

Chest Radiography Findings in Primary Pulmonary Tuberculosis in Children

Durđica Milković, Darko Richter, Ivka Zoričić-Letoja, Miljenko Raos and Ivan Koncul

Special Hospital for Pediatric Respiratory Diseases »Srebrnjak«, Zagreb, Croatia

ABSTRACT

Plain chest radiography plays a major role in the diagnosis and follow-up of pulmonary tuberculosis in childhood. The aim of our study was to investigate the distribution of characteristic chest radiographic findings at diagnosis in children with pulmonary tuberculosis. The age of the patients and the type and localization of radiographic changes at admission were retrospectively analyzed. We reviewed chest radiographs in 204 children admitted from January 1, 1991 until June 30, 1994 for newly diagnosed pulmonary tuberculosis. Mean age \pm SD was 6.4 ± 4.2 years (range 0–14). The most common lesion was lymphadenopathy (found in 172 children, 84.3%). It was significantly more common in the youngest age group (0–4 years) and was more significantly present in the right hila-mediastinal region. Parenchymal changes were found in 125 children (61.3%). They were also significantly more common in the young age group and in the right lung. Other less common lesions included pleuritis, atelectasis, destructive-cavitary lesions and miliary dissemination. In conclusion, the leading radiographic finding in pulmonary tuberculosis in childhood remains hilar lymphadenopathy, but parenchymal changes are clearly strongly present, and should be sought and appreciated in the diagnostic work-up for pulmonary tuberculosis in childhood.

Key words: pulmonary tuberculosis, chest radiography, children

Introduction

Tuberculosis (TB) in children, which is most often found in the lungs, presents a number of diagnostic difficulties¹. The diagnosis of pulmonary TB is particularly difficult in young children. The most critical need is for improved capability to confirm diagnosis². It often runs an asymptomatic or oligosymptomatic course and it is difficult to obtain a positive culture of *Mycobacterium tuberculosis*³. The diagnosis depends primarily on the suspicion of TB infection based on epidemiologic data (contact with a known TB patient), positive delayed skin reaction to tuberculin or PPD and pulmonary radiographic changes⁴.

The aim of this study was to analyze the appearance of the chest radiographs in a large group of children with pulmonary TB and investigate the characteristics with respect to the age, localization and sort of radiographic changes.

Patients and Methods

From 1 January 1991–30 June 1994, 204 pediatric patients with newly discovered TB were hospitalized in our hospital (Table 1).

Patients

Contact with a TB patient was determined in 172 (84%) of children. Children in contact with an infectious case are at the greatest risk. Contact was defined as any child who lived in a household with an adult taking anti-TB therapy⁵. The most common TB contact had been a parent (108, 53% of cases). There were 100 (49%) symptomatic children, while 104 (51%) were asymptomatic. The commonest leading symptoms were cough and fever (35% and 21% of children, respectively). Tuberculin skin test reaction >15 mm was found in 149 (73%) of patients. Proper BCG vaccination with residual scar could be found in 185 (93%) of patients. *M. tuberculosis* was isolated in 35 (17%) patients, predominantly from gastric lavage specimens.

Diagnosis

Bronchoscopy was performed in 112 (55%) of children; 44 (39%) had compression signs due to enlarged lymph nodes and 3 children had lymph node perforation into the bronchial tree and granulomatous bronchial changes.

TABLE 1
AGE DISTRIBUTION OF PEDIATRIC TB PATIENTS

Age (years)	Number	%
<1	16	7.8
1–4	66	32.3
5–9	77	37.7
10–14	45	22.1
Total	204	100

Radiography

Radiographic work-up included postero-anterior and right lateral views. Critical studies have supported the routine use of the frontal high-kV radiography for the diagnosis of pulmonary TB⁶. The radiography was done at admission for every patient and these radiographs were used for retrospective analysis in this study. Signs commonly associated with pulmonary TB were searched for: lymphadenopathy, parenchymal infiltration and consolidation, miliary dissemination, cavitary and destructive changes, atelectasis and pleuritis. Radiological lesion does not confirm the etiology of TB, as there are no pathognomonic radiological signs of tuberculosis⁵.

Statistics

Statistical analysis included the χ^2 -test and the Student t-test for the significance of differences between two proportions.

