ORIGINAL REPORT

Radiologic Manifestation of Pulmonary Tuberculosis in Children Admitted in Pediatric Ward-Massih Daneshvari Hospital: A 5-Year Retrospective Study

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Abstract- Despite the extensive preventive and therapeutic measures present against tuberculosis (TB), this disease still remains as one of the important causes of mortality and morbidity in the world. Considering the high incidence of TB in children, rareness of its' clinical features and complexity of bacteriologic diagnosis in this age group paraclinical studies, especially radiologic evaluations, is useful for reaching a final diagnosis. This 5 year study was conducted in National Research Institute of Tuberculosis and Lung Diseases (NRITLD), Massih Daneshvari Hospital, Tehran, Iran. This retrospective study was conducted on 70 children (43 (61%) female and 27 (38.5%) male) aged between 5 months to 15 years old during a five year period (from 2001-2006) in pediatric ward. It was performed on children who were confirmed to have TB by various clinical, bacteriologic and radiologic features and tuberculin skin test. We studied the radiologic features of pulmonary TB in these children. Right lung involvement was observed in 65%, left lung 23% and bilateral involvement was detected in 12%. Also middle and superior lobes were the most common lobes affected. The commonest radiographic feature was hilar (mediastinal) lymphadenopathy; 70% detected on chest x-ray (CXR) and 85% on CTscan. Lymph nodes on right side were affected more; 25% were calcified. Also nodular infiltration of lung parenchyma was observed in 35% of CXRS and 61% of CTscans. This was followed by patchy consolidation detected in 25% and 35% of CXRs and CTscans respectively. We also observed that children <3yr. of age had the highest lymph node involvement but the least parenchymal lesions as compared to older children. It is concluded that primary TB is the most common form of pulmonary TB in children. This could be in the form of hilar lymphadenopathy with or without lung parenchymal involvement. Also radiologic features could provide valuable information in regard to diagnosis, treatment and follow-up of pulmonary TB in children.

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Key words: Tuberculosis, pulmonary; radiology; pediatrics; pulmonary

Introduction

Despite the preventive, prophylactic and treatment measures against TB, this disease still constitutes a large number of mortality and morbidity cases among children (1). Based on the WHO report (2006), annually 9 million become infected with M.tuberculosis (new TB case) and 2 million die as a result of this disease; children constitute 1 million of this figure (prevalence of TB in children is 3-25%of adults). This study was conducted considering the high incidence of TB in Iran (rate of smear positive pulmonary TB was 1.33 persons per 100,000 children in 2005) and emphasizing the importance of radiographic evaluations in diagnosis, treatment and follow-up of these patients. Since in primary pulmonary TB, the number of bacilli in majority of sample is low, diagnosis of pulmonary TB in children has become one of the challenging points in this disease (2).

In TB radiographic features are variable and vast; however they could be sufficient for diagnosis in some cases. CXR is one of the useful tools for diagnosis of TB; however the role of CTscan is more pronounced. This is due to:

1. Pathologies and lesions which are not visible on CXR are detected on CTscan.
2. Diagnosing complications of pulmonary TB and controlling the activity of TB disease

Classically pulmonary TB is of two types: primary and secondary. Although they do not differ significantly

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in clinical features, radiological manifestations of primary pulmonary TB (common in childhood) differ from secondary pulmonary TB (common in adulthood). In this study, we have evaluated the radiologic features of primary pulmonary TB in children.

Patients and Methods

This retrospective study was conducted on 70 children aged 5 months to 15 years old during a 5 years. period (from 2001-2006) in the pediatric ward of Massih Daneshvari Hospital, Tehran, Iran. TB was confirmed in the understudy children by various clinical, bacteriologic and radiologic features as well as tuberculin skin test. CXRs and CTscans of the patients were evaluated and information was recorded on questionnaires. It is notable that all imagings were obtained before the initiation of anti-TB therapy. Criteria for diagnosis of TB was based on clinical features, history of contact with smear positive TB patient, PPD result, radiologic manifestation and laboratory investigations (pathologic, bacteriologic).

