

LOWER LUNG FIELD TUBERCULOSIS: AN ANALYSIS OF 146 CASES

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ABSTRACT

Medical records of 146 patients with lower lung field tuberculosis were reviewed. There was a female to male ratio of 5: 4. More than 75% of patients were under 35 years of age and average duration of symptoms before diagnosis was less than one month in 7%, between 1-6 months the in 63% and more than 12 months in 10% of our patients. PPD test was positive in 80% and direct sputum smear for acid-fast bacilli was positive in 88% of cases. Radiologically, tuberculous lesion was limited to right lower lobe (RLL) alone in more than 50%, left lower lobe (LLL) alone in 35%, while bilateral lower lobe involvement was found in 15% of our patients. Superior segments of right and left lower lobes were the most commonly involved segments respectively. Pulmonary infiltrates were nonhomogenous in more than 80% of cases while homogenous pneumonia-like consolidations were found in 15% of our series. 66% of patients had cavitary changes with air-fluid levels in 20%. Hilar adenopathy alone or in combination with paratracheal adenopathy was found in chest x-rays of 9% of cases. Fasting and two hour postprandial blood sugars were measured in 98 patients. Seven (7.1%) had overt diabetes mellitus and all of them were diabetic at the time of diagnosis of tuberculosis. Five pregnant women, a medical student, a radiology technician, an old male with metastatic carcinoma of unknown primary origin under chemotherapy, a middle-aged woman with rheumatic heart disease (mitral stenosis) who acquired tuberculosis of superior segment of RLL after valve replacement, an old female with rheumatoid arthritis on nonsteroid anti-inflammatory agents, a male with history of alcohol intake, a young male with alopecia totalis and a young female with tuberous sclerosis were included among our patients.

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INTRODUCTION

Post-primary pulmonary tuberculosis most commonly involves the upper lobes.¹⁻³ This is attributed to higher oxygen tension and impairment of lung clearance mechanisms in these areas.²⁻⁴ Lower lung field tuberculosis without upper lobe involvement has been reported in several studies.⁵⁻¹²

Most series report that lower lung field tuberculosis occurs in 1-7% of patients with post-primary pulmon-

ary tuberculosis.^{6,9-12} According to previous studies, the following conditions occur more frequently in patients with lower lung field tuberculosis than in the general tuberculous population: diabetes mellitus, pregnancy, advanced age, malignancies and advanced liver and renal diseases.^{5,9,12-14} Because of high prevalence of tuberculosis in our country and when tuberculosis is confined to the lower lung fields it often masquerades as pneumonia, bronchiectasis or bronchogenic carcinoma thus delaying the correct diagno-

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Table I. Diagnostic procedures in 146 patients with lower lobe tuberculosis

Diagnostic procedure	Number of patients (N)	percent (%)
-Sputum stain positive for AFB	129(60)	88.3
-Sputum culture positive for AFB but sputum stain negative for AFB	6	4.1
-Bronchial washing positive for AFB	6	4.1
-Caseating granuloma in biopsy specimens taken by transbronchial method	4	2.7
-Culture of pus drained from a cervical sinus positive for AFB	1	0.6

* sputum culture done in 60 of 129 patients with positive sputum stain, all were positive for *Mycobacterium tuberculosis*.

sis. we have analysed 146 adult patients with tuberculosis confined to the lower lung fields, including 10 case reports.

MATERIALS AND METHODS

Lower lung field tuberculosis is defined as tuberculous disease confined to the right middle lobe, lingula and lower lobes without concomitant upper lobe involvement. In this study, medical records of 146 patients with lower lung field tuberculosis were reviewed retrospectively. Our criteria for patient selection were as follows: (1) lower lung field localization of tuberculous lesion radiologically, (2) presence of acid-fast bacilli on direct smears prepared from patients' sputum or bronchial washing and/or positive culture for *Mycobacterium tuberculosis*, or (3) presence of caseating granuloma in histopathologic examination of tissue specimens obtained by transbronchial biopsy. 146 patients who met these criteria were included for analysis. The medical records of these patients were reviewed and age group, sex, duration of symptoms before diagnosis, tuberculin test result (PPD) radiological changes, concomitant diseases and predisposing conditions to lower lung field tuberculosis were recorded.