Results

Lymphadenopathy (Figure 1) was the most common radiographic appearance found in 172 (84.3%) of patients (Table 2). It was significantly more common in the younger children (0–4 years), found in 79 of 82 (96.3%) subjects, in comparison with the 5–14 year age group, where it was found in 93 of 122 subjects (76%, $p<0.001$). Right hilar adenopathy (103 patients, 50.4%) associated with mediastinal adenopathy (62 patients, 30.4%) was significantly more common ($p<0.001$) than left hilar adenopathy (21 patients, 10.3%) (Table 3). Bilateral hilar adenopathy was identified in 39 children (19.1%). Only 9 patients (4.4%) had enlargement of the mediastinal paratracheal lymph nodes.



Fig. 1. Paratracheal and hilar lymphadenopathy.

TABLE 2
RADIOGRAPHIC PULMONARY TB CHANGES BY AGE OF CHILDREN (N=204)

Age (years)	0–4	5–9	10–14	Total N (%)
Lymphadenopathy				
Right hilar	58	34	11	103 (50.49%)
Left hilar	7	8	6	21 (10.29%)
Bilateral	11	16	12	39 (19.12%)
Mediastinal	3	5	1	9 (4.41%)
Total	79	63	30	172 (84.31%)
Parenchymal consolidation				
Right side				
Segmental	23	12	6	41 (20.1%)
Lobar	8	6	5	19 (9.31%)
Confluent	16	16	5	37 (18.14%)
Left side				
Segmental	5	5	2	12 (5.88%)
Lobar	0	2	3	5 (2.45%)
Confluent	5	3	3	11 (5.39%)
Total N	57	44	24	125 (61.27%)
Cavities	0	2	3	5 (2.45%)
Atelectasis	4	4	1	9 (4.41%)
Miliary TB	2	0	0	2 (0.98%)
Pleuritis	2	2	9	13 (6.37%)



Fig. 2. Segmental infiltrative parenchymal lesion.



Fig. 3. Lobar infiltrative parenchymal lesion.

Infiltrative parenchymal changes were found in 125 (61.2%) children. The radiographic appearance corresponded to: segmental (Figure 2), lobar (Figure 3) or confluent opacities. Changes were more common ($p < 0.030$) in children 0–4 years old (57, 69.5%) than in 5–14 year old group (68, 55.7%). Parenchymal infiltrative changes were significantly more common ($p < 0.001$) in the right lung (97 patients, 77.6%) than in the left one (28 patients, 22.4%) (Table 4). The right lower lobe was the commonest localization of parenchymal opacities.

Parenchymal consolidation was present in 125 (61.3%) of the 204 patients. Isolated lymphadenopathy was found in 172 (84.3%; significance of difference vs. parenchy-



Fig. 4. Atelectasis.

TABLE 3
ANATOMICAL DISTRIBUTION OF LYMPHADENOPATHY

Site	N
Right hilar nodes	103
with mediastinal nodes	62
Left hilar nodes	21
with mediastinal nodes	9
Bilateral hilar nodes	39
with mediastinal nodes	30
Isolated mediastinal nodes	9

mal consolidation: $p < 0.05$). Lymphadenopathy associated with changes other than parenchymal infiltrate (atelectasis, pleuritis) was noted in further 22 cases (10.8%).

Cavitary-destructive changes were found only rarely, in 5 patients (2.4%). Atelectasis was found somewhat more frequently, in 9 (4.4%) patients (Figure 4). Miliary

TABLE 4
PRESENTATION OF RADIOGRAPHIC PARENCHYMAL PATTERNS RELATED TO LOCALIZATION

Parenchymal consolidation	RLL (N)	RML (N)	RUL (N)	LLL (N)	LNG (N)	LUL (N)	Total (N)
Segmental consolidation	21	13	7	6	4	2	53
Lobar consolidation	10	2	7	1	1	3	24
Confluent consolidation	20	11	6	6	2	3	48
Total	51	26	20	13	7	8	125
Cavities	1	0	2	1	1	0	5
Atelectasis	3	1	2	1	1	1	9

Abbreviations: RLL – right lower lobe, RML – right middle lobe, RUL right upper lobe, LLL – left lower lobe, LNG – lingula, LUL – left upper lobe.



