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# RADIOLOGICAL AND MICROBIOLOGICAL PROFILE OF PULMONARY TUBERCULOSIS IN DIABETICS VERSUS NON-DIABETICS

Respiratory Medicine

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KEYWORDS

## INTRODUCTION

M. tuberculosis is the organism that causes pulmonary tuberculosis (PTB). TB was a worldwide emergency in 1996. [1]

India is home to one-fifth of all cases of tuberculosis worldwide, which is a major issue[2]. In India, the death rate from tuberculosis is approximately 330,000[3]. According to WHO estimates, 9 million people worldwide have active tuberculosis and 1.7 million people die yearly from it. About 0.5 million people in our country die from the disease each year, with an incidence rate of about 2 million[4].

It is commonly recognised that persons with diabetes have a very high prevalence of pulmonary tuberculosis. For the first time, Avicenna noticed pulmonary tuberculosis in individuals with diabetes mellitus [5], a finding that was confirmed by other observers[6]. The risk of tuberculosis is higher in diabetics than in the general population.[7]

Glycated haemoglobin (HbA1C) is the best indicator of sugar control in diabetes and is used to assess treatment compliance and management. The one portion of haemoglobin, known as HbA1C, which reflects glucose levels over the previous three months, binds to glucose enzymatically. Hence, the patient's adherence to anti-diabetic medication is interpreted by their HbA1C level [8].

Chest X-ray is the most frequently ordered modality of investigation for all suspected tuberculosis cases [9]. The patient's immunological condition and length of sickness are the determinants in Chest X-rays of tuberculosis patients. The most common lesions in non-DM TB patients are upper lobe infiltrates, but in TB-DM patients, the lower lung zone is typically affected, exhibiting a confluent pattern with cavitary lesions and a radiological pattern of wedge lesions extending from the margins to the hilum [10, 11].

The most crucial method for diagnosing tuberculosis involves looking for acid-fast bacilli under a microscope on properly stained sputum specimens. The method, which is easy to use and reasonably priced, finds cases of infectious tuberculosis.

## AIM AND OBJECTIVES

### AIM:

To Assess radiological and microbiological profile of Pulmonary Tuberculosis in Diabetics versus Non-Diabetics

### OBJECTIVES:

1. To Grade sputum smear AFB in Pulmonary Tuberculosis patient.
2. To Compare the AFB grading of Pulmonary Tuberculosis in Diabetics versus Non-diabetics
3. To Compare the Chest X-ray Manifestations in Diabetic versus Non-diabetic patients of tuberculosis.
4. To Clinically evaluate features of Pulmonary Tuberculosis in Diabetics and non-Diabetic.

## MATERIAL AND METHODS

### Study Area:

This study was conducted in Respiratory Medicine Department of a tertiary care centre, Rajshree Medical Research Institute, Bareilly

### Study Population:

The prospective study was carried out on patients coming with Pulmonary Tuberculosis in Department of Respiratory Medicine. The study was conducted after approval from institutional scientific and ethical committee review board.

### Study Design:

A Hospital Based Prospective observational study

### Inclusion Criteria:

1. Diagnosed cases of pulmonary tuberculosis
2. Either gender with age of >15 years
3. Type 2 diabetics and non-diabetics

### Exclusion Criteria:

1. Old pulmonary TB cases
2. Drug resistant TB
3. Extra-pulmonary TB
4. Pregnancy
5. Not giving informed consent
6. Co-morbid conditions and immune suppressive like HIV, CKD, CLD, Malignancy.

### Sample Size:

All patients who are diagnosed as a case of TB-DM during study period in department of respiratory medicine RMRI, Bareilly, fulfilling the inclusion and exclusion criteria and are willing to participate in this study.

A total of 100 cases of TB with diabetes and 100 non diabetic TB cases were taken up for the study.

### Methodology:

Study was commenced after approval from IEC. Patients presenting with symptoms such as cough, fever, chest pain and/or haemoptysis, suggesting tuberculosis as a differential were advised chest radiograph (postero -anterior view) and sputum for AFB and CBNAAT.

Every positive sputum smear case was examined further. A patient who has had one or more initial sputum smear examinations that are positive for acid-fast bacilli is considered a new sputum smear-positive case [19]. All study participants gave their informed consent for the necessary investigations and the study's objectives.

Demographic information, respiratory symptoms, and diabetes-related symptoms were all part of the baseline data that was collected. Additionally, the patient's TB status was meticulously recorded, including information on past and present treatments.