RESULTS

From 146 patients with lower lung field tuberculosis analysed in this study, 82 (56.2%) were female and 64 (43.8%) were male, with a female to male ratio of 5:4. 77 (52.7%) patients in this series belonged to the age groups of 15-24 and more than 75% of cases were under 35 years of age. Only one of our patients was over 65 years of age. The most common symptoms were cough,

Table II. Radiologic pattern of tuberculous lesions in 146 patients with lower lobe tuberculosis

Radiologic pattern	Number of patients (N)	percent (%)
Nonhomogenous infiltrations	119	81.5
Homogenous pneumonia-like lesions	23	15.7
Tumor-like lesions	2	1.3
Cystic	2	1.3

sputum, chest pain, fever, weight loss, anorexia and hemoptysis. Duration of symptoms before definitive diagnosis had been recorded in only 102 patients and was less than one month in 6.8%, between 1-6 months in 63.6% and more than 12 months in 10.7% of patients.

Result of tuberculin skin test (PPD) was available from 96 patients which was 10 mm or more in 76 (79.1%) and less than 10mm in the remainder (20.8%). Direct sputum smear examination for acid-fast bacilli was positive in 129 (88.3%) patients. Sputum culture for *Mycobacterium tuberculosis* had been done in 60 cases and reported to be positive in all instances. In six (4.1%) smear-negative patients, positive sputum culture led to diagnosis. In another 10 (6.8%) patients, direct study of bronchial wash or histopathologic examination of biopsy specimens taken through bronchoscopy resulted in definitive diagnosis. In one patient with left lower lobe infiltration and a cervical draining sinus tract due to tuberculous adenitis, staining of draining pus was reported positive for acid-fast bacilli (Table I).

Radiologically, right and left lower lobes alone were involved in 74 (50.6%) and 50 (34.2%) patients, respectively. In the remaining 22 (15%) cases, both lower lobes were involved simultaneously. Superior segment of right lower lobe was the most commonly involved segment, followed by the superior segment of the left lower lobe, with or without simultaneous involvement of basal segments.

Only in a few patients the tuberculous lesion was limited to a single basal segment. The radiologic findings in lower lung field tuberculosis differ significantly from those found in upper lobe disease and often resemble viral or bacterial pneumonia. Twenty-three (15.7%) of our patients had extensive confluent (homogenous pneumonia-like) consolidation (Fig. 1), 119 (81.5%) patchy (nonhomogenous) infiltrates (Fig. 2), two had tumor-like lesions and in another two patients, the x-ray findings were cystic lesions (Table II). One of these cysts was a tension cyst. In 97 (66.4%) patients, there were cavitary changes within the tuberculous lesions, with air-fluid levels (Fig. 3) in 29 (19.8%). Pleural reaction and thickening were detected in chest x-rays of 23 (15.7%) cases. Hilar adenopathy (Fig. 4) alone or with simultaneous paratracheal

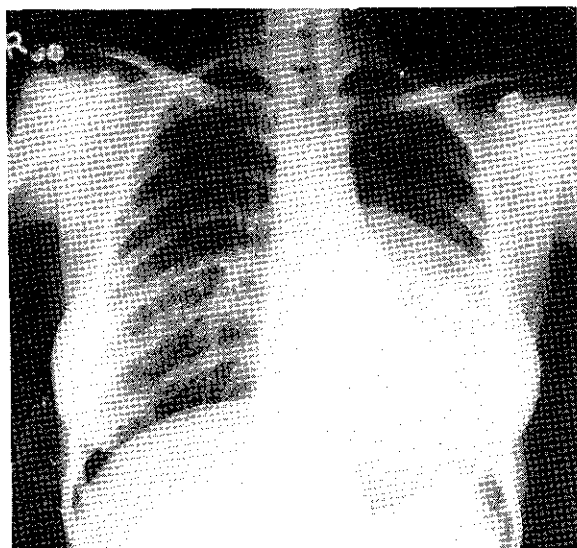


Fig.1. Extensive confluent (homogenous) pneumonia-like consolidation in the left lower lobe.

