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Abnormal chest radiographic patterns in patients with pulmonary tuberculosis in Lagos State, Nigeria: A single center study

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Abstract
Background: Tuberculosis (TB) is a disease of ancientness also referred to as white plague which became the major cause of death globally. It is a major public health challenge in Nigeria with an estimated prevalence of 616 cases per 100,000. Conventional X-ray of the chest has been the simplest, cheapest and readily available radiographic imaging modality for the diagnosis and tracking of the stages of the disease by clinicians. This study was designed to evaluate the abnormal chest radiographic patterns in patients with pulmonary tuberculosis in Lagos state, Nigeria.
Materials and methods: This is a cross sectional retrospective review of radiological reports of patients with pulmonary tuberculosis diagnosed on conventional chest x-rays. Only radiological reports with information such as age, sex, clinical indications and PTB radiological findings were included in this study. A sample size of 181 were selected purposively using the inclusion criteria set for this study among radiological reports that fall within January,2015 to July,2018 and this study was conducted between August to November,2018. Ethical approval was obtained from the management of the study center and all patients' information retrieved was treated with high level of confidentiality. A designed proforma was used for data collection. Both Excel 2013 version and statistical package for social sciences version 20 (SPSS Inc. Chicago, IL, USA) were used for data processing and analysis. We adopted both descriptive and inferential (Chi-square X^2) statistical tools for statistical analysis of the variables with statistical significance set at $p<0.05$.
Results: The male to female ratio was 2.6:1 with 72.38% (n=131) male and 27.62% (n=50) female. Consolidation was highest 57.42% (n=104) and the least was pleural effusion 1.65% (n=3).Majority of the abnormal findings were located in the left upper zone of the lung 37.56% (n=68). Chi-square test revealed that there was no statistically significant relationship between sex and abnormal chest radiographic patterns ($X^2 = 9.545$, $p = 0.089$). Chi-square analysis also revealed statistically significant difference in distribution of findings in the various anatomical locations ($X^2 = 118.8$, $p = 0.000$).
Conclusion: Consolidation was the most common abnormal chest radiographic pattern in pulmonary tuberculosis patients which was predominantly found in the left upper lobe of the lung. Majority were males when compared with their female counterpart. The most common age group was those < 30 years of age. There was no statistically significant relationship between age and abnormal chest radiographic patterns.

Keywords: Chest radiographic patterns, conventional x-ray, pulmonary tuberculosis

1. Introduction

Tuberculosis is a disease of ancientness also referred to as white plague which became the major cause of death globally [1-3]. This disease still represent a global threat, as it stands as the leading cause of death due to an infectious agent among adults population worldwide. In 2008, evidence for tuberculosis infection has been discovered in human remains from the Neolithic era dating from 9,000 years ago, in a settlement in the eastern Mediterranean [4]. According to the WHO [5], Tuberculosis kills more people than malaria and AIDS together. Annually, TB is responsible for the death of 100,000 children worldwide. From now until 2020, it is estimated that 1 billion more people will be infected, 200 million will develop the disease, and 70 million will die in case surveillance and control strategies continue as they are [6].

The rate at which new TB cases occur varies widely, even in neighboring countries, apparently because of differences in health care systems [7]. The incidence of TB varies with age. In Africa, TB primarily affects adolescents and young adults [8]. However, in countries where TB has gone from high to low incidence, such as the United States, TB is mainly a disease of older people, or of the immunocompromised [5]. Tuberculosis usually attacks the lungs but can also affect other parts of the body. It is spread through the air when people who have the disease cough, sneeze, or spit [9]. Most infections in humans result in an asymptomatic, latent infection, and about one in ten latent infections eventually progresses to active disease which, if left untreated, kills more than 50% of its victims. When the disease becomes active, 75% of the cases are pulmonary TB with small percent of extension of infection to other organs of the body.

