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Radiological evidence in clinical prevalence of hematological changes in multidrug resistant pulmonary tuberculosis

Smitha Thungathurthi
Department of Pharmacy Practice, Jayamukhi College of Pharmacy, Affiliated to Kakatiya University, Warangal, Narsampet. 506 332. Telangana, India

Dr Prabhakar Orsu*
Department of Pharmacology, GITAM Institute of Pharmacy, GITAM Deemed to be University, Gandhi Nagar, Rushikonda, Visakhapatnam. 530045. Andhra Pradesh, India
*Corresponding Author

***Abstract*---**Background: Globally, tuberculosis is the leading cause of death. India accounts for the highest proportion of drug resistant tuberculosis among all other countries. Objectives: This study investigated the changes in hematological parameters with respect to radiological evidences in multidrug resistant tuberculosis patients. Materials and Methods: The study enrolled a total of 273 patients with the confirmative diagnosis of multidrug resistant tuberculosis. The radiological evidences were classified into mild, moderate and severe lung involvement. Results: The chest radiographs illustrated tracheal deviation (74), loss of lung volume (35), pleural effusion (25), lobar collapse and fibrotic manifestations. The defensive leucocytes, phagocytic neutrophils, anucleated platelet cells and platelet volume observed an increase with severe lung grading ($p<0.0001$). Reduced lymphocyte count, mean platelet size observed with the intense lung involvement. Prevalence of normocytic, normochromic anemia, anisocytosis was prominent in these patients. The erythrocyte sedimentation rate observed no significant changes in the categorized radiological grades of lung. Radiological grading reported a weak positive correlation with the hematological parameters. Conclusion: The study noticed the changes in the complete blood count parameters with radiological signs and recommend monitoring of these investigations in determining the progression of the lung involvement in the multidrug resistant pulmonary tuberculosis patients.

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Introduction

Tuberculosis (TB) infection stands at the top and a burgeoning cause of death than any other infection globally. The year 2019 reported an incidence of 10 million cases and a mortality of 1.4 million people. India stands at the top among the 30 high TB burden countries accounting for 26% of all the estimated incident tuberculosis cases. Treating the patients affected with tuberculosis avoided 52 million HIV negative and 11 million HIV positive patients from being deceased.[1]

Blood cells show a multifaceted effect on the homeostasis, immune responses and inflammatory reactions in mycobacterial infection. The variegation in the clinical findings poses a challenge to the chest physicians about therapeutic benefits in tuberculosis diagnosis.[2] Sputum positive patients' illustrated severe anemia, increased platelet count and erythrocyte sedimentation in the advanced stages of the mycobacterial infection. Common findings include normocytic, normochromic anemia, increase in the neutrophil count, platelets, reduced lymphocyte count.[3-4] The Chest X-Ray determines the abnormal findings of lung TB and is considered for screening the patients. Culture negative reports with abnormal chest X-ray findings in TB subjects suggest the severity of infection. Active TB in primary infection illustrates the Ghon complex opacification, pleural effusion in chest X ray.[5] The post-primary TB in lungs demonstrates cavitary lesions, fibroproliferation and reticulonodular opacification. This finally results in fibrocalcific scar, fibronodular scar with lobar collapse, pleural calcification,[6] bronchial dilation, loss of lung volume in multidrug-resistant pulmonary tuberculosis (MDRPTB).[7]

The radiology findings of lungs infected with TB observed a correlation with the indices of platelets and significant with the fibro-cavitary lesions.[8] The improvement in the haematological findings indicated the healthy outcome and therapeutic benefit of the patient.[9-10] This study establishes the assessment of complete blood picture with biochemical investigations in pulmonary tuberculosis as useful aids in interpreting the diagnosis. In this study, we investigated the radiological findings and established the differences in the findings of hematological parameters with the radiological evidences. We correlated chest X-ray findings with the hematological parameters. This investigation helps in defining the complete blood picture of the patients for their severe lungs infection.

Materials and Methods

This prospective study was conducted during February, 2018 to December, 2020. Prior permission and approval of the protocol was taken from Jayamukhi College of pharmacy, Institutional Review Board (JCPN/112/2018). This study was conducted at tertiary Government TB and Chest hospital. Informed consent was obtained from the participants.