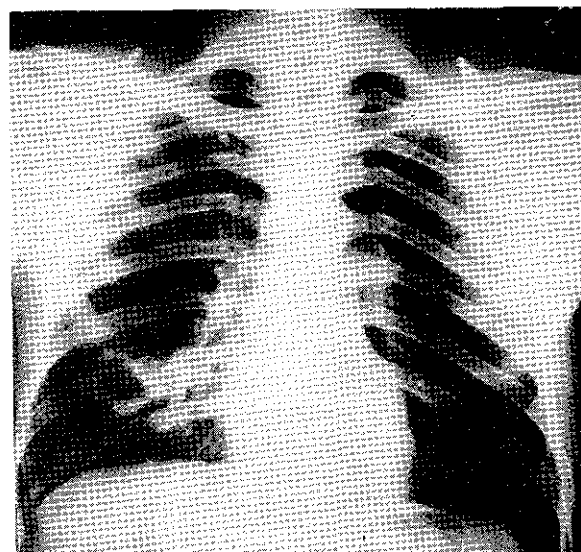


Fig.2. Nonhomogenous infiltrate with cavitary changes in the right lower lobe.

adenopathy was present in chest radiography of 13 (8.9%) patients. Also chest x-rays of 122 (83.5%) patients were positive for old parahilar calcifications compatible with primary tuberculous infection.

In 98 patients, fasting and two-hour postprandial blood sugars were measured. In one group, blood sugar measurement had been done at the time of diagnosis of tuberculosis and before treatment, while in another group blood sugar was measured after completion of treatment. seven (7.1%) patients had overt diabetes mellitus when their tuberculosis was diagnosed for the first time. There was no diabetic patient among the group whose blood sugar was measured after recovery from tuberculosis.

Five pregnant women, a medical student, a radiology technician, a man with history of metastatic carcinoma of unknown primary origin under chemotherapy, a woman with rheumatic heart disease (mitral stenosis) who acquired tuberculosis of superior segment of right lower lobe after valve replacement, an old female with rheumatoid arthritis on non-steroid anti-inflammatory agents, a young male with history of alcohol intake, another young man with alopecia totalis and a young female known case of tuberous sclerosis, were included among our patients.

DISCUSSION

Mycobacterium tuberculosis enters the body primarily through inhalation of droplets. In areas with high prevalence of tuberculosis including our country, this happens during childhood. Since lower lung lobes are ventilated better than upper lobes, the primary infection localizes in one or more segments of middle or

lower lobes and results in regional lymphadenopathy. In more than 90% of children, the primary infection is healed with resultant calcified foci within lung parenchyma and involved lymph nodes which later can be seen in chest radiography of some patients. During primary tuberculous infection, tubercle bacilli are disseminated in the body. Depending upon the individual body resistance, either bacilli are eliminated or become dormant. Later, when patients' body resistance decreases due to some factors, dormant bacilli become active and cause post-primary tuberculous infection in any organ system alone or with simultaneous pulmonary involvement (endogenous reactivation tuberculosis). In the majority of patients, post-primary tuberculosis localizes in upper lung lobes, particularly in apical and posterior segments. This tendency has been attributed to high oxygen tension on apical regions due to diminished blood flow to these areas. It is now well established that the erect posture results in greatly decreased pulmonary blood flow in the lung apices.^{15,16} West and Dollery measured regional perfusion and regional ventilation and calculated regional oxygen tension in upright human lung by radioisotopic techniques.¹⁵ These calculations indicate that the partial pressure of alveolar oxygen (paO_2) at sea level is approximately 132 mm Hg at the level of the first anterior interspace, decreasing to 89 mmHg at the level of fifth anterior interspace. This evidence of higher oxygen tensions in the lung apices together with evidence that tubercle bacilli respire maximally *in vitro* at oxygen concentrations of 20 percent to 40 percent,¹⁷ and evidence that experimental infections in animals are somewhat augmented by high concentrations of oxygen and inhibited by very low concentrations,^{4,18} has led to the now widely held belief that oxygen