Symptoms include chest pain, coughing up blood, and a productive, prolonged cough for more than three weeks. Systemic symptoms include fever, chills, night sweats, appetite loss, weight loss, pallor, and often a tendency to fatigue very easily [8]. One of the greatest works on TB was performed in 1882 by Robert Koch, an esteemed scientist of his time. Koch isolated and cultured M. tuberculosis from crushed tubercles. His experimental work revealed bacterium as the TB etiological agent with an infectious characteristic [11-12]. A complete medical evaluation for TB must include a medical history, a physical examination, a chest X-ray, microbiological smears, and cultures. It may also include a tuberculin skin test, a serological test. The interpretation of the tuberculin skin test depends upon the person's risk factors for infection and progression to TB disease, such as exposure to other cases of TB or immunosuppressant [9].

Since the discovery of X-rays by Wilhelm Roentgen in 1895, conventional X-ray of the chest has been the simplest, cheapest and readily available radiographic imaging modality for the diagnosis and tracking of the stages of the disease by clinicians [12-14]. With technological advancement in radiography which led to the invention of Computed Tomography (CT) Ultrasound and Magnetic resonance imaging (MRI) scanners has also aided in the diagnosis of chronic stages of the PTB especially with high resolution computed tomography (HRCT) which uses thinner slice thickness when compared to the conventional CT scan[15-17]. CT chest is very essential for the detection of occult disease, differential diagnosis of parenchymal lesions, assessment of mediastinal lymph nodes, disease activity and complications, bronchiectasis, cavitations related to fungal balls and with HRCT reconstruction, military and centilobular nodules, ground glass opacities and air-trapping can be evaluated [14, 17-20]. Ultrasound scan can be use to evaluate pleural effusion, characterize it and guiding in drainage processes [14, 20] while Magnetic resonance imaging is useful in the assessment of mediastinal nodules and disease activity, and it is superior to non-contrast enhanced CT chest [14, 17]. There are multifactorial conditions for the choice of imaging modalities used for radiographic investigations which include; cost of the procedure, availability and the speed of information derivation [21-23]. With X-rays as the TB imaging tool, there is slight difficulty in accurately diagnosing all the conditions since numerous diseases mimic TB roentogengraphically. However, a patterned approach to the description of the roentogengraphic shadows in the pulmonary TB is favored and it is the disease classification that has been used earlier with more detailed pathological terminologies borrowed from pathologists. For clinical and research purposes, the classification of the National Tuberculosis Association of the USA has proved useful. It is based mainly on the anatomical extent of the disease:

1. Minimal: Minimal lesions include those which are of slight to moderate density but which do not contain demonstrable cavitations. They may involve a small part of one or both lungs, but the total extent, regardless of distribution, should not exceed the volume of the lung on one side which is present above the second chondrosternal junction and the spine of the fourth or the body of the fifth thoracic vertebra.
2. Moderately advanced: May be present in one or both sides, but the total extent should not exceed the following limits: Disseminated lesion of slight to moderate density which may extend throughout the total volume of one lung or the equivalent in both lungs, dense and confluent lesions which are limited in extent to 1/3 the volume of one lung, total diameter
3. Far advanced: Lesions more extensive than moderately advanced [24]. Recently the American Lung Association has presented a new classification of pulmonary TB which rests primarily on bacteriology and the chemotherapeutic status [25]. Roentogengraphic findings are regarded as necessary only in certain circumstances and a simplified scoring system has been recently proposed for reliable diagnosis of TB on chest radiograph [26]. The abnormal patterns on chest radiograph of a patient with TB include, consolidations, cavitations, lymphadenopathy, pleural effusion, fibrosis, hilar and mediastinal adenopathy, military pattern and pleural thickening [14, 18, 20, 27-28] (Figure 1 and 2). Accurate diagnosis is a sure way to proper treatment and management of TB cases, hence, this study. This is aimed at evaluating the abnormal chest radiographic patterns in patients with pulmonary tuberculosis in our locality with the following specific objectives; i) to evaluate the sex and age group distributions of the findings identified, ii) to investigate the relationships between sex, age group of subjects and the abnormal chest radiographic patterns in our locality.

