



Pulmonary Medicine

THE IMPORTANCE OF CHEST-X-RAY (TIMIKA SCORE) TO PREDICT THE CLINICO-BACTERIOLOGICAL PROFILE OF PULMONARY TUBERCULOSIS PATIENTS

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ABSTRACT

Introduction: Chest x-ray (CXR) is the primary modality for diagnosis and severity assessment and monitoring the ATT response in pulmonary tuberculosis (PTB). The aim of our study was to determine the correlation between the radiographic involvement of disease on CXR based on Timika CXR score with the clinically and bacteriological specifications at diagnosis and initiation of ATT in sputum smear-positive PTB patients.

Material And Method: A cross-sectional study was conducted in the Department of Pulmonary Medicine, a tertiary care hospital, Punjab, from January to June 2020. Seventy new sputum smear-positive cases of PTB were included. At the time of diagnosis, the patient's baseline test, clinical signs and symptoms were evaluated using TB scores I, II, Karnofsky performance score (KPS), and body mass index (BMI). Two chest physicians, according to the Timika CXR score, evaluated the CXR of each patient Independently.

Result: Cavitory lesion on CXR resulted in a significantly higher Timika score associated with higher Mycobacterial load in sputum grading compared to non-cavitory disease. 55.17% of patients with CXR score ≥ 71 had statistically significant higher baseline sputum grading compared to 9.76% of patients with CXR ≤ 71 . Higher Timika CXR score ≥ 71 was significantly associated with a longer mean duration of symptoms, lower BMI, higher TB score, lower KPS at baseline, higher ESR, low hemoglobin, low serum albumin.

Discussion: The study shows that Timika CXR score significantly correlates with radiographic involvement and extent of disease severity on CXR with the clinically and bacteriological profile of PTB patients, which a pulmonologist can use in a medical practice. A Higher CXR Timika score is associated with the patient's poor clinical condition and the severity of the disease. Cavitory lesion on CXR associated with higher sputum smear grading. It is observed that the Timika CXR score can be used to identify the PTB patients at risk of treatment failure for their more aggressive management.

KEYWORDS : Body Mass Index, Chest X-Ray, Karnofsky Performance Score, Pulmonary Tuberculosis

INTRODUCTION

Tuberculosis (TB) is an infectious disease, caused by *Mycobacterium tuberculosis*^[1]. It is a major cause of chronic illness and the leading cause of mortality worldwide. The disease typically affects the lungs (pulmonary TB) but can also affect other sites (extra-pulmonary TB)^[2]. Imaging plays a very important role in the diagnosis and follow-up of patients with pulmonary TB. In a patient suspected to have pulmonary TB, postero- anterior [PA] view of the chest is the first imaging modality and is mostly adequate for diagnosis and subsequent follow-up of such patients^[3,4]. The initial approach for the diagnosis of PTB includes sputum smear examination, chest X-Ray and clinical features such as low grade fever, cough, hemoptysis, weight loss, anorexia, night sweats are suggestive of TB^[5]. There are multiple factors that influence tubercular disease progression in patients, their response to anti-tubercular treatment (ATT), and disease outcome. Clinical and microbiological severity, the radiographic extent of disease at diagnosis, and treatment initiation are crucial in predicting the treatment response, further prognosis, and outcome.^[6] Previous researches have shown that persistent sputum positivity at the end intensive phase is one of the predictors of unfavorable treatment outcome and treatment failure.^[6-10] At diagnosis and initiation of ATT, higher sputum positivity grade, extensive lung disease and the

presence of cavitation on CXR, low baseline health status with associated co-morbidities are the key factors responsible for treatment failure despite effective ATT.^[6,11-13] CXR has high sensitivity for detecting pulmonary abnormalities (consolidation, Cavitation, Tuberculoma, Miliary TB, Lymphadenopathy, Pleural effusion, Local fibro productive lesion), but its use for diagnosis of active PTB has been limited by modest specificity and high inter- and intra-observer differences in reporting of radiographs. Multiple CXR scoring systems have been used successfully for improving the diagnostic utility of CXR for various pulmonary diseases, but the major limitation for interpretation of CXR to determine the extent of diseases is the absence of a universally accepted, validated, and standard CXR scoring system^[14]. Ralph et al. concluded a simple validated scoring system from findings that the proportion of lung fields affected by the disease at diagnosis of PTB was associated with a greater sputum positivity grade and that the presence of cavitation (but not number or size of cavitation), along with the percentage of lung field affected on CXR, predicted two month (intensive phase) smear positivity on ATT. They found a need for a valid and accurate CXR score to classify the patients into high-risk groups in terms of treatment prognosis^[15]. The aims of Our study, to determine the correlation between the radiographic involvement of disease on CXR based on Timika CXR score with the

clinically and bacteriological specification at diagnosis and at initiation of ATT in sputum smear-positive PTB patients.