Fig. 5. Miliary pulmonary TB dissemination in an 8 months old male infant.



Fig. 6. Exudative TB pleuritis in a 2-year old boy.



Fig. 7. Primary tuberculous complex in the right lung.

TB was found in 2 (1%) infants (Figure 5). Exudative pleuritis (Figure 6) was present in 13 (6.3%) patients at admission, significantly more commonly in the 5–14 year old age group than at other ages ($p < 0.001$).

Primary tuberculous complex was a singular exceptional finding in this series (Figure 7).

Seven (3.4%) of patients had normal pulmonary radiographs at admission.

Discussion

The study showed that besides lymphadenopathy, parenchymal infiltration was frequently identified on chest radiographs at admission for childhood TB, despite nonspecific and at times absent physical findings.

A great number of children had been in contact with a known TB patient, especially in the close family circle (52.9%). This fact plays a great role in childhood TB and has an outstanding diagnostic significance^{1,3,4,7,8}. A significant number of patients (75%) had tuberculin skin reactivity ≥ 15 mm, a finding that in areas with moderate or high TB prevalence indicates high probability of TB infection^{3,8–10}. In contrast to other published series with more significant numbers of asymptomatic patients^{1,11–13}, almost half of the children in our series were clinically symptomatic (49.5%). The epidemiological, clinical and radiographic findings were sufficient diagnostic criteria for TB in expectation of the results of culture^{3,4,7,14}. The chest radiography had an important role in the diagnostic algorithm.

The radiographic findings were consistent with patho-immunological changes induced by *M. tuberculosis* infection in lung parenchyma and the draining lymph nodes^{3,15–17}. Changes consistent with the primary complex are rarely found on chest radiographs in children. Parenchymal consolidation (segmental, lobar and confluent) is seen more frequently, depending on the point in time, i.e. the stage of disease. Most common is lymphadenopathy, isolated, or associated with parenchymal consolidation. Right upper lobe non-TB bacterial pneumonia in an infant often persists with radiological shadow for 4 weeks, but in this situation, the child is clinically normal with appropriate antibiotic therapy. Such a child does not need further evaluation for TB, especially in the absence of any risk factors⁵.

Primary intrathoracic tuberculosis in children and juveniles consists of adenopathy – hilar, paratracheal or mediastinal, and parenchymal infiltrate. The hilar lymph node may perforate into adjacent bronchus creating a fistula and bronchogenic spread of tuberculous infection¹⁸.

Lymphadenopathy was noted in 84.3% of our patients. Leung *et al.*⁸ found lymphadenopathy in more than 90% children with TB, similarly to Pineda *et al.*¹⁰ who cited literature figures between 59–79%. Lymph node enlargement was more common on the right side, especially in the youngest age group of 0–4 year old children, of whom 96.3% had lymphadenopathy. The lymph

from the right lung, left lower lobe and lingula is drained into the right hilus, while the left hilus receives the lymph from the left upper lobe. This specific lymph drainage pattern accounts for the prevalent right-sided adenopathy¹⁹.

Parenchymal consolidation was found in 61.3% children. The youngest age group was also most commonly affected, although such changes, in combination with cavitary-destructive lesions are considered to be characteristic of older age groups^{15,20–21}. Similarly to the findings of Woording *et al.*²⁰, the changes were prevalent in the right lung. Few authors found other prevailing localizations¹⁶ and some could not determine any predominance among lung lobes^{11,21}.

Lymphadenopathy associated to parenchymal changes was found in 131 patients. Lymphadenopathy associated with other lesions (atelectasis, pleuritis) was less common. Isolated enlargement of hila-mediastinal nodes was comparatively more frequent. Lymph node changes may persist for years. Tuberculous infection of the lymph nodes may lead to extramural compression of the main, lobar or segmental bronchi resulting in obstructive emphysema, due to partial obstruction, or, more commonly, atelectasis due to complete obstruction.

Compression of the tracheobronchial tree by enlarged lymph nodes may cause a series of complications^{11,15,16}. Atelectasis due to extramural compression was present in 9 patients (4.4%). This is less than reported by other authors^{11,13,22}. The reason is probably the earlier stage of disease at admission, because atelectasis could be

found in a larger proportion of patients during hospitalization. Extramural compression signs were identified in 39.3% of our patients at bronchoscopy. Destructive-cavitary lesions are mainly considered to be characteristic of older age groups and are comparatively rare in children^{15,20,21}.

