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Role of Chest X-Ray with Ultrasonography in Evaluation of Pneumonia in an Icu Setting: A Prospective Study

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Abstract

Aim: *Evaluation of role of Chest X-ray & Ultrasonography in pneumonia in an ICU setting.*

Introduction: *Critically ill patients frequently need thoracic imaging due to dynamic nature of their clinical conditions. I studied the role of Chest X-ray & Ultrasonography in patient with pneumonia in an ICU setting in KEM Hospital, Pune.*

Materials and Methods: *The present study was carried out at KEM Hospital, Pune in the Intensive Care Unit from 1st June 2018 to 31st May 2019 on patients with findings of pneumonia.*

Sample size: *150 patients as per calculation*

Summary and Conclusion

- *Lung sonography was **able to evaluate** homogeneous opacities, air bronchogram, Kerley- A line, Kerley-B line, fluid in pleural space.*
- *The **limitations** of ultrasonography were non visualization of inhomogeneous opacities and volume loss.*
- *Thus lung sonography is complimentary for evaluation of pneumonia along with chest radiography.*

1. Introduction

Critically ill patients frequently need thoracic imaging due to dynamic nature of their clinical conditions. Computed Tomography (CT) scans remain the gold standard imaging technique for thoracic evaluation, but transportation of patients outside the ICU may be difficult and potentially harmful [1]. Chest CT scans expose patients to large doses of radiation and are reserved for specific situations (e.g., the evaluation of mediastinal pathologies and confirmation of pulmonary embolism) [2–4]. Bedside chest X-ray (CXR) is still considered the standard of care for many diagnostic applications in the Intensive Care Unit (ICU). However, this imaging technique has important limitations and does not show soft tissues clearly[5,6]. Furthermore, radiation is also present. Bedside sonography has become essential in the ICU for several indications.[7-11]

Pneumonia is an inflammatory condition of the lung affecting primarily the alveoli[12]. Typically symptoms include some combination of productive or dry cough, chest pain, fever, and trouble breathing.[13] Pneumonia ranks as the third cause of death worldwidede, preceded only by ischemic heart disease and cerebrovascular diseases. It is the leading infectious cause of death and one of the most common reasons for emergency room (ER) visits and hospital admissions. In patients with clinically suspected pneumonia, a correct diagnosis is essential for proper treatment orientation. Diagnostic and treatment delays and failure can entail a significant increase in mortality. Traditionally, the diagnosis of pneumonia is based on three mainstays: clinical and laboratory data, imaging techniques, and microbiological studies. Chest X-ray (CXR) currently constitutes the first approach in suspected pneumonia, where the presence of a new infiltrate is the characteristic radiographic finding. However, several studies point to CXR's low sensitivity for the diagnosis of pneumonia. Besides, image quality is lower in patients in decubitus position and when using portable devices. Ultrasound can play a significant role in this scenario.

I studied the role of Chest X-ray & Ultrasonography in patient with pneumonia in an ICU setting in KEM Hospital, Pune. Few studies have been done on this topic in India.

This is the first such study in our hospital. Routine Chest X-ray will be done and ultrasound will be done on patients with findings of pneumonia.

2. Aims and Objectives

Aim: Evaluation of role of chest radiography & ultrasonography in pneumonia in an ICU setting.

Objectives

1. To evaluate the role of Chest X-ray with Ultrasonography in pneumonia in an ICU setting.
2. To analyze the advantages and disadvantages of Chest X-ray & Ultrasonography in pneumonia in an ICU setting.

3. Material and Methods

Study Area

The present study was carried out at KEM Hospital, Pune in the Intensive Care Unit from 1st June 2018 to 31st May 2019 on patients with findings of pneumonia.

Study Population: A total of 150 patients of clinically diagnosed pneumonia were included in the study.

Study Design: Prospective, observational study.

Sample Size: The sample size comes to **N = 150**

Sample Size Calculation

We calculated sample size by the following formula:

$$\text{Sample Size} = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1+\left(\frac{z^2 \times p(1-p)}{e^2 N}\right)}$$

Population Size = N | Margin of error = e | z-score = z

e is percentage, put into decimal form (for example, 3% = 0.03).

The sample size comes to N = 150

Study Duration: The duration of the study was **12 months** ranging from May 2018 to April 2019.

1. Inclusion Criteria

- Patients with clinically suspected pneumonia admitted in ICU.
- The patients with lung pathologies like pleural effusion, empyema, consolidation, collapse, pneumothorax will be assessed.

2. Exclusion Criteria

- Patients not admitted in ICU.
- Patient not having pneumonia.
- Patients so severely sick that lung ultrasound or chest X-ray may be difficult.