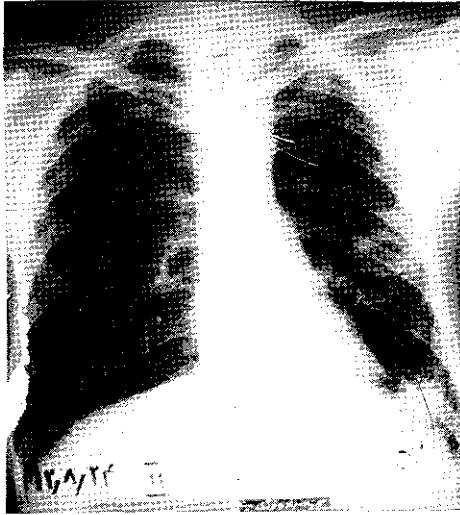


Fig. 3. Large reticulonodular shadows confined to the left lower lobe. Note a large cavity with air-fluid level in the superior segment of left lower lobe.

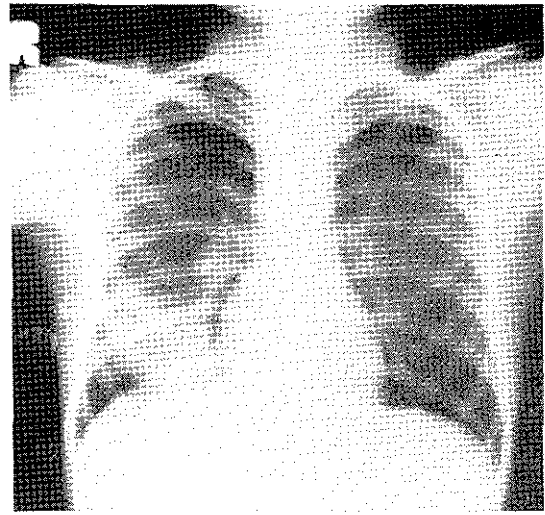


Fig. 4. Nonhomogenous right lower lobe infiltrate and right hilar adenopathy.

tension is the major determinant of apical localization of pulmonary tuberculosis.

The concept that reduced apical blood flow is responsible for the apical localization of tuberculosis is strongly supported by many lines of evidence. These changes in regional blood flow of lungs leading to apical localization of pulmonary tuberculosis, operate by at least two mechanisms²:

A- Oxygen Tension Theory

Mycobacterium tuberculosis is an aerobic organism and the oxygen tension theory is based on the premise that the demonstrated higher oxygen tensions in the apex of the upright lung produce increased bacterial virulence. Evidence for this contention consists of both *in vitro* studies and experimental infections in animals.^{17,20} However, this interesting theory is not capable of explaining all aspects of apical localization of pulmonary tuberculosis.

B- Disordered Lung Clearance Mechanisms

Particulate matter, insoluble substances and most products of inflammatory reactions not cleared by bronchial secretions are thought to be removed from the lungs mainly by the lymphatics either by mononuclear phagocytes or free in the lymph.²² Some protein is apparently absorbed by vascular capillaries.²³ Regional lymph flow in the lung has not been measured directly. Staub's calculations indicate that lymph flow in the most dorsal aspects of the standing sheep's lung is quite low²³. Since lymph flow (and venous return) is linearly related to microvascular pressure, it can be assumed that lymph flow is greatly diminished or absent in the extreme apex of the human lung when the

individual is sitting or standing.²³ Therefore, clearance mechanisms must be impaired in proportion. This would include the clearance of antigenic substances in pulmonary tuberculosis and chronic pulmonary histoplasmosis and also injurious mineral dusts.