Sample size was calculated referring the changes in hematological parameters from the previous study. The reference for determining the sample size reported thrombocytois in 23% tuberculosis patients.[11] The same proportion of 23% was used to calculate the sample size assuming 95% confidence interval and desired precision of 0.05. The estimated sample size for the present study was 273.

This prospective observational study included the patients diagnosed with MDRPTB diagnosed using rapid molecular tests. Patients with the radiograph, hematological report, with or without comorbid condition were the inclusion criteria. Excluded patients include patients <18 years, pregnant women, subjects with the diseases and medication that affect the hemogram. The patients' demography, past history of pulmonary TB, subjective assessment and radiograph presentation of lung recorded. Blood sample (4ml) collected for hemogram and ESR findings. The hematological parameters estimated on the same day of sampling using 'Mindray BC 2800 Automated Hematology Analyzer' (Shenzhen Mindray, Bio-Medical Electronics Co., Ltd.). Westergren method utilized to determine Erythrocyte Sedimentation Rate (ESR). The grading of the severity of lung involvement based on the radiological findings. Accordingly, the mild infection analyzed as the involvement of one lobe, no cavitations and pleural implication. The moderate stage categorized based on unilateral lung involvement, with cavitary lesions and pleural thickening, effusion. The severe lung infection classified with the involvement of bilateral lungs, multiple cavitations, pleural involvement, tracheal deviation, fibrosis and loss of lung volume.

The data was presented in the numbers, mean±SD. The Shapiro Wilk test determined the normal distribution of the continuous variables data. One way analysis of variance with a post-hoc Tukey's multiple comparison test for parametric data and Kruskal Wallis test with a post-hoc Dunns' multiple comparison tests for non-parametric data performed to find the significant differences between the categories of severity grading of lung. Pearson correlation test for parametric data and Spearman correlation test for non-parametric variables used to assess the relation between radiological findings and hemogram. The data was analyzed in the statistical software IBM SPSS 26.