Methodology

The study protocol was reviewed and approved by the scientific & ethics committees; it was therefore performed in accordance with ethical standards. An informed consent for the use of personal data was obtained. The patient data and clinical history was recorded as per proforma attached (Annexure – A).

Technical Parameters

USG was done using Sonosite WK2VYO Ultrasound machine in ICU.

Probes used were:

1. Straight linear array probe- 5 – 12 MHz,
2. Curvilinear probe- 2-5 Mhz,

X-ray was taken using GE Healthcare Brivo XR115 portable x-ray machines and CR (computed radiography) cassettes.

Technique of Performing Lung Sonography Used in My Study

I have used Sonosite WK2VYO portable machine available in the ICU of our hospital. Straight linear array probe (5 – 12 MHz) and curvilinear probe (2-5 Mhz) was used.

Patients was examined posteriorly while sitting or in lateral position if extremely sick and anteriorly in the supine position. A systematic examination of all intercostals was performed. My diagnostic aim was to explore the accessible pleural surface in order to find pleural-based consolidations. However, it should be noted that only lesions that extend up to the pleura are detected by LUS. Several areas remain hidden behind other anatomical structures or are barely visible. In particular, part of the left lung is covered by the heart. One way to partially avoid these limitations is to have the patients in a sitting position with their hands behind their neck and use a subcostal approach. The probe was positioned and moved in both the longitudinal and transverse direction. The longitudinal scan was obtained by positioning the probe over the cranio-caudal axis, allowing

visualization of a large part of the pleural line. This approach is limited by the shadows caused by the ribs, which partially hide the pleural line. The transverse scan was obtained by positioning the probe over the horizontal axis. This positioning allows the study of the pleural line without any acoustic interference from the ribs, but within the limits of a single intercostal space. As in other situations, the upper pane of the ultrasound screen represents the superficial layers and the bottom of the screen the deeper layers. In the longitudinal scan the cranial parts are displayed on the left of the screen. In the transverse scan the left pane shows the right side of the patient, and vice-versa.

Each hemithorax is divided into three different areas: anterior, lateral and posterior. The anterior region extends from the parasternal to the anterior axillary line, the lateral region from the anterior axillary line to the posterior and, finally, the posterior region from the posterior axillary to the paravertebral line. Each of these regions was divided into upper and lower halves. Examination of the supradiaphragmatic region plays an important role in LUS. Each lung was divided into 6 segments by anterior and posterior axillary lines.

Sono-Morphology of Pneumonia

Pneumonia has echo poor echogenicity and an inhomogeneous echotexture. The most characteristic sign is a positive air bronchogram. The air bronchogram reflects residua of air within consolidated areas comparable to the air bronchogram visible on X-ray and CT.

Lines: Lungs were assessed for the presence of A lines, B lines.

A lines: Horizontal, regularly spaced hyperechogenic lines representing reverberations of the pleural line.

B lines: These are diffuse bright echogenic lines arising from the pleural line to the edge of the ultrasound screen. These occur due to accumulation of fluid in the interstitium. When several B lines are visible, the term used is "lung rockets"**.** These are seen in pulmonary oedema giving 'B' profile.

Pleural effusion: Effusions are looked for in the dependent lung areas delineated by the chest wall and the diaphragm. The standard curvilinear ultrasound probe was used. The probe was placed in the intercostal space with the long axis of the foot of the probe parallel to the adjacent rib. The effusion appears as a hypoechoic (i.e. dark) and homogenous structure in the dependent areas which is present both in inspiration and expiration.

4. Findings and Signs of Pneumonia on Sonography in my Study

This ultrasound image of 45 year old man shows A-lines in left lung lower lobe. A –line defines normal lung surface. It indicates gas movement and the echoes are produced due to air within normal lung. Linear lines are due to air in the lung. Rib shadowing is seen distally.

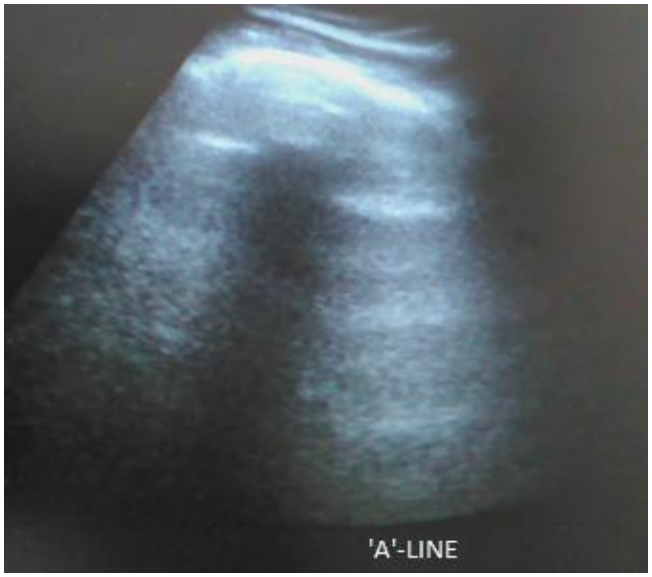

Image1. *'A'-Line*

This ultrasound image of 52 year old woman shows B-lines in right lung lower lobe. They are long, well defined, laser-like, and hyperechogenic lines that erase the A -lines. It is a comet-tail artefact from the pleural surface which is seen on the image.