This reasoning, if based only on the effects of gravity on pulmonary blood flow and consequently on lymph flow, would not explain the fact that pulmonary tuberculosis, chronic pulmonary histoplasmosis and progressive massive fibrosis are not only apical but also posterior in their characteristic location. However, focus on the nongravity-related aspects of lymph flow does offer an attractive explanation due to rhythmic contractions of the enveloping smooth muscle,²⁴ while tissue fluid flow and lymph flow in small lymph channels is passive and depend on forces from without, particularly respiratory movement.^{23,25} The anterior rib cage moves with respiration, but the posterior rib cage is fixed. This would imply that the immobile posterior aspect of the lung apices would be the most deficient areas of the lung in terms of lymphatic drainage. This is the best explanation for the apical localization of chronic pulmonary tuberculosis, as well as chronic pulmonary histoplasmosis and progressive massive fibrosis.

Lower lung field tuberculosis has long been known as a distinct clinical syndrome. Tuberculosis can involve lower lung lobes without upper lobe involvement and in areas where tuberculosis is prevalent many patients can be affected by this distinct and unusual type of tuberculosis. Lower lung field tuberculosis without concomitant upper lobe disease occurs in between 1% to 7% of patients with active pulmonary tuberculosis.^{6,9-12}

In our study, this figure was about 5%. The majority of previous studies have revealed that lower lung field tuberculosis occurs more frequently in younger patients when compared to upper lobe disease. In this analysis more than 75% of patients were between 16-35 years of age. Previous studies have emphasized the predominance of lower lung field tuberculosis in females. Seventy-two percent of the patients in the report of Segarra, et al¹ were women. In this respect our results are also consistent with most previous reports. It has been reported that lower lung field tuberculosis occurs more frequently in patients with diabetes mellitus, advanced renal and liver diseases, malignancies, chronic alcoholism and patients on immunosuppressive agents. It has also been found more commonly in nurses pregnant women and patients of advanced age.^{5,9,12-14} Diabetes mellitus seems to be the most common predisposing condition to lower lung field tuberculosis. In the present study, 7.1% of 98 patients whose fasting and two-hour postprandial blood sugar had been measured had overt diabetes and all of them were diabetic at the time of diagnosis of tuberculosis.

Although there is no reasonable explanation why patients with diabetes mellitus are predisposed to lower lung field tuberculosis, it has been shown that poorly-controlled diabetics are more prone to bacterial and fungal infections. It has long been suggested that there is some relationship between diabetes mellitus and tuberculosis, and the incidence of tuberculosis is high among poorly controlled diabetics. Prior to discovery of effective antituberculous agents and more emphasis on better glycemic control, about 5% of mortality of diabetic patients was due to tuberculosis. The American Thoracic Society includes patients with diabetes in their list of patients who are considered immunosuppressed enough to require isoniazid for a positive tuberculin skin test. The clinical course of tuberculosis seems to follow a different pattern in diabetics. Diabetic tuberculosis has been described as an acute, exudative, rapidly caseating disease that progresses to a toxic downhill course.³¹ Patients with diabetes also present with advanced disease and have more lower lobe involvement.³² The decline in tuberculosis in the general population has also been experienced in the diabetic population. However in a recent survey from New York City, diabetes was second only to alcoholism as a major factor in reactivation of tuberculosis.³³ The death rate from tuberculosis among diabetic persons has fallen from 5.5% in the 1930s to 0.3% in the 1960s. However this rate is still higher than in the general population. It would seem reasonable to screen for diabetes in any patient with tuberculosis and no other predisposing cause.