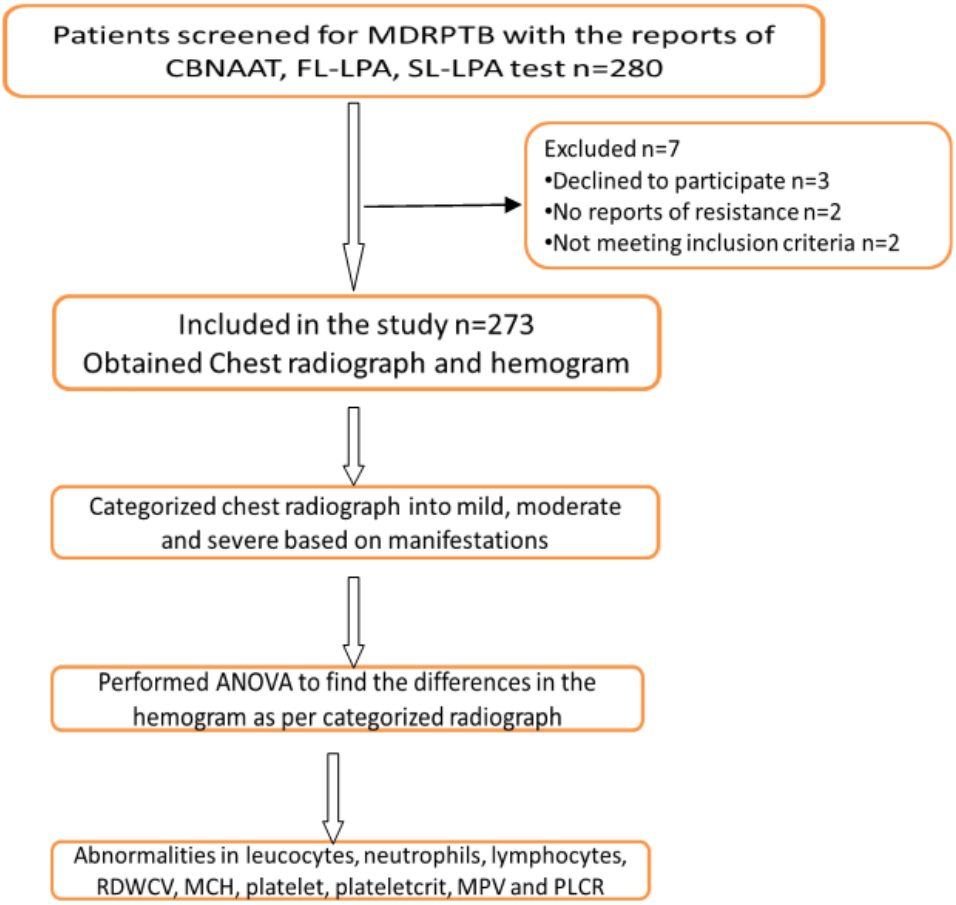

Fig 1. Consort diagram of the study conducted in multidrug resistant tuberculosis

Results

The study enrolled male (196) and female (76) patients accounting to a total of N=273 MDRPTB patients. The present study categorized the subjects into mild (71), moderate (102) and severe (100) radiographic manifestations. The involvement of the three zones (120) was more followed by anyone zone (83) and two (58) zones of lungs. The radiological manifestations found in bilateral lungs (107), right unilateral lung (103) found to be more than left lung (50).The homogenous consolidation was prominent in right upper, left middle and lower zones of the lung. The homogenous opacity was due to replacement of air with fluid, pus, blood or water. The dense, patchy alveolar infiltrates presented with air bronchograms observed in few patients (33). More patients manifested besides interstitial infiltrates with reticulonodular opacities (129) than alveolar infiltrates. Subcutaneous emphysema observed in a single patient. Trachea, the common passage for air into the lungs was in central position (197) in maximum patients while the remaining (74) had a tracheal deviation. The shift in the trachea disturbs the location of the upper mediastinum. The shift in the trachea is known for an abnormal intrathoracic pressure in the thoracic cavity. The increase in the pressure on the affected side of the lung pushes the trachea towards the low

pressure. Collapsed lung, pneumothorax resulting in the loss of lung volume and massive pleural effusion on the contralateral lung cause the shift in tracheal position. The loss of lung volume was observed (35) in subjects with either the right (12) or the left (23) lung involvement. Smaller lung volume with fibrosis examined as the loss of lung volume. In general, pneumothorax sequences to the loss of lung volume. The left pneumothorax in three, left hydropneumothorax in one, right hydropneumothorax in three, and massive pleural effusion was present in two subjects. The air in the pleural cavity collapses the lung due to accumulated air consequence to the partial or complete collapse of the lung. Pneumothorax caused by the lung infections classified under secondary spontaneous pneumothorax. The wind pipe located central in six patients with pneumothorax (2) and hydropneumothorax (4) patients. The presence of air and fluid in the pleural space ascertains hydropneumothorax. The costophrenic angle was blunt with pleural effusion (25). Pleural effusion was more in the right lung than the left. Pleural thickening (10) was on the left apical part of the upper lobe (6). The massive pleural effusion leading to tracheal shift manifested as homogenous opacity with the identity of meniscus in the lobes of lung. Compensatory pulmonary hyperinflation (12) noticed on one side of the lung manifested as the overinflation of the unaffected part of the lung due to loss in the lung volume. Pulmonary hyperexpansion (44) was observed in bilateral (11), right (21) and left (12) unilateral lungs of the patients. The hyperinflated lungs interfere with the exhalation of air and are recognized by the flattened diaphragm. The anterior ribs and posterior ribs more than six and ten respectively define the pulmonary overinflation. Upper lobar collapse (38) illustrated as the tenting of hemidiaphragm or Kattan sign on the same side of the lung. The indistinct right heart border defined the right middle lobe collapse. The triangular opacity in the right lower zone, obscuration of the midpoint of the dome of diaphragm identified as lower lobe collapse. Hilar lymphadenopathy, enlarged lymph nodes (28) at the hilar region and the mediastinal shift (19) observed in the patients. The homogenous opacification with the tracheal shift, loss of cardiac silhouette with the mediastinal shift noticed together. Loss of lung volume was the prominent cause for the shift in the lower mediastinum among the MDRPTB patients. Cardiomegaly determined by the cardiothoracic ratio above 0.5 was observed in one patient. Bilateral dilated bronchiolar manifestations (9) known as bronchiectasis mostly observed in the upper lobes of the lungs. The unilateral bronchiectasis (13) observed involving right (8) and left (6) sides of the lungs. The thick, stiff, scary fibrotic manifestations presented as fibrotic bands in spread in unilateral lungs (Table 1).