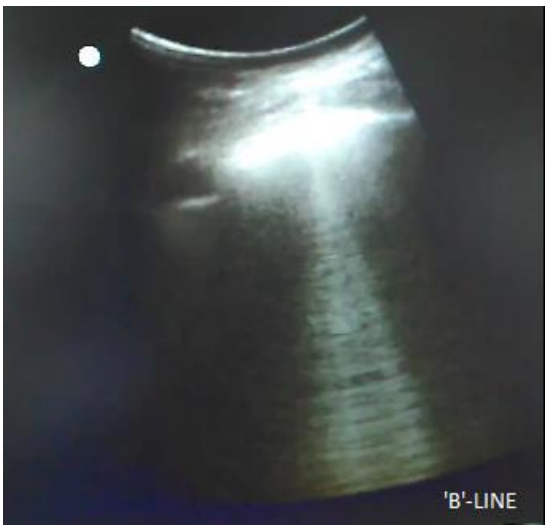

Image2. *'B' - Line*

This ultrasound image of 35 year old man shows Bat sign in left lung lower lobe. The combination of pleural line and A lines is called Bat sign.

Image3. *Bat Sign*

This ultrasound image of 50 year old man shows pleural effusion in left costophrenic angle. Pleural effusion is hypoechoic area seen in pleural space due to fluid accumulation in the pleural cavity.

Image4. *Pleural Effusion*

This ultrasound image of 30 year old man shows fractal (shred) sign in right lung lower lobe. It is non-translobar consolidation, with an irregular border between aerated and consolidated lung regions.

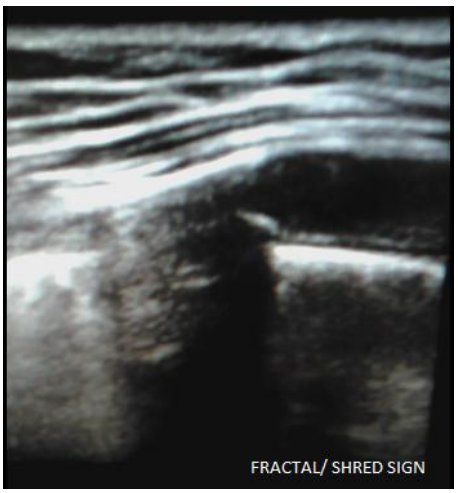

Image5. *Fractal (or Shred sign)*

This ultrasound image of 35 year old man shows lung rockets in left lung middle lobe. They are multiple B lines and they indicate interstitial edema.

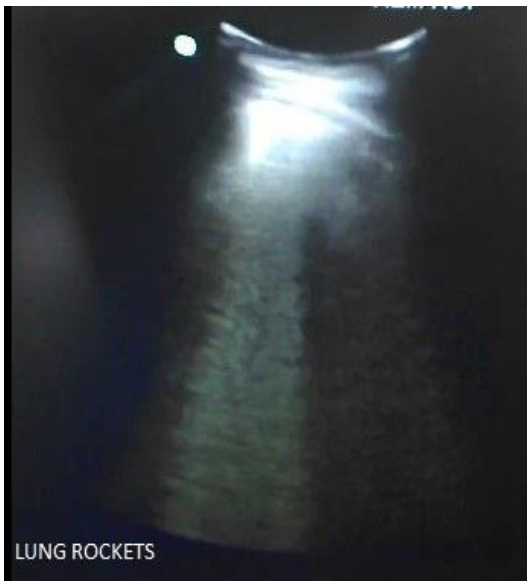

Image6. *Lung Rockets*

This ultrasound image of 52 year old woman shows quad sign in right costophrenic angle. Pleural fluid accumulation between the visceral pleura, parietal pleura, and the shadow of the ribs, form a kind of quadrilateral shape which is called the quad sign.