The patients were directly enrolled in the trial as known cases of DM with TB, as they were already known to have DM. In order to screen for

diabetes mellitus (DM) in other sputum smear positive cases, their FBS, PPBS, and HbA1c levels were subjected to derangement in RBS (if RBS more than 200 mg/dl). The American Diabetic Association's (ADA) guidelines 2022 for the screening and diagnosis of diabetes mellitus (DM) stated that FBG >= 126 mg/dl or PPBS >= 200 mg/dl implies diabetes [20].

New DM cases with TB were classed as positive cases.

Sputum Smear Microscopy [33]
The most crucial method for diagnosing tuberculosis involves looking for acid-fast bacilli under a microscope on properly stained sputum specimens. The method, which is easy to use and reasonably priced, finds cases of infectious tuberculosis. Additionally helpful in determining whether a patient has recovered or not at the conclusion of treatment is sputum microscopy for evaluating response to treatment. Methylene blue counterstain, acid alcohol decolorizer, and carbolic fuchsin stain are the tools used in the Ziehl-Neelsen technique. Organisms that are acid-fast dye red, while debris-covered backgrounds dye blue. The acid-fast ability of mycobacteria is validated by the ZN stain.

Procedure for Ziehl-Neelsen Staining
1. Apply primary stain of carbolfuschin for 30 seconds
2. Heat fix cells to the slide using flame
3. Decolourize with acid alcohol for 15-20 seconds
4. Apply counterstain of methylene blue for 30 seconds then rinse excess stain

**Result:**
AFB: Pink or red bacillus Background: Blue (If counter stain is malachite green, background will be green.)

**Reporting:**
International Union Against Tuberculosis and Lung Disease (IUATLD):

No organism seen- Negative
1-9/100 OIF: Exact number
10-99/100 OIF: +
1-10/OIF: ++
>10/OIF: +++

## RESULTS

**Table 1. Distribution Of Study Subjects As Per Diabetic Status**

| Diabetes | N | % |
|---|---|---|
| Yes | 100 | 50.0% |
| No | 100 | 50.0% |
| Total | 200 | 100.0% |

Study included 100 cases of diabetes and 100 non diabetic controls.

**Table 2. Mean Age Comparison Between Diabetics And Non-diabetics**

| Variable | Diabetes | N | Mean | SD | p- value |
|---|---|---|---|---|---|
| Age (yrs) | Yes | 100 | 54.32 | 9.93 | <0.01 |
| | No | 100 | 49.81 | 11.11 | |

Mean age of the TB cases was 52.07 years with 33.5% cases between the age of 41-50 years, 36% between age of 51-60 years and 15% above 60 years respectively. Mean age of the diabetic cases was significantly more than non-diabetic control (54.32 vs 49.81 years; p<0.01).

**Table 3. Gender Comparison Between Diabetics And Non-diabetics**

| Gender | Diabetes | | Total |
|---|---|---|---|
| | Yes | No | |
| Female | 15 | 20 | 35 |
| | 15.0% | 20.0% | 17.5% |
| Male | 85 | 80 | 165 |
| | 85.0% | 80.0% | 82.5% |
| Total | 100 | 100 | 200 |
| | 100.0% | 100.0% | 100.0% |
| p-value - 0.32 | | | |

Overall male predominance was seen among tuberculosis cases with 82.5% males to 17.5% females.

**Table 4. Comparison Of Smoking History Between Diabetics And Non-diabetics**

| Smoking | Diabetes | | Total |
|---|---|---|---|
| | Yes | No | |
| Yes | 30 | 40 | 70 |
| | 30.0% | 40.0% | 35.0% |
| No | 70 | 60 | 130 |
| | 70.0% | 60.0% | 65.0% |
| Total | 100 | 100 | 200 |
| | 100.0% | 100.0% | 100.0% |
| p-value - 0.18 | | | |

Smoking history was given by 35% of tuberculosis cases in present study with no difference between diabetic cases and controls (p-0.18).