Table 1
Radiological presentation in multidrug resistant tuberculosis patients

Tracheal deviation (74)		Narrow intercostal space (52)		Elevated diaphragm (27)	
Right	53	Right	20	Right	11
Left	21	Left	32	Left	16
Alveolar infiltrates (51)		Consolidation (65)		Cavitations (101)	
Right upper zone	14	Right upper zone	27	Right upper zone	47
Right middle zone	22	Right middle zone	13	Right middle zone	32
Right lower zone	27	Right lower zone	14	Right lower zone	06
Left upper zone	22	Left upper zone	20	Left upper zone	28
Left middle zone	27	Left middle zone	25	Left middle zone	19
Left lower zone	26	Left lower zone	26	Left lower zone	11
Interstitial infiltrates (197)		Fibrotic changes (67)		Calcification (20)	
Right upper zone	76	Right upper zone	32	Right upper zone	07
Right middle zone	80	Right middle zone	16	Right middle zone	13
Right lower zone	81	Right lower zone	12	Right lower zone	10
Left upper zone	57	Left upper zone	24	Left upper zone	05
Left middle zone	59	Left middle zone	19	Left middle zone	12
Left lower zone	60	Left lower zone	17	Left lower zone	08

The primary defensive cells leucocytes and phagocytic neutrophils increased in the severity of lung infection and observed a significant difference between various grades of the radiological evidences in MDRPTB (P<0.0001). The lymphocytes accountable for the antibody responses were much reduced in the severe lung involvement (P<0.0001). No significant changes noticed in differential counts involved in phagocytic monocytes, granulocytes, eosinophils, and basophils that facilitate the inflammatory responses. The immature granulocytes increased with the progression of lung infection (Table 2).

Table 2
WBC and differential count in the severity grading of radiographs in MDRTB patients

Variable	Mild (71)	Moderate (102)	Severe (100)	P-value
White blood cell (4-11*103/µl)	8.95±3.86	10.77±4.94	11.90±4.89	<0.0001 ***
Confidence interval	8.04-9.87	9.80-11.75	10.93-12.87	
Dunn's multiple comparision test			Significance	
Mild vs Moderate			*	
Mild vs Severe			***	
Neutrophil (40-70%)	63.17±11.45	70.57±12.05	71.72±13.93	<0.0001 ***
Confidence interval	60.46-65.88	68.20-72.93	68.96-74.48	
Dunn's multiple comparision test			Significance	
Mild vs Moderate			***	

Mild vs Severe			***	
Lymphocyte (20-40%)	22.46±8.47	16.32±8.39	14.85±7.80	<0.0001
Confidence interval	20.45-24.46	14.67-17.97	13.30-16.40	***
Dunn's multiple comparision test			Significance	
Mild vs Moderate			***	
Mild vs Severe			***	
Monocyte (0-11%)	9.32±3.08	8.92±3.18	8.48±2.42	0.44
Confidence interval	8.59-10.05	8.30-9.55	7.99-8.96	
Eosinophil (0-8%)	4.59±5.59	3.71±4.53	4.60±8.59	0.06
Confidence interval	3.27-5.92	2.82-4.60	2.02-6.31	
Basophil (0-3%)	0.32±0.29	0.35±0.22	0.30±0.21	0.12
Confidence interval	0.25-0.39	0.30-0.39	0.25-0.34	
Immature granulocyte(%)	0.47±0.64	0.48±0.59	0.72±1.44	0.09
Confidence interval	0.32-0.62	0.36-0.60	0.43-1.00	

The results noticed a reduction in the hemoglobin and hematocrit levels indicating the prevalence of anemia in MDRPTB patients. The mean corpuscular hemoglobin (MCH) denoted the hemoglobin carrying capacity of a red cell was also reduced. The mean corpuscular hemoglobin concentration (MCHC) referring to the hemoglobin per unit volume of blood was at the lower end of the reference range denoting the inclination towards hypochromic anemia. The mean corpuscular volume (MCV) implied the size of the red cell was normocytic. From these findings, the red cell and its indices in MDRPTB indicated normocytic, normochromic anemia. The size of the erythrocyte given by RDWSD illustrated the prominence of anisocytosis in severe lung infection of the MDRPTB subjects. The coefficient of variation in the size of the red cell (RDWCV) around MCV observed an increase in the severe lung involvement. An inverse relation observed between the MCV and RDWCV denoting the increase in anisocytosis with the microcytic red cell. Negative correlation of NRBC count observed with hemoglobin, and accompanying indices of RBC implies the anemic, hypoxemic or lung infections (Table 3).