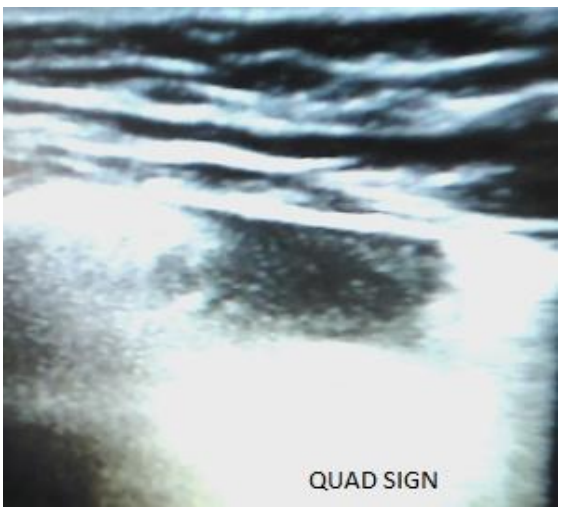

Image7. *Quad Sign*

This ultrasound image of 66 year old man shows tissue sign in left lung middle lobe. The lung looks like liver parenchyma so it is called tissue sign and it is seen in translobar consolidation. Pleural effusion is also seen around the consolidated lung.

Image8. *The 'tissue' sign*

5. Observations and Results

Table1: *Age Distribution of patients with pneumonia in my study*

The age distribution (n= 150) of all patients with pneumonia in my study is shown in Table 1 and Chart 1.

Range in years	Number of patients
20-29	3
30-39	24
40-49	15
50-59	24
60-69	58
70-79	26
Total	**150**

- *Average age of patient was 64 Years.*
- *Range of patients' age was from 20-79 years.*
- *Standard Deviation is **18.31***
- *Maximum patients were seen between 50 to 79 years of age (n=108).*
- *Least number of patients were seen in 20-29 years of age (n=3).*

Table2: *Gender distribution of patients with pneumonia in my study*

The gender distribution of all patients with pneumonia in my study (n= 150) is shown in Table 2 and Chart 2.

Gender	No.of. subjects	Percentage (%)
Male	86	57
Female	64	43
Total	150	100

- *Pneumonia was commoner in males (n=86, 57 %) than in females (n=64, 43 %).*

Table 3a: *List of various imaging findings on chest radiograph and ultrasonography in my study with frequency of each (n= 150)*

Findings	Chest radiography	Ultrasonography
Inhomogeneous Opacities. (only seen in chest radiography)	100	-
Homogeneous Opacities (equivalent to Fractal/tissue like sign on ultrasonography)	110	79
Air bronchogram	110	79
Volume loss(only seen in chest radiography)	22	-
Kerley A lines	32	24
Kerley B lines	100	75
Fluid in pleural space	55	55

"-" indicates that this findings cannot be assessed on sonography.

All findings were found in higher number in chest radiography except pleural effusion which was equally found on chest radiography and ultrasonography.

Table 3b1: *List of various imaging findings on Chest radiograph in my study with frequency of each finding (n=150)*

The list of various imaging findings in my study with frequency of each finding on Chest radiograph is shown in Table 3a and Chart 3a.

Types of Findings	Chest Radiograph	RELATIVE PERCENTAGE ON CHEST RADIOGRAPH (%)
Inhomogeneous Opacities	100	66.67
Homogeneous Opacities	110	73.33
Air bronchogram	110	73.33
Volume loss	22	14.67
Kerley A lines	32	21.33
Kerley B lines	100	66.67
Fluid in pleural space	55	36.67
Total	529	353

Inhomogeneous opacities, homogeneous opacities, air bronchogram, Kerley B lines were the commonest findings on chest radiography.

Table 3b2: *Number of patients with solitary and multiple findings on chest radiography (n=150)*

NUMBER OF FINDINGS ON CHEST RADIOGRAPHY FOUND SIMULTANEOUSLY IN A PATIENT	NUMBER OF PATIENTS
ONLY 1	84
ONLY 2	140
ONLY 3	32
ONLY 4	0

Table 3c1: *List of various imaging findings in my study with frequency of each finding on ultrasonography (n= 150)*

The list of various imaging findings in my study with frequency of each finding on ultrasonography is shown in Table 3b and Chart 3b.

Types of Findings	Ultrasonography	Relative Percentage on Ultrasonography (%)
The fractal sign (equivalent to homogenous opacities on chest radiography)	79	52.67
Tissue-like sign (equivalent to homogenous opacities on chest radiography)	79	52.67
Air bronchogram	79	52.67
Kerley A lines	24	16.00
Kerley B lines	75	50.00
Fluid in pleural space / Quad sign	55	36.67
Total	391	261

Fractal sign, tissue like sign, air bronchogram, Kerley B lines were the commonest findings on ultrasonography.

Table 3C2: *Number of patients with solitary and multiple findings on sonography (n=150)*

NUMBER OF FINDINGS ON SONOGRAPHY FOUND SIMULTANEOUSLY IN A PATIENT	NUMBER OF PATIENTS
ONLY 1	64
ONLY 2	40
ONLY 3	90
ONLY 4	0

Table 4a: *Age distribution of Inhomogeneous Opacities on chest radiograph in patients with pneumonia in my study (n= 150)*

The age distribution of Inhomogeneous Opacities in patients with pneumonia in my study is shown in Table 4a and Chart 4a.