2. Materials and Methods

All the chest radiographic investigations were performed using GE static X-ray unit with an erect bucky stand. Standard techniques and parameters were adopted by licensed Radiographers to acquire the images and the obtained images were interpreted by consultant Radiologists. This is a cross sectional retrospective review of radiological reports of patients with pulmonary tuberculosis diagnosed on conventional chest x-rays. Only radiological reports with information such as age, sex, clinical indications and PTB radiological findings were included in this. A sample size of 181 were selected purposively using the inclusion criteria set for this study among radiological reports that fall within January,2015 to July,2018 and this study was conducted between August to November,2018. Ethical approval and permission to conduct this study was obtained from the management of Rovina Medical Diagnostic Services Lagos State, Nigeria and all patients' information retrieved were treated with high level of confidentiality and used for the purpose of this research only. A designed proforma was used for data collection. Both Excel 2013 version and statistical package for social sciences version 20 (SPSS Inc. Chicago, IL, USA) were used for data processing and analysis. We adopted both descriptive and inferential (Chi-square X^2) statistical tools for statistical analysis of the variables with statistical significance set at $p<0.05$.

3. Results

In this retrospective cross sectional study, 181 radiological reports met the inclusion criteria set for the study. The male to female ratio was 2.6:1 with 72.38% (n=131) male and 27.62% (n=50) female. With regards to the abnormal patterns on chest radiographs identified, consolidation was highest 57.42% (n=104) and the least was pleural effusion 1.65% (n=3)(Table1). Table 2 shows that majority of the

abnormal findings in this study were located in the left upper zone 37.56% (n=68) and the least was found in bilateral zone which is 7.18% (n=13). Among the total sample studied, males were highest 72.38% when compared to the female population of 27.62% with consolidation as the highest abnormal chest radiographic pattern 37% in male and 20.4% in female and Chi-square test result revealed that there was no statistically significant relationship between sex and abnormal chest radiographic patterns (X^2 = 9.545, p = 0.089) (Table 3). Chi-square analysis also revealed statistically significant difference in distribution of findings in the various anatomical locations (X^2 = 118.8, p = 0.000)(Table 4). The relationship between age and abnormal chest radiographic patterns was evaluated using Chi-square and the result showed no statistically significant relationship between age and abnormal chest radiographic patterns and age (X^2 = 20.878, p = 0.141) (Table 5).

Table 1: Abnormal patterns of Chest radiographs in TB cases studied

Patterns	Frequency and Percentage (N, %)
Cavitations	48 (26.52)
Consolidations	104 (57.46)
Fibrosis	7(3.87)
Lymphadenopathy	19 (10.50)
Pleural effusion	3 (1.65)
Total	181 (100%)

Table 2: Anatomical locations of the various chest x-ray patterns

Anatomical locations	Frequency and Percentage (N, %)
Bilateral	13 (7.18)
Left upper zone	68 (37.56)
Left lower zone	11 (6.08)
Right upper zone	60 (33.15)
Right lower zone	12(6.63)
Right middle zone	17 (9.40)
Total	181 (100%)

Table 3: Relationship between Sex and abnormal chest radiograph patterns studied

Abnormal patterns	Sex n (%)		X^2	p-value
	Males	Females		
Cavitation	38 (21%)	10 (5.5%)	9.545	0.089
Consolidation	67 (37%)	37 (20.4%)		
Fibrosis	7 (3.9%)	0		
Lymphadenopathy	16 (8.8%)	3 (1.72%)		
Pleural effusion	3 (1.68%)	0		
Total	131(72.38%)	50(27.62%)		

Table 4: Relationship between sex and anatomical locations of the abnormal chest radiograph patterns

Location	Sex n (%)		X^2	p-value
	Males	Females		
Bilateral	13 (7.18)	0	118.8	0.000
Left upper zone	68 (37.56)	0		
Left lower zone	11 (6.08)	0		
Right upper zone	13 (7.18)	47 (26)		
Right lower zone	9 (4.98)	3 (1.62)		
Right middle zone	17 (9.4)	0		
Total	131(72.38%)	50(27.62%)		