Results

Result of this study is as follows: 70 children admitted in the pediatric ward during 2001-2006; 43 patients (61%) were females and 27 (38.5%) were males. Most patients were in the age range of 11-15 years old (n=29), followed by 4-7 years old (n=18), 8-11 years old (n=11), 1-3 years old (n=7) and <1 years (n=5). (Figure 2) Meanwhile:

(1) 45 patients (64.2%) had negative smears and cultures (3x) at the time of admission and had not received any anti TB medication

(2) 25 (35.7%) patients were smear positive

(3) 5 (7.1%) patients had positive culture of gastric lavage (Mycobacterium tuberculosis).

Tuberculin skin test results were as follows: 60 children (85.7%) were PPD positive (>5mm in contact cases, symptomatic, and >10mm in others) and 9 (12.8%) were PPD negative; six patients had Acute Disseminated TB disease. PPD result was not available in one child. (Figure.3)

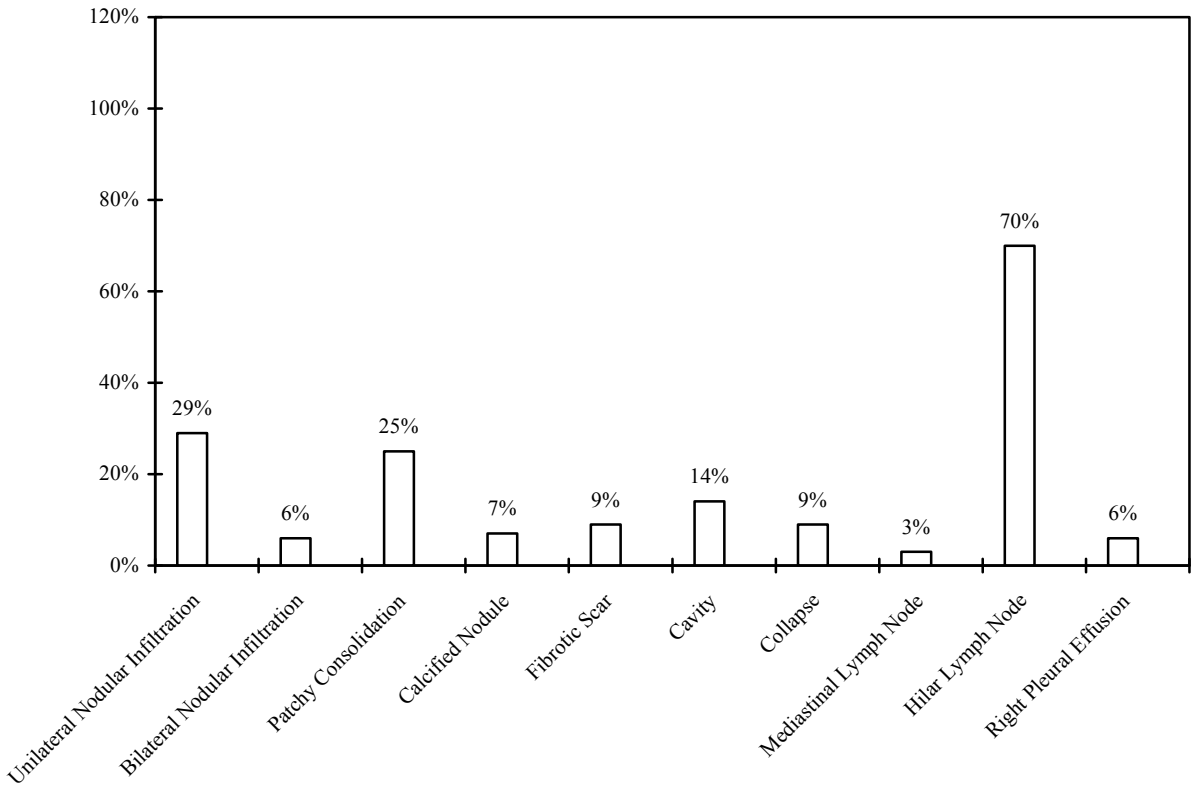

Figure 1. The Radiographic findings of Primary Tuberculosis in CXR

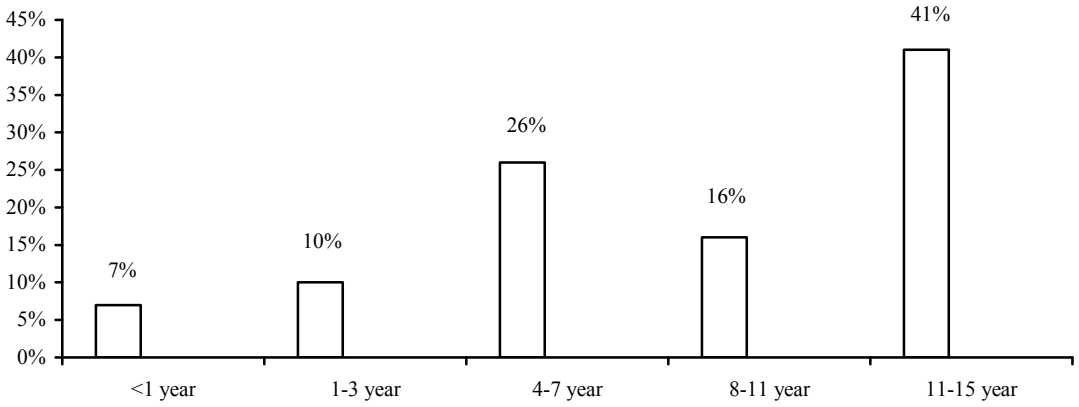

Figure 2. Age distribution of patients with pulmonary tuberculosis

In regard to clinical features 30 (42%) had clinical manifestations; the commonest being cough (76.6%), followed by fever, sputum and weight loss (16.6%). Hemoptysis was the rarest symptom (3%). Sixty seven (95%) patients had history of close contact with smear positive patient in the last 2 yrs. Out of this group, 36 children (51%) had scar of BCG vaccination. In the remaining, history of vaccination and BCG scar was unclear, since most of patients were Afghans. CXR graphies were normal in 22 (31%) children but their CT scan images showed hilar and/or lung parenchymal lymphadenopathies.