Table 3
Red cell count and its indices in radiological grading of MDRPTB patients

Variable	Mild (71)	Moderate (101)	Severe (99)	P-value
RBC (♂=4.3-5.9*106/µl;♀=3.5-5*106/µl)	4.34±0.70	4.20±0.71	4.44±0.66	0.07
Confidence interval	4.18-4.51	4.06-4.34	4.31-4.57	
HB (♂=14-18g/dl; ♀=12-16g/dl)	11.32±1.91	10.60±1.97	11.01±2.07	
Confidence interval	10.86-11.77	10.21-10.99	10.60-11.42	0.07
Hematocrit (42-54%)	35.95±5.36	33.97±5.43	35.16±5.92	
Confidence interval	34.68-37.22	32.91-35.04	33.98-36.33	0.10
Mean corpuscular volume (76 - 100fl)	83.10±7.68	80.81±8.53	80.16±8.78	0.06

Confidence interval	81.29-84.92	79.13-82.49	78.41-81.90	
Mean corpuscular HB (27-34pg)	26.31±3.18	25.21±3.60	24.86±3.92	0.03*
Confidence interval	25.56-27.07	24.50-25.92	24.08-25.64	
Mean corpuscular HB conc. (31-37g/dl)	31.57±1.45	31.09±1.74	31.21±1.52	0.17
Confidence interval	31.23-31.92	30.75-31.44	30.91-31.52	
RDWSD (40-55fl)	45.01±6.58	45.79±6.58	45.81±7.66	0.53
Confidence interval	43.45-46.57	44.49-47.08	44.29-47.33	
RDWCV (11-15%)	15.01±2.21	15.81±2.56	16.10±2.89	0.04*
Confidence interval	14.48-15.53	15.30-16.31	15.53-16.67	
Nucleated RBC (% per 100 WBC)	0.04±0.10	0.02±0.08	0.02±0.05	0.56
Confidence interval	0.01-0.06	0.01-0.04	0.01-0.03	

The anucleated platelet cells and the platelets per unit volume of blood, plateletcrit increased significantly with the severe lung infection (*P*<0.0001). The mean cell size of the platelets (MPV) is a useful indicator for platelet activation. The MPV reduced in the severe infection an indication for inflammation (*P*=0.01). The large platelet cell (PLCR) in circulation was within the normal limit in all grades of infection but observed a significant difference between mild and moderate infection (*P*=0.03). PLCR count was inversely related to platelet count. The distribution width of the platelets (PDW) reduced in severe lung infection. An acute phase reactant and an indicator for infectious and inflammatory condition, erythrocyte sedimentation rate (ESR) observed an increment in all the patients (Table 4).

Table 4
Platelet, its indices in radiological grading of lung involvement in MDRPTB patients

Variable	Mild (71)	Moderate (101)	Severe (99)	P-value
Platelet count (150-450*10^3/µl)	302.9±92.50	392.3±131.60	417.5±151.70	<0.0001***
Confidence interval	281.0-324.8	366.4-418.1	387.4-447.6	
Dunn's multiple comparison test			Significance	
Mild vs Moderate			***	
Mild vs Severe			***	
Mean platelet volume (8.6-15.5fl)	10.21±1.14	9.70±0.93	9.65±1.45	0.01*
Confidence interval	9.94-10.48	9.51-9.88	9.36-9.94	
Dunn's multiple comparision test			Significance	
Mild vs Moderate			*	