MATERIAL AND METHOD

The present study was a cross-sectional study conducted in the Department of Pulmonary Medicine, a tertiary care hospital, Punjab, from January 2020 to June 2020. Seventy new sputum smear-positive cases of PTB were included. At the time of diagnosis patient baseline test, clinical signs and symptoms were evaluated by using TB score I (Bedim TB score) and II^[16], KPS^[17], BMI. Two chest physicians, according to the Timika score, evaluated the CXR of each patient independently. Sputum smear grading (fluorescent microscopy), and other relevant blood investigations (ESR, hemoglobin, serum albumin) were done. Correlation between the radiographic involvement of disease on CXR based on Timika CXR score with the clinically and bacteriological specification at diagnosis and at initiation of ATT in sputum smear-positive PTB patients were analyzed statistically. All the sputum-positive patients were registered for study after obtaining valid consent.

Inclusion Criteria:

- New sputum smear-positive PTB patients
- Age ≥ 18 years

Exclusion Criteria:

- Previously treated cases of PTB
- HIV positive cases
- Any other viral illness
- Pregnant and lactating women
- Any other co-morbidities (cardiac disease, hypertension)

Table-1: Karnofsky Performance Status Scale Definitions Rating(%) Criteria^[17]

Able to carry on normal activity and to work; no special care needed.	100	Normal no complaints; no evidence of disease.
	90	Able to carry on normal activity; minor signs or symptoms of the disease.
	80	Normal activity with effort; some signs or symptoms of the disease.
Unable to work; able to live at home and care for most personal needs; the varying amount of assistance needed.	70	Cares for self; unable to carry on normal activity or to do active work.
	60	Requires occasional assistance but is able to care for most of his personal needs.
	50	Requires considerable assistance and frequent medical care.
Unable to care for self; requires the equivalent of institutional or hospital care; disease may be progressing rapidly.	40	Disabled; requires special care and assistance.
	30	Severely disabled; hospital admission is indicated although death is not imminent.
	20	Very sick; hospital admission necessary; active, the supportive treatment necessary.
	10	Moribund; fatal processes progressing rapidly.
	0	Dead

Table-2: TB Score I And II

Score Variables	TB Score I	TB score II
Symptoms		
Cough	1	1
Hemoptysis	1	
Dyspnea	1	1
Chest Pain	1	1
Night Sweats	1	
Signs		
Anaemia	1	1
Pulse rate > 90bpm	1	
Positive finding at Lung auscultation	1	
Temperature > 37°C	1	
Body mass index < 18	1	1
Body mass index < 16	1	1

Mid Upper Arm Circumference < 220mm	1	1
Mid Upper Arm Circumference < 200mm	1	1
Total number of points possible	13	8

A CXR postero-anterior (PA) view was done for all patients. The cavitory disease was defined radiographically as "a lucency within a zone of pulmonary consolidation, a mass, or a nodule; thus, a lucent area within the lung which may or may not contain a fluid level and surrounded by a wall, usually of the varied thickness (greater than 1mm)^[18]. The CXR in PTB mainly shows pulmonary infiltrates in the apical and posterior segments of the upper lobe or the superior segment of the lower lobe, often associated with cavitation.^[18-20] Two experienced chest physicians examined each CXR independently. The extent of lung involvement was assessed using the radiological Timika score described by Ralph AP et al.^[15].

Calculation of Timika score^[15]

- The CXR PA view was divided into six zones of similar size with two horizontal lines.
- For each zone, the percentage area showing active disease (consolidation, nodules) involvement was estimated depending on the visual estimation of the extent of opacification (5 or 10-100% in 10% increments)
- The percentage of all six zones was added and divided by 600 to get the total % of the lung affected.
- A constant value of 40 was added to the above value if at least one cavity was present to obtain the final score
- CXR score = Proportion of total lung affected (%) + 40 if cavitation present

The fluorescent staining method was used for Sputum AFB smear grading. The results were reported as per the NTEP guideline^[21].