It is notable that CTscan is more sensitive in diagnosing lymphadenopathies than CXR. The commonest finding was hilar lymph-adenopathy: 49(70%) patients on CXR and 60(85%) on CTscan (with predominance on right side 76%).

Mediastinal lymphadenopathy was observed in 47% of CTscan images; 33% on right side, 25% was associated with calcification. Nodular infiltration was observed in 61% of CTscan and 35% of CXR images; unilateral parenchymal involvement, especially on right side, was more common. Lobar patchy consolidation came next; 18 (25%) patients on CXR and 24(35%) patients on CTscan demonstrated such feature.

On CXR, following hilar lymphadenopathy, nodular infiltration and patchy consolidation, is cavity formation (14.2%), collapse and fibronodular scar, each observed in 6 patients (8.5%); calcified nodule was detected in 5 patients (7.1%); pleural effusion in 4 patients (in all of the cases it was unilateral and occurred on right side). The least CXR finding was mediastinal lymphadenopathy (2.8%). On CTscan, superior and middle lobes were the commonest ones involved (13 % and 40% respectively); cavity formation (24.2%) including thick wall in 7 (10%) and intracavitary lesion in 3 (4.2%).

Table1. Radiographic Findings of Pulmonary Tuberculosis in CT scan

Lymphadenopathy	85%
Mediastinal	47%
Right	33%
Left	5%
Bilateral	9%
Calcified	25%
Hilar	85%
Right	76%
Left	5%
Bilateral	60%
Calcified	40%
Nodular Infiltration	61%
Patchy Consolidation (Lobar)	35%
Cavity Formation	24/2%
Thick wall	10%
Intracavitary Lesion	4/2%
Calcified Nodule	15/7%
Tree in Bud	13/4%
Fibrotic Scar	17%
Pleural thickening	18/5%
Bronchiectasis	12/8%
Lobar	10%
Segmental	2%
Collapse Consolidation	8/5%
Atelectasis (RML)	11%
Granuloma	7/1%
Air-Space Lesions	5/7%