Cell-mediated immunity is the major host defense mechanism against tuberculosis. With regard to cell-mediated or T-cell mediated immune response in

diabetes, there have been a limited number of investigations over the past decades. Impaired delayed hypersensitivity reaction, abnormal lymphocyte transformation and granuloma formation all have been described in diabetics, especially in those with poorly-controlled diabetes mellitus.³⁴ Thus, the problem which the diabetic patient has in dealing with infections such as tuberculosis could be related to decreased cell-mediated immunity due to impaired lymphocyte metabolism in poorly controlled diabetes. In addition an increased chance of exposure to patients with tuberculosis during hospital admission may be another factor predisposing diabetic patients to tuberculosis.

Despite previous reports on unusual radiographic presentation of pulmonary tuberculosis in diabetic patients,³² radiologic features of lower lung field tuberculosis were similar in both diabetic and non-diabetic patients in our study.

In the majority of our patients, sputum smear examination and culture for tubercle bacilli were the basis of diagnosis of tuberculosis. However it must be emphasized that tubercle bacilli may be difficult to demonstrate on smear or even in culture and that multiple examinations are often necessary to confirm bacteriologic diagnosis. When sputum examination does not reveal tubercle bacilli, bronchoscopy and examination of bronchial washing may be positive. If bronchoscopy is not available, repeated sputum examination is recommended.

Chang, et al. reported endobronchial involvement proved by bronchoscopy in 32 of 42 patients.¹² There was evidence of endobronchial disease in many of our patients who underwent surgery or received bronchoscopy, but since these procedures had been performed only in a small proportion of our series, we could not comment on this feature of lower lung field tuberculosis.

Some investigators believe that lower lung field tuberculosis is a primary infection. In our series except for 13 patients with concomitant hilar adenopathy, there was no other evidence indicative of primary tuberculous infection.

The response to treatment with anti-tuberculosis agents was similar to that seen in upper lobe disease. Surgical intervention is rarely indicated. Familiarity with this form of tuberculosis and high index of clinical suspicion are necessary for early and correct diagnosis. Tuberculosis should be considered as a diagnostic possibility especially in young patients with lower lung field disease who have had symptoms for weeks or longer.

REFERENCES

- 1- Rich AR: The pathogenesis of pulmonary tuberculosis. Springfield IL; Charles C. Thomas Publishers, 1944; 768-78.