Table 3

Florescence microscopy Grading(400x magnification) 1 length = 40 field=200 HPF	Grading
>50 AFB/ 1 field	Positive 3+
5-50 AFB/ 1 field	Positive 2+
20-199 AFB/1 length	Positive 1+
1-9 AFB/ 1 length	Scanty
No AFB / 1 length	Negative

RESULTS

In this cross-sectional study, 70 new sputum smear-positive cases of PTB were included. There were 44 (62.86%) males and 26 (37.14%) females. On evaluating the CXR for cavitory lesion and applying CXR Timika score cut off value of ≥71, which was used in previous studies, Ralph et al.^[15], it was observed that 38(54.29%) patients had a cavitory lesion. In comparison, 32(45.71%) patients had no cavity and 29(41.43%) patients had CXR score ≥ 71 while 41(58.57%) patients had score < 71. Patients with cavitory lesions had higher baseline sputum smear grading as compared with a non-cavitory lesion. 16(42.11%) patients with cavitory lesions had higher baseline sputum smear grading (sputum grade 3+) as compared to 4(12.50%) patients with non-cavitory diseases, which was statistically significant. 16(55.17%) patients with CXR score ≥71 had higher baseline sputum smear grading (sputum grade 3+) as compared to 4(9.76%) patients with a score ≤ 71, which was statically significant. In this study, the cavitory lesion on CXR was significantly associated with a higher Timika CXR score, lower BMI, higher ESR, and lower hemoglobin than patients with non-cavitory lesion. Our study found no statistically significant relation between cavitory lesion on CXR with age, gender, and clinical scores of patients, TB score I and II, KPS, and duration of symptoms. We observed that Timika score ≥ 71 was significantly associated with a higher mean duration of symptoms, higher clinical scores TB score I and II, lower KPS, lower BMI, higher ESR, lower hemoglobin, and lower serum albumin when compared with Timika score ≤ 71.

Table-4: Comparison Of Clinical And Bacteriological Parameters According To The Cavitory Or Non-cavitory Disease On CXR

Variables	Cavitory n = 38(54.29%)	Non cavitory n = 32(45.71%)	p-value
Mean age (years) ± SD	41.32±14.37	44.50±9.57	0.289 (t=1.069) NS
Gender			
Male	21 (55.26%)	23 (71.88%)	0.159 (X ² =3.69)
Female	17 (44.74%)	9 (28.13%)	NS

Sputum AFB smear grade n (%)			0.023 ($X^2=5.18$) S
1+	12(31.58%)	16(50.0%)	
2+	10(26.32%)	12(37.50%)	
3+	16 (42.11%)	4(12.50%)	
Mean TB score I \pm SD	6.87 \pm 1.65	6.66 \pm 0.79	0.507(t=0.667) NS
Mean TB score II \pm SD	4.95 \pm 2.08	4.16 \pm 1.35	0.069 (t=1.850) NS
Mean KPS \pm SD	69.47 \pm 20.13	76.56 \pm 12.60	0.089(t=1.727) NS
Mean duration of symptoms (days) \pm SD	67.03 \pm 25.53	57.03 \pm 18.52	0.070(t=1.843) NS
Mean Timika CXR score \pm SD	77.50 \pm 9.92	35.31 \pm 12.70	0.001 (t=15.604) S
Mean BMI (kg/m ²) \pm SD	18.48 \pm 1.46	19.81 \pm 1.98	0.002(t=3.242) S
Mean ESR \pm SD	68.45 \pm 14.41	43.84 \pm 11.23	0.001 (t=7.855) S
Mean haemoglobin (g/dl) \pm SD	8.86 \pm 1.28	11.36 \pm 1.47	0.001 (t=7.621) S
Mean serum albumin \pm SD	3.54 \pm 0.46	3.48 \pm 0.45	0.596(t=0.533) NS

Table-5: Comparison Of Clinical And Bacteriological Parameters According To Timika Score Cut-off Value Of 71 Points

Variables	Timika Score \geq 71 n = 29 (41.43%)	Timika Score <71 N =41 (58.57%)	P value
Mean Age (years) M \pm SD	41.14 \pm 15.65	43.93 \pm 9.56	0.359(t=0.924) NS
Gender			
Male	15 (51.72%)	29 (70.73%)	0.105 ($X^2=2.63$) NS
Female	14 (48.28%)	12 (29.27%)	
Sputum AFB smears grade n (%)			0.010 ($X^2=5.52$) S
1+	3(10.34%)	25(60.98%)	
2+	10(34.48%)	12(29.27%)	
3+	16(55.17%)	4 (9.76%)	
Mean TB score I \pm SD	7.34 \pm 1.32	6.37 \pm 1.18	0.002(t=3.262) S
Mean TB score II \pm SD	5.31 \pm 2.02	4.07 \pm 1.47	0.004(t=2.966) S
Mean KPS \pm SD	67.59 \pm 21.66	76.34 \pm 12.60	0.037(t=2.132) S
Mean duration of symptoms (days) \pm SD	71.31 \pm 27.12	56.20 \pm 17.33	0.006(t=2.845) S
Mean BMI (kg/m ²) \pm SD	18.57 \pm 1.27	19.46 \pm 2.07	0.043(t=2.058) S
Mean ESR \pm SD	74.21 \pm 11.12	45.17 \pm 10.39	0.001 (t=11.185) S
Mean haemoglobin (g/dl) \pm SD	8.30 \pm 0.72	11.21 \pm 1.40	0.001 (t=10.244) S
Mean serum albumin \pm SD	3.37 \pm 0.23	3.62 \pm 0.54	0.021 (t=2.365) S