Platelet large cell ratio (11.9-66.9%)	26.08±9.13	22.37±7.06	22.84±8.09	0.03*
Confidence interval	23.92-28.25	20.98-23.76	21.24-24.45	
Dunn's multiple comparision test			Significance	
Mild vs Moderate			*	
Plateletcrit (0.15-0.62%)	0.31±0.09	0.38±0.12	0.40±0.13	<0.0001
Confidence interval	0.28-0.33	0.35-0.40	0.37-0.43	***
Dunn's multiple comparision test			Significance	
Mild vs Moderate			***	
Mild vs Severe			***	
Platelet distribution width (8.3-25fl)	11.28±2.51	10.48±1.77	10.60±2.11	0.10
Confidence interval	10.68-11.87	10.13-10.82	10.18-11.02	
ESR (♂=0-20mm/hr; ♀=0-30mm/hr)	66.62±30.89	71.57±26.54	66.71±25.82	0.27
Confidence interval	59.31-73.93	66.36-76.78	61.58-71.82	

All the hematological parameters observed a weak positive or negative correlation with the radiological grading of lung severity in MDRPTB patients (Table 5).

Table 5
Correlation between chest X-ray and hematological parameters in MDRTB patients

Variable	P-value	CI	r value
White blood cells	<0.0001***	0.15 to 0.38	0.27
Neutrophil	<0.0001***	0.17 to 0.39	0.28
Lymphocyte	<0.0001***	-0.42 to -0.20	-0.32
Monocyte	0.21	-0.19 to 0.04	-0.07
Eosinophil	0.01*	-0.25 to -0.01	-0.14
Basophil	0.77	-0.13 to 0.10	-0.01
Immature granulocyte	0.04*	-0.0005 to 0.24	0.12
Red blood cells	0.27	-0.05 to 0.18	0.06
Hemoglobin	0.44	-0.16 to 0.07	-0.04
Hematocrit	0.49	-0.15 to 0.07	-0.04
Mean corpuscular volume	0.04*	-0.23 to 0.002	-0.11
Mean corpuscular hemoglobin	0.02*	-0.25 to -0.01	-0.14
Mean corpuscular HB conc.	0.15	-0.20 to 0.03	-0.08
RDWSD	0.47	-0.07 to 0.16	0.04
RDWCV	0.01*	0.01 to 0.25	0.14
Nucleated RBC	0.47	-0.16 to 0.07	-0.04
Platelet count	<0.0001***	0.20 to 0.41	0.31
Mean platelet volume	0.04*	-0.24 to -0.001	-0.12
Platelet-large cell ratio	0.07	-0.22 to 0.01	-0.10
Plateletcrit	<0.0001***	0.16 to 0.38	0.28
Platelet distribution width	0.12	-0.21 to 0.02	-0.09
ESR	0.90	-0.12 to 0.11	-0.007

Discussion

A study determining the incidence of TB afflicting both genders recorded and observed male diagnosed more than the female.[12] Similar to this, our study reported more number of male MDRPTB subjects.

The extensive, bilateral lung radiological manifestations noticed in drug resistant tuberculosis. The bronchial dilation, involvement of pleural membrane along with cavity with more than three millimeter size illustrates the drug resistant TB.[13] The present study radiological findings also found thick fibrotic bands, pneumothorax, loss of lung volume corroborated with the above findings. The extensive lung involvement manifested large and small nodular, interstitial opacifications, more number of cavities, bronchiolar dilatation in MDRPTB patients.[14] Lung parenchyma with reticulonodular opacification and large nodular opacifications in alveolar infiltration observed. Similarly, homogenous opacifications reported in a very few MDRPTB patients. Severe lung involvement of all the three zones manifested alveolar infiltration, loss of lung volume, bronchiectatic changes, pneumothorax, hydropneumothorax, fibrotic manifestations.

The reduced MCH and MCHC are distinct features for iron deficiency. The normocytic anemia links to the chronic disease in the subjects rather than malabsorption, hemorrahage, renal dysfunction and red cell lysis.[15] The reduced hemoglobin, normocytic and hypochromic anemia in the present study defines the prevalence of iron deficiency among MDRPTB patients. The severe lung involvement is a testimonial to a negative correlation of RBC indices and hemoglobin in MDRPTB subjects. Being a chronic disease, TB has an impact on the red cell production resulting in reduced HCT and hemoglobin,[16] while the other study observed higher HCT values compared to the control group. Diet plays a prominent role in healthy outcomes among TB patients.[17] The subjects in the present study were mostly from the rural locality and on daily wages define the low socio-economic status having an impact on their health outcome. The study observed significant difference in RDW count and intervening in the stages of moderate and severe extent of lung involvement with a positive correlation. The study attests the RDW as an inflammatory marker and is useful in managing patients with pulmonary tuberculosis along with neutrophil-lymphocyte ratio and platelet-lymphocyte ratio.[18] Existing study also suggested that significant and positive correlation with RDW, the predictor for progression of the inflammation in MDRPTB patients.