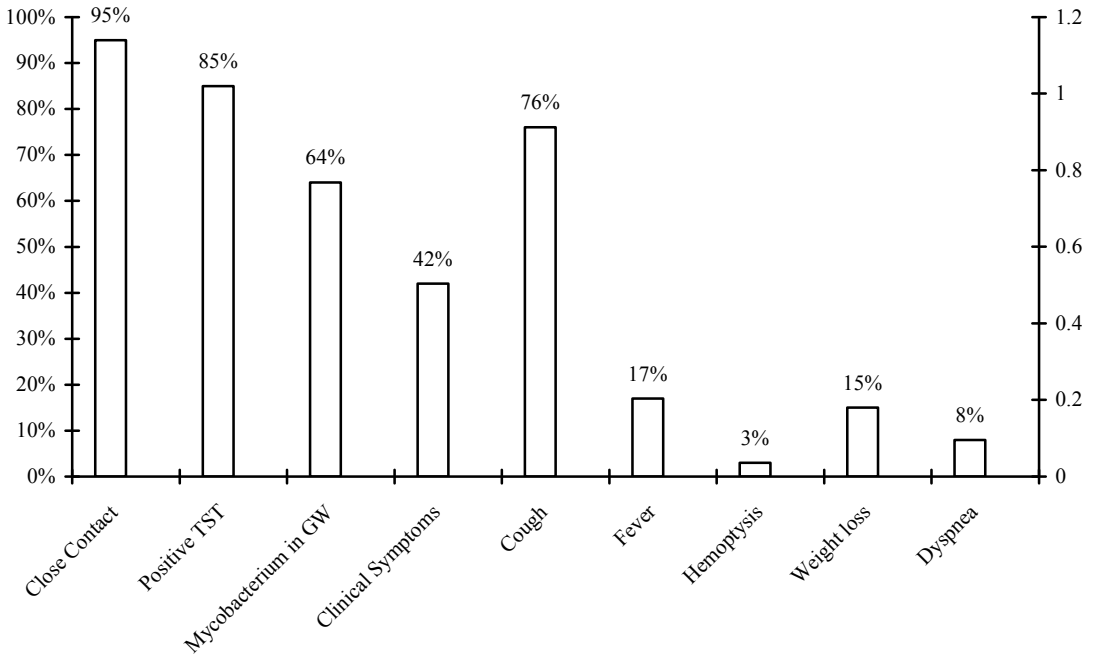

Figure 3. Clinical and Para clinical findings of Pulmonary tuberculosis (Number=70)

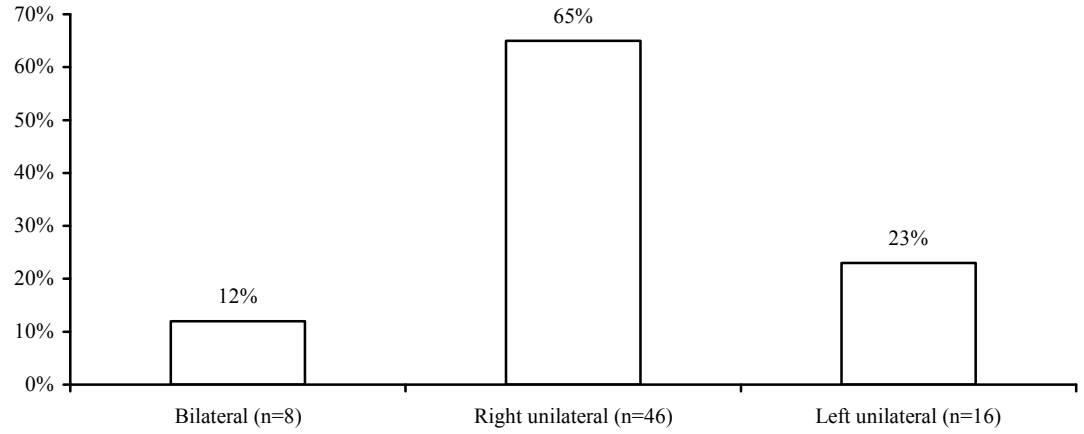

Figure 4. Distribution of the findings in abnormal chest X-rays according to the sites of lesions (n=70)

Discussion

According to CDC report in 1989 detection, treatment and prevention of childhood pulmonary TB are of utmost importance; the reason being the significant effect of treatment on the life quality of children and their family and also the fact that these children can become an important source for "new cases" of TB (1).