**Table 5. Distribution Of Presenting Symptoms Among Diabetics And Non-diabetics**

| Symptoms | Diabetes | | Total | p- value |
|---|---|---|---|---|
| | Yes | No | | |
| Cough | 100 | 100 | 200 | NA |
| | 100.0% | 100.0% | 100.0% | |
| Fever | 77 | 74 | 151 | 0.62 |
| | 77.0% | 74.0% | 75.5% | |
| Night Sweats | 75 | 71 | 146 | 0.52 |
| | 75.0% | 71.0% | 73.0% | |
| Shortness of breath | 58 | 48 | 106 | 0.20 |
| | 58.0% | 48.0% | 53.0% | |
| Chest Pain | 36 | 28 | 64 | 0.29 |
| | 36.0% | 28.0% | 32.0% | |
| Hemoptysis | 23 | 5 | 28 | <0.01 |
| | 23.0% | 5.0% | 14.0% | |
| Loss of Appetite | 73 | 69 | 142 | 0.64 |
| | 73.0% | 69.0% | 71.0% | |
| Loss of Weight | 72 | 65 | 137 | 0.28 |
| | 72.0% | 65.0% | 68.5% | |

Most common presenting symptom among tuberculosis cases was cough (100%) followed by fever (75.5%), night sweats (73%) and loss of appetite (71%). Hemoptysis cases were observed more in diabetic group (23% vs 5%). Apart from this, no difference with regards to clinical presentation was observed between diabetics and non-diabetics respectively (p>0.05).

**Table 6. Mean Glycemic Indices In Diabetics**

| Glycemic Indices | N | Mean | SD |
|---|---|---|---|
| RBS | 100 | 199.85 | 27.35 |
| FBS | 100 | 151.70 | 23.88 |
| 2-h post-prandial | 100 | 172.18 | 26.25 |
| HbA1c | 100 | 7.83 | 0.83 |

Mean random blood sugar in diabetic cases was 199.85 mg% while fasting and post-prandial blood sugar was 151.7 and 172.18 mg%. Mean glycated hemoglobin level was 7.83 gm%.

**Table 8. Distribution Of Cases As Per Side Involved In Chest X-ray**

| Side Involved | Diabetes | | Total |
|---|---|---|---|
| | Yes | No | |
| B/L | 20 | 11 | 31 |
| | 20.0% | 11.0% | 15.5% |
| Left | 43 | 47 | 90 |
| | 43.0% | 47.0% | 45.0% |
| Right | 37 | 42 | 79 |
| | 37.0% | 42.0% | 39.5% |
| Total | 100 | 100 | 200 |
| | 100.0% | 100.0% | 100.0% |
| p-value - 0.211 | | | |

Bilateral lung involvement was seen in 20% diabetics and 11% non-diabetics. Overall no difference was observed between cases and controls with regards side of lung involvement (p-0.211).

**Table 9. Distribution Of Cases As Per Zones Of Lung Involvement**

| Zones involved | Diabetes | | Total |
|---|---|---|---|
| | Yes | No | |
| All | 4 | 0 | 4 |
| | 4.0% | 0.0% | 2.0% |

| | | | |
|---|---|---|---|
| Lower | 39 | 7 | 46 |
| | 39.0% | 7.0% | 23.0% |
| Lower & Middle | 18 | 13 | 31 |
| | 18.0% | 13.0% | 16.5% |
| Middle | 0 | 6 | 6 |
| | 0.0% | 6.0% | 3.0% |
| Upper | 36 | 66 | 102 |
| | 36.0% | 66.0% | 51.0% |
| Upper & Middle | 3 | 8 | 11 |
| | 3.0% | 8.0% | 5.5% |
| Total | 100 | 100 | 200 |
| | 100.0% | 100.0% | 100.0% |
| p-value <0.01 | | | |

Overall lower and lower middle lobe involvement was observed to be more among diabetic cases (57% vs 20%) as compared to upper and upper middle (39% vs 74%). The difference was statistically significant (p<0.01).

**Table 10. Association Of Glycemic Control In Diabetics With Involvement Of Lung Zones**

| Lung Zones involved | Glycemic Control | | | Total |
|---|---|---|---|---|
| | Good | Moderate | Poor | |
| All | 0 | 0 | 4 | 4 |
| | 0.0% | 0.0% | 9.3% | 4.0% |
| Lower | 3 | 18 | 18 | 39 |
| | 15.8% | 47.4% | 41.9% | 39.0% |
| Lower Middle | 3 | 3 | 12 | 18 |
| | 15.8% | 7.9% | 27.9% | 18.0% |
| Upper | 13 | 17 | 6 | 36 |
| | 68.4% | 44.7% | 14.0% | 36.0% |
| Upper & Middle | 0 | 0 | 3 | 3 |
| | 0.0% | 0.0% | 7.0% | 3.0% |
| Total | 19 | 38 | 43 | 100 |
| | 100.0% | 100.0% | 100.0% | 100.0% |
| p-value <0.01 | | | | |

A significant association was observed between glycemic control and lung zones involved. Cases with poor and moderate glycemic control have more involvement of lower zones while cases with good control, had more involvement of upper zones (p<0.01).