Range in years	Inhomogeneous Opacities	RELATIVE %
20-29	3	3
30-39	14	14
40-49	15	15
50-59	14	14
60-69	28	28
70-79	26	26
Total	100	100

- *Average age of patient was 61 Years.*
- *Range of patient's age was from 20-79 years.*
- *Standard Deviation is **9.16***
- *Maximum patients were seen in 60 to 79 years of age.*
- *Out of 150 patients in my study, inhomogeneous opacities were seen in 100 patients (Table 4a as above). In 50 patients there were no inhomogeneous opacities found.*

Table 4b: *Gender distribution of Inhomogeneous Opacities on chest radiograph in patients with pneumonia in my study (n= 150)*

The gender distribution of Inhomogeneous Opacities on chest radiograph in patients with pneumonia in my study is shown in Table 4a and Chart 4a.

Types of Findings	Male	Female
Inhomogeneous Opacities.	62	38

Inhomogeneous opacities were commoner in males (n=62) than females (n=38).

Table 4c: *Frequency distribution of Inhomogeneous opacities on chest radiograph in lung lobes in patients with pneumonia in my study (n= 150)*

RIGHT LUNG		LEFT LUNG	
UPPER LOBE	18	UPPER LOBE	20
MIDDLE LOBE	12	LINGULA	16
LOWER LOBE	20	LOWER LOBE	14
TOTAL	50	TOTAL	50

Inhomogeneous opacity was highest in left upper lobe (n=20) and right lower lobe (n=20)

Table 5a: *Age distribution of Homogeneous Opacities on chest radiograph and ultrasonography in patients with pneumonia in my study (n= 150)*

	CHEST RADIOGRAPHY		ULTRASONOGRAPHY	
Range in years	Homogeneous Opacities	RELATIVE %	The fractal sign, Tissue-like sign (equivalent to homogenous opacities on chest radiography)	RELATIVE %
20-29	3	2.73	3	3.80
30-39	14	12.73	4	5.06
40-49	15	13.64	5	6.33
50-59	24	21.82	13	16.46
60-69	28	25.45	28	35.44
70-79	26	23.64	26	32.91
Total	110	100	79	100

- *Average age of patient was 66 years in chest radiography and 63 years in ultrasonography.*
- *Range of patients' age was from 20-79 years.*
- *Standard Deviation is 9.48 for homogenous opacities and 11.30 for fractal, tissue like sign.*
- *Out of 150 patients in my study, Homogeneous opacities were seen in 110 patients on chest radiography and 79 patients on sonography (Table 5a as above). In 40 patients there were no homogeneous opacities found on chest radiography and in 71 patients no fractal sign was seen.*
- *Maximum patients were seen in 50 to 79 years of age for homogenous opacities and 60 to 79 years of age for fractal, tissue like sign.*

Table 5b: *Gender distribution of Homogeneous Opacities on chest radiograph and ultrasonography in patients with pneumonia in my study (n= 150)*

Types of Findings	Male	Female
Homogeneous Opacities on chest radiography	60	50
Fractal/tissue like sign on ultrasonography	52	27

Homogeneous opacities were commoner in males (n=60) and fractal, tissue like sign also was commoner in males (n=52).

Table 5c: *Frequency distribution of Homogeneous opacities on chest radiograph in lung lobes in patients with pneumonia in my study (n= 150)*

Right Lung	Homogenous Opacity On Chest Radio Graphy	Fractal , Tissue Sign Ultra Sonography	Left Lung	Homogenous Opacity On Chest Radiography	Fractaltissue Sign Ultra Sonography
Upper Lobe	14	14	Upper Lobe	18	9
Middle Lobe	16	06	Lingula	12	10
Lower Lobe	20	20	Lower Lobe	30	20
Total	50	40	Total	60	39

Homogeneous opacity was highest in left lower lobe and fractal, tissue like sign was highest in bilateral lower lobes.

Table 6a: *Age distribution of air bronchogram on chest radiograph in patients with pneumonia in my study (n= 150)*

Range in years	Air Bronchogram on chest radiography	RELATIVE %	Air Bronchogram on ultrasonography	RELATIVE %
20-29	13	11.82	3	3.80
30-39	14	12.73	4	5.06
40-49	15	13.64	5	6.33
50-59	14	12.73	13	16.46
60-69	28	25.45	28	35.44
70-79	26	23.64	26	32.91
Total	110	100	79	100