Table 5: Relationship between Age and abnormal Chest radiograph patterns

Patterns	Age Range n (%)				X^2	p-value
	≤30 yrs	31-40 yrs	41-50 yrs	>50 yrs		
Cavitation	15 (8.29)	22 (12.16)	7 (3.87)	4 (2.21)	20.878	0.141
Consolidation	56 (30.94)	36 (19.89)	9 (4.97)	3 (1.66)		
Fibrosis	2 (1.11)	3 (1.66)	1(0.54)	1(0.54)		
Lymphadenopathy	8 (4.41)	6 (3.32)	1 (0.54)	4 (2.21)		
Pleural effusion	2 (1.11)	1 (0.54)	0	0		
Total	83 (45.86)	68 (37.57)	18 (9.95)	12 (6.62)		

Fig 1: Heterogenous opacity with cavitations noted at the upper lobe of the right and left lung fields with bilateral hilar adenopathy. Costophrenic sulci are empty. With an impression of Pulmonary tuberculosis with no focal bony lesion is seen.

Fig 2: The trachea is deviated to the right presumably from fibrotic changes with heterogeneous cavitations noted at the upper zone of the right lung field with associated volume loss, features in keeping with pulmonary tuberculosis: An impression of pulmonary tuberculosis.

4. Discussion

The most prevalent abnormal chest radiographic pattern identified in this study was consolidation and the least was pleural effusion. This finding is consistent with the findings of similar studies conducted by many authors [14, 29-36]. On the contrary, Ahidjo *et al.* [34] and Marchie *et al.* [37] reported different findings from our report. This variation may be ascribed to the nature of the study adopted by the different studies and the geographical variations.

In our result only five abnormal patterns of TB manifestation on chest radiographs were identified (consolidation, cavitation, lymphadenopathy, pleural effusion and fibrosis). Additional patterns such as hilar /mediastinal adenopathy, milliary pattern and pleural thickening were not captured in our study as compared to similar studies. This discrepancy in our findings may be attributed to the nature of the subjects studied, imaging modality employed for the diagnosis and the geographical variation. According to Ito *et al.* [18], Rizz *et al.* [17], Ashu *et al.* [14] and Heusel *et al.* [19], computed tomography and magnetic resonance imaging give more information of the various abnormal patterns of chest radiograph in patients with pulmonary tuberculosis than conventional chest x-rays which was the investigating tool used in our study. According to Rizzi *et al.* [17], MRI can be used to diagnosed PTB in pregnant women as an alternative to both conventional x-rays and computed tomography.

The abnormal patterns of chest radiograph presentation of TB in our study were categorized based on six different anatomical regions of the lungs. The left upper zone was highly involved followed by the right upper zone and the least involved region was the left lower zone. This is in keeping with the finding of similar study conducted by Nagwa [29]. The abnormal chest radiographic patterns are distributed around six different anatomical regions of the lungs as revealed in our study. The six identified anatomic regions were: Bilateral lung fields, Left upper zone, Left lower zone, Right upper zone, Right lower zone and Right middle zone. There was a significant difference in the anatomical distribution of the abnormal chest radiographic patterns. Majority of the lesions were located at the upper zones of the lungs, this is consistent with the previous research conducted by Nagwa [29]. However, there was no significant difference between right and left lung fields. The prevalence of the parenchyma lesions such as consolidation and cavitations were quite lower compared to a similar conducted by Balowa [38] where he reported a prevalence of 58% and 42% respectively. There was no statistical significant relationship between sex and abnormal chest radiographic patterns. Chi-square analysis also revealed statistically significant difference in distribution of findings in the various anatomical locations. The relationship between age and abnormal chest radiographic patterns was evaluated using Chi-square and the result showed no statistically significant relationship between age and abnormal chest radiographic patterns.

5. Conclusion

The most common abnormal chest radiographic pattern in pulmonary tuberculosis patients was consolidation which was predominantly located at the left upper lobe of the lung.Male preponderance was noted.The most common age group was those between 0- 30 years of age. There was no statistically significant relationship between sex and abnormal chest radiograph patterns. Chi-square analysis also revealed statistically significant difference in distribution of findings in the various anatomical locations. There was no statistically significant relationship between age and abnormal chest radiographic patterns.

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