**Table 11. Distribution Of Cases As Per Presence Of Cavitation**

| Cavitation | Diabetes | | Total |
|---|---|---|---|
| | Yes | No | |
| Yes | 63 | 26 | 89 |
| | 63.0% | 26.0% | 44.5% |
| No | 37 | 74 | 111 |
| | 37.0% | 74.0% | 55.5% |
| Total | 100 | 100 | 200 |
| | 100.0% | 100.0% | 100.0% |
| p-value <0.01 | | | |

Significant higher proportion of diabetics present with lung cavitation as compared to non-diabetics (63% vs 26%; p<0.01).

**Table 17. Distribution Of Cases As Per Sputum AFB Grading**

| Sputum AFB Grade | Diabetes | | Total |
|---|---|---|---|
| | Yes | No | |
| 1+ | 35 | 33 | 68 |
| | 35.0% | 33.0% | 34.0% |
| 2+ | 25 | 26 | 51 |
| | 25.0% | 26.0% | 25.5% |
| 3+ | 40 | 41 | 81 |
| | 40.0% | 41.0% | 40.5% |
| Total | 100 | 100 | 200 |
| | 100.0% | 100.0% | 100.0% |
| p-value - 0.956 | | | |

No difference was observed among diabetics and non-diabetics with regards to sputum AFB grading (p-0.956).

## DISCUSSION:-

In developing nations, diabetes is becoming more common along with the prevalence of tuberculosis. It is commonly known that these two illnesses are related. In this hospital-based study, our goal was to examine the AFB grading and chest x-ray symptoms of pulmonary tuberculosis in diabetics with non-diabetics, as well as across different degrees of glycemic control in diabetics. There were 100 diabetic cases and 100 non-diabetic controls in the study. Evaluations of glycosylated haemoglobin (HbA1c) were also performed on each of the DM cases. All patients had their chest radiographs taken and interpreted independently by licensed pulmonologists. Based on criteria established by the American Thoracic Society (ATS), radiological lesions identified on a chest X-ray were categorised as minor, moderately progressed, or far advanced.

### Baseline Data:

The average age of the tuberculosis cases was 52.07 years, with 33.5% of cases falling within the age range of 41 to 50, 36% falling between 51 and 60, and 15% falling over 60. The diabetic cases' mean age (54.32 vs. 49.81 years; p<0.01) was substantially higher than that of the non-diabetic control group. In instances of tuberculosis, there was an overall male predominance of 82.5% compared to 17.5% females.

Among the 280 tuberculosis cases that Sangral R et al. [14] examined, 183 (65.3%) were male and 97 (34.6%) were female. Of the patients, around two thirds (58%) belonged to the productive age range of 31 to 60 years. 75 TB cases were examined by Kavalikai SS et al. [15]. According to the statistics, the male to female ratio was 5.25:1, meaning that 84% of the patients were male. Ages 31 to 50 made up the largest age group (45%). The demographic distribution of the current study was similarly consistent with those of other earlier investigations on individuals with tuberculosis [16, 17].The mean age of the diabetic cases in the Presnet trial was substantially higher (p<0.01) than the non-diabetic control group (48.2 vs. 39.3 years). Perenz-Guzman et al. [67] also noted that patients with TB-DM had an average age of 51.3 ± 0.9 years, compared to 44.9 ± 1.8 years for the TB group. The findings of the Yurteri G et al. [2] study also suggest that diabetes patients are more likely to develop tuberculous disease later in life.