- *Average age of patient was 66 years in chest radiography findings and 63 years in ultrasonography findings.*
- *Range of patients' age was from 20-79 years.*
- *Standard Deviation is 9.48 for air bronchogram on chest radiography and 11.30 for air bronchogram on ultrasonography.*
- *Out of 150 patients in my study, air bronchogram were seen in 110 patients on chest radiography and 79 patients on sonography (Table 6a as above). In 40 patients there were no air bronchogram found on chest radiography and in 71 patients there were no air bronchogram on sonography.*
- *Maximum patients were seen in 50 to 79 years of age for air bronchogram on chest radiography and 60 to 79 years of age for air bronchogram on ultrasonography.*

Table 6b: *Gender distribution of Air bronchogram on chest radiograph in patients with pneumonia in my study(n= 150)*

Types of Findings	Male	Female
Air bronchogram on chest radiography	62	48
Air bronchogram on ultrasonography	52	27

Air bronchogram were commoner in males on chest radiograph (n=52) and ultrasonography (n=27)

Table 6c: *Frequency distribution of Air bronchogram on chest radiograph in lung lobes in patients with pneumonia in my study (n= 150)*

RIGHT LUNG	AIR BRONCHOGRAM ON CHEST RADIOGRAPHY	RELATIVE %	AIR BRONCHO GRAM ON ULTRA SONO GRAPHY	RELATIVE %	LEFT LUNG	HOMOGENOUS OPACITY AIR BRONCHOGRAM ON CHEST RADIOGRAPHY	RELATIVE %	AIR BRONCHOGRAM ON ULTRA SONO GRAPHY	RELATIVE %
Upper Lobe	14	28%	14	35%	Upper Lobe	18	30%	9	23%
Middle Lobe	16	32%	06	15%	Lingula	12	20%	10	25%
Lower Lobe	20	40%	20	50%	Lower Lobe	30	50%	20	51%
Total	50	100%	40	100%	Total	60	100%	39	100%

Air bronchogram was highest in left lower lobe and fractal, tissue like sign was highest in bilateral lower lobes.

Table 7a: *Age distribution of Volume loss on chest radiograph in patients with pneumonia in my study (n= 150)*

Range in years	Volume Loss.	RELATIVE %
20-29	1	4.55
30-39	1	4.55
40-49	4	18.18
50-59	4	18.18
60-69	6	27.27
70-79	6	27.27
Total	22	100

- *Average age of patient was 72 Years.*
- *Range of patients' age was from 20-79 years.*
- *Standard Deviation is* ***2.25***
- *Maximum patients were seen in 60 to 79 years of age.*
- *Out of 150 patients in my study, volume loss was seen in 22 patients (Table 7a as above). In 128 patients there was no volume loss found.*

Table 7b: *Gender distribution of Volume loss on chest radiograph in patients with pneumonia in my study(n= 150)*

Types of Findings	Male	Female
Volume loss	12	10

Volume loss was commoner in males (n=12).

Table 7c: *Frequency distribution of volume loss in lung lobes on chest radiograph in patients with pneumonia in my study (n= 150)*

RIGHT LUNG	VOLUME LOSS on CXR	RELATIVE %	LEFT LUNG	VOLUME LOSS on CXR	RELATIVE %
Upper Lobe	4	33.3%	Upper Lobe	3	30%
Middle Lobe	4	33.3%	Lingula	3	30%
Lower Lobe	4	33.3%	Lower Lobe	4	40%
Total	12	100%		10	100%

- *Volume loss was commoner in right lung (n=12) than in left lung (n=10)*

Table 8a: *Age distribution of Kerley-A lines on chest radiograph in patients with pneumonia in my study (n= 150)*

Range in years	Kerley-A lines on chest radiography	RELATIVE %	Kerley-A lines on ultrasonography	RELATIVE %
20-29	3	9.38	2	8.33
30-39	3	9.38	2	8.33
40-49	6	18.75	5	20.83
50-59	7	21.88	5	20.83
60-69	7	21.88	5	20.83
70-79	6	18.75	5	20.83
Total	32	100	24	100

- *Average age of patient was 54 Years for kerley A lines on chest radiography and 56 years for kerley A lines on sonography.*
- *Range of patients age was from 20-79 years.*
- *Standard Deviation is **1.86** for kerley A lines on chest radiography and 1.55 for kerley A lines on sonography.*
- *Out of 150 patients in my study, kerley A lines were seen in 32 patients on chest radiography and 24 patients on sonography (Table 8a as above). In 118 patients there were no kerley A lines found on chest radiography and in 126 patients there were no kerley A lines on sonography.*
- *Maximum patients were seen in 40-79 years of age for kerley A lines on chest radiography and on sonography.*

Table 8b: *Gender distribution of Kerley A lines on chest radiograph in patients with pneumonia in my study (n= 150)*

Types of Findings	Male	Female
Kerley A lines on chest radiography	18	14
Kerley A lines on ultrasonography	14	10