DISCUSSION

The current guidelines for PTB diagnosis include history, physical examination, CXR, and sputum smear microscopy. These are primary diagnostic modalities and severity assessment tools at ATT initiation and monitoring the treatment response. In various studies, cavitory lung lesion on CXR was found in 40-50% of PTB cases^[11,22,23]. In our study, 54.29% of patients had cavitation on CXR. 42.11% of patients with cavitation on CXR had sputum 3+ smear grade compared to 12.50% patients in non-cavitory diseases, which showed that cavitation on CXR was significantly associated with high Mycobacterial load in sputum smear grading ($p < 0.05$). This result was in concordance with Ralph et al.^[15], Perrinet al.^[24], Palaci et al.^[25], Rathman et al.^[13]. They also concluded that cavitory lesion on CXR was significantly associated with higher baseline sputum Mycobacterial load on sputum smear and culture. In cavity walls, the bacillary load was estimated to range from 10^7 to 10^9 in contrast with only 10^2 to 10^4 in areas of caseous necrosis^[26]. The cavitory disease was

a crucially important independent risk factor for treatment failure and relapse in PTB patients^[27]. It was observed that higher sputum smear grading was associated with cavitory diseases on CXR and a higher CXR Timika score (≥ 71). KPS is useful for objective assessment of a patient's functional status. It predicts the disease severity, treatment response, and overall survival of the patient^[17]. Terret et al. found that KPS was less accurate tool than the Physical Performance Test to assess the functional status of elderly patients^[28]. Bandim TB score and TB score II were used for an initial assessment at the start of ATT and monitoring treatment response^[29]. Increased TB score at diagnosis and during the intensive phase of ATT is associated with high treatment failure and increased mortality^[30]. Hence, these clinical parameters can be used to assess the severity of disease at treatment initiation and identify the patients at risk of poor treatment outcome. Our study found no significant correlation between KPS and Bandim TB score and TB score II and cavitory lesion on CXR. Patients with higher CXR Timika score ≥ 71 had significantly lower KPS and higher Bandim TB score and TB score II. In this study there was no association between patients' mean age and gender with the cavitory disease on CXR and Timika score; this was in concordance with Palaci et al.^[25]. This study shows that, patients with cavitory lesions had significantly lower BMI (18.48 \pm 1.46) than the patients with the non-cavitory disease with BMI (19.81 \pm 1.98) similar results were found by Palaci et al.^[25], Ralph et al.^[15]. It was observed that, patients with higher Timika CXR scores had significantly lower BMI (18.57 \pm 1.27) than (19.46 \pm 2.07) in patients with lower Timika scores, which correlates with Ralph et al.^[15]. In their study, Ralph et al.^[15] found that at an optimal cut-off point of 71, the Timika score could predict a positive sputum smear at the end of the intensive phase of ATT with a sensitivity and specificity of 80% and 67.7%, respectively. In the present study, we found that cavitory disease was associated with a higher CXR score. In this study, 55.17% of patients with higher CXR score ≥ 71 had 3+ sputum smear grade compared to 9.76% of patients with lower CXR scores, which was statistically significant ($p < 0.05$). we found that a higher CXR score ≥ 71 was significantly associated with the cavitory lesion, higher baseline sputum smear grading, longer duration of symptoms, lower BMI, higher clinical scores TB score I, II, lower KPS at diagnosis of PTB ($p < 0.05$) similar results were found by Palaciet al.^[25], Ralph et al.^[15]. In our study, we found that a high CXR Timika score ≥ 71 was significantly associated with high mean ESR and low mean serum albumin and low mean hemoglobin, this was in concordance with Ralph AP et al.^[15] and Ozsahin SL et al.^[31]

Limitations

The present study was limited by a small sample size taken from a single hospital source. Exclusion of previously treated PTB patients in which cavitory lesion and other radiographic abnormality remain even after treatment. Exclusion of HIV patients due to subtle or varied CXR manifestation may be present.

CONCLUSION:

The study shows That Timika CXR score significantly correlates with radiographic involvement and extent of disease severity on CXR with the clinically and bacteriological profile of PTB patients, which a pulmonologist can use in a medical practice. A Higher CXR Timika score is associated with the patient's poor clinical condition and the severity of the disease. Cavitory lesion on CXR associated with higher sputum smear grading. It is observed that the Timika CXR score can be used to identify the PTB patients at risk of treatment failure for their more aggressive management.

Conflict Of Interest

The author declares no conflict of interest.

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