### Chest X-ray Findings:

Studies comparing radiography in diabetics with TB have also shown conflicting findings. These individuals' chest radiograph images have been labelled as "atypical" in a number of published studies, mostly due to the fact that they usually show cavities in the lower lung fields.In the current investigation, it was shown that diabetes subjects had higher lower and lower middle lobe involvement (57% vs. 20%) compared to upper and upper middle (39% vs. 74%). A statistically significant difference was observed (p<0.01). Compared to non-diabetics, a significantly larger percentage of diabetics (63% vs. 26%; p<0.01) have lung cavitation. When compared to controls, a greater percentage of diabetic individuals with lung cavitation have numerous cavitations (26% vs. 7%; p<0.01). Diabetics were shown to have a higher overall radiological lesion severity when compared to controls. In comparison to 10% of controls, 35% of patients had far-advanced lesions, whilst 22% and 38% of cases had intermediate lesions. Mild lesions were frequently seen in non-diabetics (68% vs 27%; p<0.01)

Perenz-Guzman et al. [67] found that patients with tuberculosis-related diabetes mellitus (TB-DM) exhibited a lower (19% vs. 7%) and upper and lower (64% vs. 36%) lung field lesion frequency, respectively, compared to upper (17% vs. 56%) individuals. In the lower lung areas (29% vs. 3%), cavitations occurred more frequently in TB-DM patients (82% vs. 59%). All patients with diabetes mellitus and pulmonary TB were reviewed by Jabbar A et al. [3]. Most often, the lower lung field was affected, then the upper and intermediate lung fields. Half of the patients had bilateral involvement, and one-third had a pleural effusion in addition. 15% of women and 32% of men had cavitating lesions. Chiang CY et al. [5] found that TB patients with DM had a considerably higher likelihood of having opacity over lower lung fields, extensive parenchymal lesions, any cavity, numerous cavities, and large cavities (>3 cm) in comparison to those without DM. In comparison to the non-diabetic population, the Burney S et al. [7] investigation found that radiological alterations were more often abnormal in the diabetes group (21/33 or 63.6% vs. 8/42 or 19%). Large non-cavitary nodules, many cavities in a single lesion, odd locations, and full lobe involvement of lesions on thoracic CT scans were more common in DM patients as compared to non-DM patients, according to Huang LK et al. [8].

### Glycemic Control & Chest X-ray Findings:

There was a noteworthy correlation seen between the lung zones implicated and glycemic control. Lower zones are more involved in instances with poor and moderate glycemic control, whereas upper

zones are more involved in patients with high control (p<0.01). Among patients with good and moderate glycemic control, lung cavitation was seen in 47.4% and 44.7% of cases, respectively, but in those with poor control, the percentage was 86%. A statistically significant correlation was found (p<0.01). In instances with good and moderate glycemic control, far advanced lesions were found in 26.3% and 13.2% of the cases, respectively, whereas in cases with poor control, the percentage was 58.1% (p<0.01).

According to Chiang CY et al. [5], patients with DM with an A1C of less than 7% had a relative risk of 0.80 for lower lung field opacities, 2.32 and 1.62 for A1C: 7-9 and >9%; similarly, patients with DM with an A1C of less than 7% had a relative risk of 0.87 for any cavity versus none at all, 1.84 for A1C 7%–9%, and 3.71 for A1C>9%, in comparison to those without DM. The study found that, "in patients with DM, glucose management had a substantial impact on the radiographic signs of pulmonary tuberculosis". According to Avuthu S et al. [6], "patients with poorly controlled blood sugar (HbA1c 7%) also had a higher probability of far advanced lesions (40% vs. 4%; P 0.001), lower lung area involvement (29.8% vs. 13.04%; P 0.01), and cavitary disease (76.6% vs. 43.4%; P 0.05) on chest radiographs".

In contrast to 11/21 (52.3%) patients with optimal glucose control, or HbA1c<7%, Burney S et al.'s [7] study found that nine out of the 12 (75%) diabetic patients with poor glycemic control—that is, those with HbA1c levels >7%—had cavitations, lower zone involvement, and bilateral changes. This difference was statistically significant (p-value<0.01). The study found that abnormal results on a chest X-ray in cases of pulmonary tuberculosis are associated with poor glycemic management. None of the members of the excellent glycemic group developed lower zone lesions, according to Saalai KM et al.'s study [11]. Non-homogenous opacity was the most prevalent kind of lesion, with cavities following in both the excellent and poor glycemic groups. Lower zones were typically where cavities were found. Since the glycemic control is inadequate, the size and number of cavities were greater. Huang LK et al. [8] found that patients with HbA1c > 8% had a higher probability of exhibiting uncommon abnormalities (P < 0.001), lymphad-enopathy (P = 0.028), far advanced extensive lesions (P < 0.001) on CXRs, many cavities in a single lesion (P < 0.001), and involvement of all lobes (P = 0.041) on thoracic CT scans.