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- 2- Goodwin RA, Des Prez RM: Apical localization of pulmonary tuberculosis, chronic pulmonary histoplasmosis and progressive massive fibrosis of the lung. *Chest* 1983;83:801-805.
- 3- Dock W: Apical localization of phthisis. *Am Rev Tuberc* 1946;53:297-305.
- 4- Rich AR, Follis RH: The effect of low oxygen tension upon the development of experimental tuberculosis. *Am Rev Tuberc* 1942; 45:345-57.
- 5- Reisner D: Pulmonary tuberculosis of the lower lobe. *Arch Int Med* 1965, 56:258-80.
- 6- Hamilton CE, Fredd H: Lower lobe tuberculosis, a review. *JAMA* 1935;105:427-30.
- 7- Ossen Emilz. Z: Tuberculosis of the lower lobe. *N Engl J Med* 1944; 230:693-98.
- 8- Rothstein E: Pulmonary tuberculosis involving the lower lobes. *Am Rev Tuberc* 1949; 59:39-49.
- 9- Segarra F, Sherman DS, Rodriguez-Aguero J: Lower lung field tuberculosis. *Am Rev Respir Dis* 1963; 87:37-40.
- 10- Parmar MS: Lower lung field tuberculosis. *Am Rev Respir Dis* 1967; 96:310-13.
- 11- Berger HW, Granada MG: Lower lung field tuberculosis. *Chest* 1974; 65:522-26.
- 12- Chang SC, Lee P Y, Perng RP: Lower lung field tuberculosis. *Chest* 1987; 91:230-232.
- 13- Chambers JS Jr; Tuberculous cavities of the lower lobe; result of treatment in 103 patients. *Am Rev Tuberc* 1951; 63:625-643.
- 14- Ross EI; Tuberculosis in nurses; A study of the disease in sixty nurses admitted to the Manitoba Sanitarium. *Can Med Assoc J* 1930; 22:347-354.
- 15- West JB, Dollery CT; Distribution of blood flow and ventilation-perfusion ratio in lung, measured with radioactive CO₂. *J Appl Physiol* 1960; 15:405-10.
- 16- Anthonisen NR, Milic-Emili J: Distribution of pulmonary perfusion in erect man. *J Appl Physiol* 1966; 21:760-66.
- 17- Kempner W: Oxygen tension and the tubercle bacillus. *Am Rev Tuberc* 1939; 40:157-68.
- 18- Sever JL, Youmans GP: The relation of oxygen tension to virulence of tubercle bacilli and to acquired resistance in tuberculosis. *J Infect Dis* 1957; 101:193-202.
- 19- Auerbach O, Stemmerman MG: The development of pulmonary tuberculosis in congenital heart disease. *Am J Med Sci* 1944; 207:219-30.
- 20- Novy FG, Soule MH: Microbic respiration. II: Respiration of the tubercle bacillus. *J Infect Dis* 1925; 30:168-232.
- 21- Monge C Sr, Monge C, Jr: High altitude diseases. Springfield, IL: Charles C. Thomas Publishers, 1966:55.
- 22- Batte Zatti M, Donini I: The lymphatic system. New York; John Wiley and Sons, 1972:338-40.
- 23- Staub NC: Pulmonary edema. *Physiol Rev* 1974;54:678-811.
- 24- Hall JG, Morris B, Woolley G: Intrinsic rhythmic propulsion of lymph in the unanaesthetized sheep. *J Physiol* 1965; 180:336-49.
- 25- Drinker CK: The clinical physiology of the lungs. Springfield IL; Charles C. Thomas Publishers, 1954:74-84.
- 26- Root HF: The association of diabetes and tuberculosis: epidemiology, pathology, treatment and prognosis. *N Engl J Med* 1934, 210:1.
- 27- Cheung OT: Treatment of pulmonary tuberculosis in diabetic patients. *Med Serv J Canada* 1962; 18:665.
- 28- Luntz GR WN: Management of the tuberculous diabetic: Follow up of 84 cases for one year. *Br Med J* 1957; 1:1082.
- 29- Boucot K R, Cooper D A, Dillon E S, et al: Tuberculosis among diabetics. The Philadelphia Survey. *Am Rev Tuberc* 1952; 65 (Suppl):1.
- 30- Mullen LM, Higgins GK: Incidence of undiscovered adult diabetes in a tuberculous sanitarium. *Canad Med Assoc J* 1963; 88:424-25.
- 31- Younger D, Hardley W R: Infection and diabetes. In Marble A. White H, Hardley, et al: *Joslin's Diabetes Mellitus*, Philadelphia, Lea and Febiger, 1971, P. 628.
- 32- Weaver RA: Unusual radiographic presentation of pulmonary tuberculosis in diabetic patients. *Am Rev Respir Dis* 1974; 109:162-63.
- 33- Edsall J, Collins JG, Gray JAG: The reactivation of tuberculosis in New York City in 1967. *Am Rev Respir Dis* 1970; 102:825.
- 34- Wing E J, Reminton J S: Cell-mediated immunity and its role in resistance to infection. *West J Med* 1977; 126:14.
- 35- Maccuish AC, Urbaniak SJ, Campbell CJ; Phytohemagglutinin transformation and circulating lymphocyte subpopulation in insulin-dependent diabetic patients, *Diabetes* 1974;23:708.
- 36- Edwards JE, Jr, Tillman DB, Miller ME: Infection and diabetes mellitus. *West J Med* 1979; 130:515-521.