraj and Suresh, 2014).**

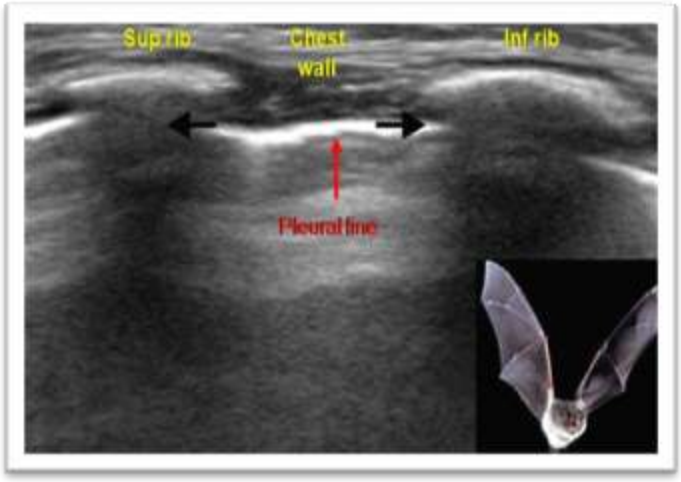

Fig. 2: Bat sign. (Prithviraj and Suresh, 2014).

The normal ribs appear as hyperechoic surfaces with prominent acoustic shadows beneath the ribs. Approximal 0.5 cm below the ribs shadows, the visceral and parietal pleura appear as an enchogenic bright line named pleural lines (Fig.3). During respiratory movement, the two pleural lines glide with each other and is referred to as the "Gliding sign". Loss of this sign can be seen in pneumothorax or diffuse pleural thickening **(Liao et al, 2013).**

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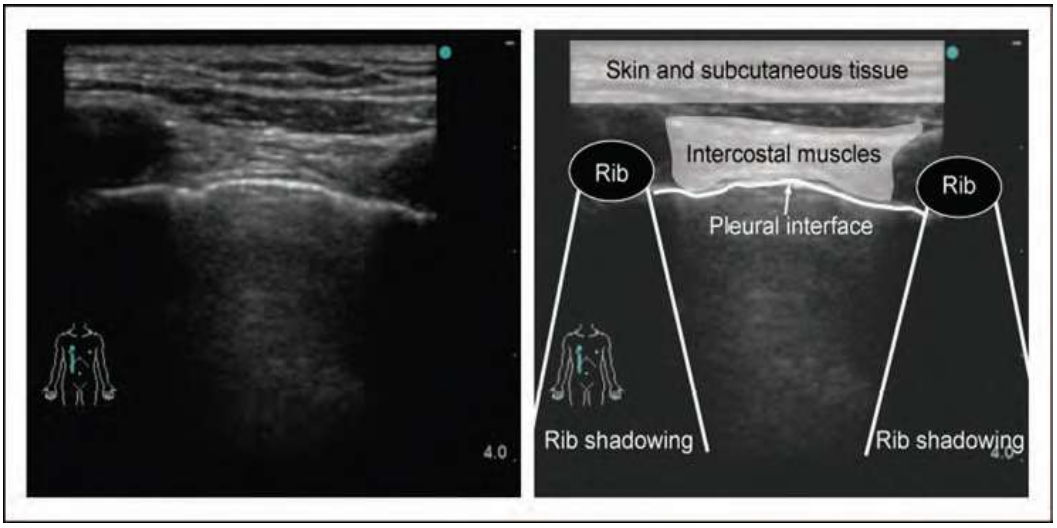

Fig.3: Typical lung ultrasound image showing normal ribs (Piette et al, 2013).