**Sputum AFB:**

In the current study, 35% of diabetics and 33% of non-diabetics had grade 1+ sputum positivity, whereas 40% and 41% of cases had grade 3+ sputum smear positivity. Regarding sputum AFB grading, there was no difference between diabetics and non-diabetics (p-0.956). Similarly, there was no change in the sputum AFB grading across diabetic subjects with good, moderate, and poor glycemic control (p-0.083). Not a single member of the group displayed resistance.

The features of 505 participants without diabetes mellitus (PTB group) and 187 patients with the disease (PTB-DM group) were compared by Singla R et al. [4]. When sputum smear examination was performed, 65.2% of patients in the PTB-DM group showed many acid-fast bacilli (AFB), compared to 54.1% in the control group (P = 0.08). The rates of resistance and treatment outcomes were similar in the two groups (P = 0.7005). The study conducted by Farrag MA et al. [9] found no distinction in smear positivity between diabetics and controls. Nevertheless, patients with DMTB exhibited a delayed smear conversion and response to treatment when compared to patients with pulmonary TB alone. A substantial (p=0.042) and strong (r=1) connection between the HbA1C level and the extent of pulmonary tuberculosis lesion was discovered by Soerono LU et al. [10]. It was determined that in patients with Type 2 DM, there is a substantial correlation between the HbA1C level and chest radiography images of pulmonary tuberculosis.In contrast to our results, Saalai KM et al. [11] found that there was a statistically significant increase in sputum smear grade in diabetics, particularly in patients with higher HbA1c. In addition, diabetic TB patients had more acid-fast bacilli on sputum microscopy (3+ in 56%) than non-diabetic TB patients (1+ and 2+). These findings were reported by Mood N et al. [12].

In summary, the results of this study indicate that instances of diabetes are distinguished by atypical radiological manifestations, such as increased involvement of the middle and lower lobes relative to the top lobes in non-diabetic. Diabetics were also shown to have a higher prevalence of cavitation and severe radiological abnormalities. Patients with severe and cavitary lesions are more likely to have poorly controlled blood glucose levels. There was no appreciable difference between the AFB sputum grading and resistance pattern between the diabetes and non-diabetic groups.

## CONCLUSION

Present study observed that cases of diabetes present with atypical radiological presentations i.e. more involvement of middle and lower lobes as compared to upper lobes in non-diabetic cases. We also observed higher prevalence of severe lesions and cavitation among diabetics. Among diabetics, cases with poor glycemic control are more prone to sever lesions and cavitation and present with these atypical presentations. No difference was observed among cases and controls in terms of AFB sputum grading and pattern of resistance.