- *Kerley A lines were commoner in males (n=14) on chest radiography and ultrasonography (n=10)*

Table 8c: *Frequency distribution of Kerley- A lines in lung lobes on chest radiography and ultrasonography in patients with pneumonia in my study (n= 150)*

Right Lung	Kerley A Lines On Chest Radio graphy	Relative%	Kerley A Lines On Ultra sono graphy	Relative %	Left Lung	Kerley A Lines On Chest Radio graphy	Relative %	Kerley A Lines On Ultra sono graphy	Relative%
Upper Lobe	18	100%	14	29%	Upper Lobe	14	100%	10	100%
Middle Lobe	0	0%	0	0%	Lingula	0	0%	0	0%
Lower Lobe	0	0%	0	0%	Lower Lobe	0	0%	0	0%
Total	18	100%	14	100%	Total	14	100%	10	100%

- *Kerley A-lines were commoner in left upper lobe (n=18) on chest radiography and in right upper lobe (n=14) on ultrasonography.*

Table 9a: *Age distribution of Kerley-B lines on chest radiograph and ultrasonography in patients with pneumonia in my study (n= 150)*

Range in years	Kerley-B lines on chest radiography	RELATIVE %	Kerley-B lines on ultrasonography	RELATIVE %
20-29	14	14	4	5.33
30-39	3	3	3	4.00
40-49	15	15	5	6.67
50-59	14	14	9	12.00
60-69	26	26	26	34.67
70-79	28	28	28	37.33
Total	100	100	75	100

- *Average age of patient was 68 Years for kerley B lines and 71years for kerley B lines on sonography.*
- *Range of patients' age was from 20-79 years.*
- *Standard Deviation is **9.16** for kerley B lines and 11.43 for kerley B lines on sonography.*
- *Out of 150 patients in my study, kerley B lines were seen in 100 patients on chest radiography and 75 patients on sonography (Table 9a as above). In 50 patients there were no kerley B lines found on chest radiography and in 75 patients there were no kerley B lines on sonography.*
- *Maximum patients were seen in 40-79 years of age for kerley A lines on chest radiography and on sonography.*

Table 9b: *Gender distribution of Kerley B lines on chest radiograph and ultrasonogaphy in patients with pneumonia in my study (n= 150)*

Types of Findings	Male	Female
Kerley B lines on chest radiography	75	25
Kerley B lines on ultrasonography	50	25

- *Kerley B lines were commoner in males on chest radiography (n=75) and ultrasonography (n=50)*

Table 9c: *Frequency distribution of Kerley- B lines in lung lobes on chest radiography and lung sonography in patients with pneumonia in my study (n= 150)*

Right Lung	Kerley B LinesOn Chest Radio graphy	Relat ive %	Kerley B Lines On Ultrasono graphy	Relat ive %	Left Lung	Kerley B Lines On Chest Radio graphy	Relati ve %	Kerley B Lines On Ultrasono graphy	Relati ve %
Upper Lobe	0	0%	0	0%	Upper Lobe	0	0%	0	0%
Middle Lobe	0	0%	0	0%	Lingula	0	0%	0	0%
Lower Lobe	50	100%	40	45%	Lower Lobe	14	100%	35	100%
Total	50	100%	40	100%	Total	14	100%	35	100%

- *Kerley B lines were commonest in right lower lobe on chest radiography (n=50) and left lower lobe on ultrasonography (n=35)*

Table 10a: *Age distribution of fluid in pleural space on chest radiography and ultrasonography in patients with pneumonia in my study (n= 150)*

Range in years	Fluid in pleural space	RELATIVE %	Fluid in pleural space	RELATIVE %
20-29	5	9.09 %	5	9.09%
30-39	5	9.09%	5	9.09%
40-49	11	20.00%	11	20.00%
50-59	11	20.00%	11	20.00%
60-69	12	21.82%	12	21.82%
70-79	11	20.00%	11	20.00%
Total	55	100	55	100

- *Average age of patient was 62 Years on both chest radiology and sonography.*
- *Range of patients' age was from 20-79 years on both chest radiology and sonography.*
- *Standard Deviation is **3.25** on both chest radiology and sonography*
- *Maximum patients were seen in 40 to 79 years of age on both chest radiology and sonography.*
- *Out of 150 patients in my study, fluid in pleural space was seen in 55 patients on chest radiography and on sonography (Table 10a as above). In 95 patients there were no fluid in pleural space found on chest radiography or on sonography.*

Table 10b: *Gender distribution of Fluid in pleural space on chest radiography in patients with pneumonia in my study (n= 150)*

Types of Findings	Male	Female
Fluid in pleural space on chest radiography	33	22
Fluid in pleural space on ultrasonography	33	22

- *Fluid in pleural space was commoner in males on chest radiography(n= 33) and sonography (n= 33)*