Due to rareness of clinical features in children, the final diagnosis of primary pulmonary TB is difficult to make; 56-65% of children are without any significant symptoms (5). In our study 40 cases (57%) were without

symptoms but had history of contact. In a study conducted in Canada in 1992 by Pineda and Muller, about 58% of children were without any clinical features at the time of referral (1).

In their study, 60% of children acquired pulmonary TB after close contact with smear positive patients.

We had 62 children (88%) that had history of contact with smear positive individuals. Starke Taylor in 1989 in Houston and Nolun in North Carolina in 1986 detected about 50-80% of their patients following screening for contacts. (5,6). Since children can not expectorate easily, bacteriologic confirmation of TB disease is nearly impossible. Also culture of gastric lavage was positive in 30-40% of the cases (7). In our study 10 patients had positive culture gastric lavage. As compared with a study conducted in North America, our rate of positive gastric lavage (14%) as very small.

According to the published statistics of CDC in 1985 about 35% of children with TB had positive bacteriologic and histologic results (8). Based on this research 30 patients had confirmed bacteriologic report. Forty percent of TB diagnosis in children is based on the epidemiologic features and close contact with smear positive adult in the absence of any positive culture (7).

Indirect diagnostic measures such as CXR and TST provide only supportive data. The most prominent feature of primary pulmonary TB on graphies is lymphadenopathy; a feature which is present in 70% of our CXRs. On CTscan images in 60 patients (85%) lesions are mostly on right side and calcified.

In a study conducted in Canada in 1992, 92% of children had hilar lymphadenopathy on their CXRs. Weber and Bird performed studies in Massachusetts and observed hilar lymphadenopathy (predominately unilateral and on right side) in 96% of children (9).

Based on studies conducted earlier and the present research, predominance of lymphadenopathy and parenchymal involvement is on right side; nodular infiltration (61%) is unilateral and on right side (10). Infiltrations can involve any segment of lung; although middle and inferior lobes are more susceptible because of greater ventilation volume (11). In the present study, middle and right superior lobes were commonly involved. Most of our lesions were dense and homogenous. Muller (1) in his study performed in Canada observed equal involvement of inferior and superior lobes; atelectasis constituted 9% of their cases at the time of admission (9). In Weber's study rate of atelectasis was 4% at the time of admission (9).

We detected collapse consolidation on CXR in 7% of patients; with predominance in right middle lobe. On CTscan, atelectasis was seen in 12.8% with predominance in right middle lobe. In 30% of children atelectasis was observed after several months following treatment (1).

Following lymphadenopathy, unilateral nodular infiltration was the commonest finding; next is patchy consolidation. In our study nodular infiltration was observed in 61% and 35% of CTscan and CXR images respectively. In 34% of CTscan and 25% CXR images patchy consolidations were identified.

In a study performed by Basta (12) in Portugal in 2006, 43% of CXRs showed nonspecific infiltrations; 39.1% showed parenchymal involvement in the form of patchy consolidation and 36% had normal imaging (12). Cavity formation was unusual and was observed in progressive stages. We detected cavities in 13% of CXRs' and 24.2% of CTscan images. The most common form of cavity formation was thick wall (41%); it is notable that cavity formation occurs in the end stages of disease and is accompanied by cystic and bronchiectic changes. In our study bronchiectasia was observed on 9 CTscan images (12.8%); 7 cases were lobar and 2 were segmental. Based on Andrea's study conducted in spain in 2004, obstruction of bronchi by large nodules occurs in the final stages of disease, leading to obstructive atelectasis and (2). This is one of the rarest findings of primary pulmonary TB.

According to Freimann and Soloman study, performed in Africa, cavity formation especially happens in children <3years old having extra pulmonary features. This is compatible with our findings in which 5 patients (7%) <4 years old with extra-pulmonary features had multiple small and large pulmonary cavities (13).