## REFERENCES:-


1. World Health Organization. Global tuberculosis control: epidemiology, strategy, financing: WHO report 2009. World health organization; 2009.
2. Bhargava A, Pinto L, Pai M. Mismanagement of tuberculosis in India: Causes, consequences, and the way forward. Hypothe-sis 2011:9(3):7-12.
3. Schaberg T, Rebhan K, Lode H. Risk factors for side-effects of isoniazid, and pyrazinamide in patients hospitalized for pul-monary tuberculosis. Eur Respir J 1996; 9:2026-30.
4. Parthasarathi G, Hansen KN, Nahata MC. Textbook of clinical pharmacy practice. India: Universities press private Ltd; 2004. pp. 104-22.
5. Avicenna - quoted by H.P. Root and W.R. Bloor. Am. Rev. Tubercie., 1939;39:714.
6. Younger, D. Infections and diabetes. Med. Clin. North Am., 1965;49: 1005-13.
7. Nichols, G.P. Diabetes among young tuberculosis patients: a review of the association of the two diseases. Am. Rev: Tubercle., 1957;76:1016-30.
8. Higgins T. HbA1c for screening and diagnosis of diabetes mellitus. Endocrine. 2013; 43(2):266–73.
9. Ralph AP. A simple, valid, numerical score for grading chest x-ray severity in adult smear-positive pulmonary tuberculosis. Thorax. 2010; 65(10):863–9
10. Patel AK, Rami KC and Ghanchi FD. Radiological presentation of patients of pulmonary tuberculosis with diabetes mellitus. Lung India? 2011;28(1):70
11. Rami H Fiona P Critchley JAand Laith J. 2017. Association between diabetes mellitus and active tuberculosis: A systematic review and meta-analysis. PLoS ONE. 2017; 12(11):187-96.
12. Chiang C-Y, Lee J-J, Chien S-T, Enarson DA, Chang Y-C, Chen Y-T, et al. Glycemic Control and Radiographic Manifestations of Tuberculosis in Diabetic Patients. PLoS ONE 2014; 9(4): 93-97.
13. Soerono LU, Soewondo W. The Correlation of Chest Radiographic Image of Pulmonary Tuberculosis in Type 2 Diabetes Mellitus Patients with HbA1C Level. KnE Life Sciences. 2019;25:45-51.
14. Burney S, Khan OA, Zafar SI. Effect of Glycemic Control on Radiological Manifestations of Pulmonary Tuberculosis–A Hospital Based Study. Journal of Islamic International Medical College (JIIMC). 2016;11(2):52-6.
15. Avuthu S, Mahishale V, Patil B, Eti A. Glycemic control and radiographic manifestations of pulmonary tuberculosis in patients with type 2 diabetes mellitus. Sub-Saharan Afr J Med. 2015; 2: 5-9.
16. Saalai KM, Mohanty A. The effect of glycemic control on clinico-radiological manifestations of pulmonary tuberculosis in patients with diabetes mellitus. Int J Mycobacteriol 2021;10:268-70.
17. Alavi SM, Khoshkho MM, Salmanzadeh S, Eghtesad M. Comparison of epidemiological, clinical, laboratory and radiological features of hospitalized diabetic and non-diabetic patients with pulmonary tuberculosis at razi hospital in ahvaz. Jundishapur journal of microbiology. 2014;7(9):11-15.
18. H. Herzog. History of Tuberculosis. Respiration 1998;65:5–15.
19. Flick LF. Development of our knowledge of tuberculosis. Philadelphia: Wickersham;1925.
20. Rubin SA. Tuberculosis. The Captain of all these men of death. Radiol Clin North Am 1995;33:613-39.
21. Rosenblatt MB. Pulmonary tuberculosis: evolution of modern therapy. Bull NY Acad Med 1973;49:163-96.
22. Dubos R, Dubos J. The white plague. Tuberculosis, man and society. Boston: Little Brown and Company;1952.
23. Waksman SA. The conquest of tuberculosis. Berkeley and Los Angeles: University of California Press; 1964.
24. Pearce-Duvet J. The origin of human pathogens: evaluating the role of agriculture and domestic animals in the evolution of human disease. Biol Rev Camb Philos Soc 2006;81:369–82.
25. Ernst JD, Trevejo-Nuñez G, Banaiee N. Genomics and the evolution, pathogenesis, and diagnosis of tuberculosis. J Clin Invest 2007;117:1738–45.
26. Keers RY. Pulmonary Tuberculosis: A Journey Down the Centuries. London, Baillière-Tindall;1978.
27. R N Doetsch. Benjamin Marten and his new theory of consumptions. Microbiol Rev. 1978;42:521–28.
28. Daniel TM. The history of tuberculosis. Respir Med 2006;100:1862-70.
29. Sakula A. Robert Koch: Centenary of the Discovery of the Tubercle Bacillus, 1882. Can Vet J. 1983;24:127–31.
30. Sakula A, Forlanini C. Inventor of artificial pneumothorax for treatment of pulmonary tuberculosis. Thorax 1983;38:326-32.
31. World Health Organization. 47th World Health Assembly: Provisional agenda item 19. Tuberculosis programme - Progress report by the Director-General, Geneva: WHO; 1994.
32. Raviglione MC, O'Brien RJ. Tuberculosis. In, Fauci AS (ed.). Harrison's principles of Internal Medicine, 17th edition, New York, The McGraw-Hill Companies, Inc., 2008;1006-20.
33. Van Deun A, Salim AH, Cooreman E, Hossain MA, Rema A, Chambugonj N, Hye M, Kawria A, Declercq E. Optimal tuberculosis case detection by direct sputum smear microscopy: how much better is more?. The International Journal of Tuberculosis and Lung Disease. 2002 Mar 1;6(3):222-30.
34. A. K. Niazi and S. Kalra, "Diabetes and tuberculosis: a review of the role of optimal glycemic control," Journal of Diabetes and Metabolic Disorders, vol. 11, no. 1, article 28, 2012.
35. C. R. Stevenson, J. A. Critchley, N. G. Forouhi et al., "Diabetes and the risk of tuberculosis: A neglected threat to public health?" Chronic Illness, vol. 3, no. 3, pp. 228–245, 2007.