In general, infection increases the neutrophil count and reduces the lymphocyte in circulation. Hence, the elevated count of neutrophil identified as a marker of infection and reduced count considered to manage the infection. These cells voluntary predict the infectious disease for their proliferation in the incidence of severe disease.[19] Previous probes observed an association with an increase in neutrophil in severe lung infection. A positive correlation between neutrophils and extent of lung involvement in TB defines the role of neutrophils in pathophysiology of TB.[20] Our study explored the accumulation of neutrophils in the peripheral blood in the severe extent of lung involvement. A preceding study noticed inverse relation of lymphocytes with greater involvement of lung in TB.[21]

Similarity of the findings observed in the present study. The immature granulocytes along with increase in neutrophils count observed with the progression of the infection. Monocytes, the precursors for macrophages play a key role in defending microbial infection.[22] A study observed reduction in the monocytes with the advanced stages of the TB.[23] The ongoing study implied the same in MDRPTB patients with a reduced count of monocytes in severe stages of pulmonary infection.

The studies observed the increase in the platelet count with the severity of lung infection.[24] Studies support the platelets accumulation in the alveoli of the lung and their activation at the later stages of infection due to altered immune responses. The increased platelet count normalizes with the anti-TB therapy.[25] The severity of lung infection increases the platelet count and plateletcrit in the MDRPTB patients. The increase in the platelet count and plateletcrit with a reduced PDW noticed in severe lung infection.[26] Comparable findings recorded in the present study signify the role of platelets in the pathophysiology of TB. PLCR count reduced with advance in lung infection. In general, there exists an inverse relation between MPV and platelet count, this helps in blood hemostasis and normal count of platelets. Various pathophysiological conditions alter the balance between platelet cells and MPV.[27] The increase in the platelet count in active TB denotes with the inflammatory responses. Interleukins and cytokines imbalance the megakaryocyte production leading to the smaller size of platelets.[28] The reduction of MPV in active TB associates with microthrombus formation in the cavitary lesions, which help in reducing the spread of the disease.[29] A study noted a weak correlation of MPV with severe extent of lung injury.[30] MPV significantly correlates with the differences in the radiological findings.[31] Reduction in the MPV with severity of lung infection, negative correlation was observed in the present study. Reporting of ESR in many studies of active TB was high with a positive correlation with the lung infection.[31] In the present study ESR was above the normal levels in all the radiological stages of MDRPTB patients with active disease and observed an insignificant and negative correlation.

Conclusion

The severe lung infection evidences the abnormalities in leucocytes, neutrophils, lymphocytes, RDWCV, MCH, platelet, plateletcrit, MPV and PLCR. The study recommends an examination of the hematological parameters in regular monitoring of the patients for the beneficial treatment outcomes.

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Conflict Of Interest
The authors declare that there is no conflict of interest.

Abbreviations

Conc: Concentration; **CI:** Confidence interval; **ESR:** Erythrocyte sedimentation rate; **HB:** hemoglobin; **RBC:** Red blood cell; Red blood cell distribution width standard deviation; Red blood cell distribution width coefficient of variation; **WBC:** white blood cells; **Units:** fl:femtoliter; **g/dl:** gram per deciliter; **µl:** microliter; **mm/l:** millimeter per liter; **pg:** pictogram; **%:** percentage.

Summary

The study details the findings of hemogram in radiological grading of lung. Severe lung involvement evidenced changes in the parameters leucocytes, neutrophils, lymphocytes, RDWCV, MCH, platelet, plateletcrit, MPV and PLCR. The current work favors regular monitoring of complete blood picture for successful treatment outcomes in drug resistant tuberculosis patients.

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