Also, in a study performed by Wong in Taiwan in 1999 on 10 children, lymphadenopathy was the commonest finding on CXR and CTscan; paratracheal and hilar lymphnodes being more affected. This point was similar to our study. Since majority of lymphnodes are not detectable on normal routine CXRs', CT scan is needed for confirmation. Also in their study air space consolidation was the rarest finding (3%); this is also compatible with our study in which air bronchogram was observed on CXR of 4 patients (5.3%) (14). A study was performed by Mikovic *et al.* in Crovatia in 2005 and based on their results the commonest findings on CXR, in order of appearance were lymphadenopathy (84%), parenchymal lesions (61.3%), pleuritis and atetactasia; which were observed in young children and commonly on right side (15).

In our study, pleurisy was observed on CXR of 4 children (5.7%); pleural thickening was observed on 13 CT scan images (18.5%); mostly it was on right side and in one case it was associated with calcification. In conclusion, CXR could be normal in a significant number of children (9). As compared to CXR, CTscan is more sensitive in detecting pulmonary lesions and enlarged lymphnodes. Also CT scan can identify hilar and mediastinal lymph nodes greater than 0.5 cm. Enlarged nodes are included in the differential diagnoses of lymphoma, metastasis and infections (10,11). In pulmonary diseases, lymphadenopathy resolves more slowly. Since TB still remains as one of the biggest dilemmas in infectious and pediatric sections of the medical science, radiology plays an important role in confirming the initial diagnosis. Radiologic features of TB in children are vast; however it could be specific and diagnostic in certain cases. At times when CXR reports are inconclusive, CTscan is a valuable diagnostic method. Also radiology provides significant information in regard to follow-up, resolution and possible complications in case of TB (2).

References

1. Leung AN, Müller NL, Pineda PR, FitzGerald JM. Primary tuberculosis in childhood: radiographic manifestations. Radiology 1992;182(1):87-91.
2. Andreu J, Cáceres J, Pallisa E, Martinez-Rodriguez M. Radiological manifestations of pulmonary tuberculosis. Eur J Radiol 2004;51(2):139-49.
3. Franco R, Santana MA, Matos E, Sousa V, Lemos AC. Clinical and radiological analysis of children and adolescents with tuberculosis in Bahia, Brazil. Braz J Infect Dis 2003;7(1):73-81.
4. Manual de Normas para o Controle da Tuberculose. Brasila, Ministerio da Saude-Brasil, 2006.
5. Starke JR, Taylor-Watts KT. Tuberculosis in the pediatric population of Houston, Texas. Pediatrics 1989;84(1):28-35.
6. Nolan RJ Jr. Childhood tuberculosis in North Carolina: a study of the opportunities for intervention in the transmission of tuberculosis to children. Am J Public Health 1986;76(1):26-30.
7. Starke JR. Modern approach to the diagnosis and treatment of tuberculosis in children. Pediatr Clin North Am 1988;35(3):441-64.
8. Snider DE Jr, Rieder HL, Combs D, Bloch AB, Hayden CH, Smith MH. Tuberculosis in children. Pediatr Infect Dis J 1988;7(4):271-8.
9. Weber AL, Bird KT, Janower ML. Primary tuberculosis in childhood with particular emphasis on changes affecting tracheobronchial tree. AJR 1968;103:123-32.
10. Berger HW, Granada MG. Lower Lung field tuberculosis. Chest 1974;65(5):522-6.
11. Havlir DV, Barnes PF. Tuberculosis in patients with human immunodeficiency virus infection. N Engl J Med 1999;340(5):367-73.
12. Basta PC, Alves LC, Coimbra Júnior CE. Radiographic patterns of pulmonary tuberculosis among the Suruí indians of Rondônia, Amazonia. Rev Soc Bras Med Trop 2006;39(2):221-3.
13. Freiman I, Geefhuysen J, Solomon A. The radiological presentation of pulmonary tuberculosis in children. S Afr Med J 1975;49(41):1703-6.
14. Wong KS, Huang YC, Lin TY. Radiographic presentation of pulmonary tuberculosis in young children. Acta Paediatr Taiwan 1999;40(3):171-5.
15. Milković D, Richter D, Zoricić-Letoja I, Raos M, Koncul I. Chest radiography findings in primary pulmonary tuberculosis in children. Coll Antropol 2005;29(1):271-6.