Table 10c: *Frequency distribution of fluid in pleural space in lung lobes on chest radiography in patients with pneumonia in my study (n= 150)*

FLUID IN PLEURAL SPACE ON CHEST RADIOGRAPHY	**RIGHT LUNG 30**	**LEFT LUNG 25**
FLUID IN PLEURAL SPACE ON ULTRASONOGRAPHY	**RIGHT LUNG 30**	**LEFT LUNG 25**

- *Fluid in pleural space was commoner on right side on chest radiography (n=30) and ultrasonography (n=30).*

I did not encounter any patient with mediastinal shift, pleural lesion/thickening, lung mass, cavity, lymphadenopathy, air in pleural space in my study. These findings were included in my

thesis protocol as they were found in other published studies[28, 29, 30].

6. Conclusion

- In my study of 150 patients **mean age** of patients with pneumonia was 64 years. Maximum patients (n = 108) were in the **age range** of 50-79 years. There were 86 males (57 %) and 64 females (43%).
- **Total spectrum of findings** in my study were seven, with all findings seen on chest radiography and six of them seen on lung ultrasonography. N**umber of findings** were 529 on chest radiography (529 out of 921; 57.4 %) and 391 on lung ultrasonography (391 out of 921; 42.4 %). The total number of findings were thus less on lung ultrasonography than chest radiography.
- **On chest radiography** the distributions of spectrum of findings were: **i)** homogenous opacity (n=110; 73.3%), **ii)** inhomogeneous opacity (n=100; 66.7%), **iii)** air bronchogram (n=110; 73.3%), **iv)** volume loss (n= 22; 14.7%), **v)** kerley A line (n=32; 21.3%), **vi)** kerley B line (n=100; 66.7%), **vii)** fluid in pleural space (n=55; 36.7%).
- **On lung ultrasonography** the distributions of spectrum of findings were: **i)** fractal sign which is equivalent to homogenous opacity (n=79; 52.7%), **ii)** tissue like sign which is equivalent to homogenous opacity (n=79; 52.7%), **iii)** air bronchogram (n=79; 52.7%), **iv)** kerley A line (n=24; 16.0 %), **v)** kerley B line (n=75; 50.0%), **vi)** fluid in pleural spaces (n=55; 36.67%).
- In my study inhomogeneous opacity and volume loss were **detected only on chest radiography**.
- In my study following findings had higher incidence on chest radiography than ultrasonography: H**omogeneous opacity** (73.3% vs 52.7%), **Air bronchogram** (73.3% vs 52.7 %), **Kerley A line** (21.3 % vs 16.0 %), **Kerley B line** (66.7% vs 50.0 %).
- In my study **fluid in pleural space** was equally seen on chest radiography and lung sonography (55 out of 150; 36.67 %).
- **Homogeneous opacity** was commoner in **males** on both chest radiography and ultrasonography (54.5% and 65.8 %). It was highest in left lower lobe on chest radiography (30 out of 110; 27.3 %) and in bilateral lower lobes on lung ultrasonography (50 out of 79; 63.2%).
- **Inhomogeneous opacity** was commoner in males (62 out of 100; 62%). and was highest in left upper lobe (20%) and right lower lobe (20%) on chest radiography. Inhomogeneous opacity was not seen on lung ultrasonography.
- **Air bronchogram** was commoner in males on both chest radiography (56.4%) and ultrasonography (71%) and was commonest in left lower lobe on chest radiography (27.2%) and in bilateral lower lobes on lung ultrasonography (51%). It was commonest in left lower lobe on chest radiography (30 out of 110; 27.2%) and was commonest in bilateral lower lobes on lung ultrasonography (40 out of 79; 51%).
- **Volume loss** was commoner in right lung (54.5%) than in left lung (45.4%). It was not appreciated on lung ultrasonography.
- **Kerley A line** was commoner in males on both chest radiography (56.3%) and lung ultrasonography (58.3%). It was commonest in left upper lobe (n=18 out of 32; 56.3%) on chest radiography and in right upper lobe (14 out of 24; 58.3%) on ultrasonography.
- **Kerley B line** was commoner in males on both chest radiography (75 %) and on lung ultrasonography (66.6%). It was commonest in right lower lobe on chest radiography (35 out of 100; 46.7%) and in left lower lobe on ultrasonography (24 out of 75; 32%).
- **Fluid in pleural space** was commoner in males on chest radiography (60%) and sonography (60%). It was commoner on right side on both chest radiography (54.5 %) and on ultrasonography (54.5 %).
- Thus lung sonography was **able to evaluate** homogeneous opacities, air bronchogram, Kerley- A line, Kerley- B line, fluid in pleural space.
- The **limitations** of ultrasonography were non visualization of inhomogeneous opacities and volume loss.

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