Miliary TB, characteristic for the youngest age^{22–24}, was found in 2 infants in this series.

Exudative pleuritis was found in 13 (6.3%) patients, comparatively more frequently in the 5–14 year age group. This corresponds to findings of other authors^{11–13,16,22}.

Safety aspects are also important²⁵. In this respect the diagnostic yield appears to justify the radiation dose delivered during the radiological-work-up.

It should be stressed that tuberculous disease cannot be excluded on grounds of normal chest radiography, as exemplified by 7 patients in our series who had a normal finding.

This analysis of chest radiographs demonstrated the importance of lymphadenopathy and parenchymal consolidation in the diagnosis of tuberculosis in pediatric patients. Other radiographically well defined lesions (atelectasis, cavities, miliary TB, pleuritis) were also found, but comparatively rare. Since lymphadenopathy and even parenchymal consolidation may be asymptomatic and the diagnostic work-up initiated on circumstantial data (possible contact, regular skin testing result) the chest radiography remains an important method in the diagnosis of childhood TB.

REFERENCES

1. TOPPET, M., A. MALFROOT, B. HOFMAN, G. CASIMIR, F. CANTRAINED, I. DAB, Eur. J. Pediatr., 150 (1991) 331. — 2. GRAHAM, S. M., R. P. GIE, H. S. SCHAAF, J. B. COULTER, M. A. ESPINAL, N. BEYERS, Int. J. Tuberc. Lung Dis., 8 (2004) 648. — 3. STARKE, J. R., Pediatr. Clin. North Am., 35 (1988) 441. — 4. KENDIG, E. L. Jr., L. S. INSELMAN, Adv. Pediatr., 38 (1991) 233. — 5. IAP working group, Indian Pediatrics, 41 (2004) 146. — 6. DE VILLIERS, R. V., S. ANDRONIKOU, S. VAN DE WESTHUIZEN, Australas. Radiol., 48 (2004) 148. — 7. JACOBS, R. F., J. R. STARKE, Med. Clin. North Am., 77 (1993) 1335. — 8. NEMIR, R. L., K. KRASINSKI, Pediatr. Infect. Dis. J., 7 (1988) 375. — 9. STARKE, J. R., R. F. JACOBS, J. JEREB, J. Pediatr., 120 (1992) 839. — 10. American Academy of Pediatrics. Committee on Infectious Diseases, Pediatrics, 93 (1994) 131. — 11. LEUNG, A. N., N. L. MULLER, P. R. PINEDA, J. M. FITZGERALD, Radiology, 182 (1992) 87. — 12. STARKE, J. R., K. T. TAYLOR-WATTS, Pediatrics, 84 (1989) 28. — 13. PINEDA, P. R., A. LEUNG, N. L. MULLER, E. A. ALLEN, W. A. BLACK, J. M. FITZGERALD, Tuber. Lung. Dis., 74 (1993) 261. — 14. STARKE, Jr., Chest, 104 (1993) 329. — 15. MILLER, W. T., W. T. MILLER Jr., Semin. Roentgenol., 28 (1993) 109. — 16. BACCIALONE, J., D. GENDREL, G. KALIFA, Ann. Pediatr. (Paris), 39 (1992) 281. — 17. DANNENBERG, A. M. Jr., Am. Rev. Respir. Dis., 125 (1982) 25. — 18. American Thoracic Society, Am. Rev. Respir. Dis., 142 (1990) 725. — 19. INSELMAN, L. S., Pediatr. Pulmonol., 21 (1996) 101. — 20. WOODRING, J. H., H. M. VANDIVIERE, A. M. FRIED, M. L. DILLON, T. D. WILLIAMS, I. G. MELVIN, Am. J. Roentgenol., 146 (1986) 497. — 21. CHOYKE, P. L., H. D. SOSTMAN, A. M. CURTIS, C. E. RAVIN, J. T. CHEN, J. D. GODWIN, C. E. PUTMAN, Radiology, 148 (1983) 357. — 22. LAMONT, A. C., B. J. CREMIN, R. M. PELTERET, Pediatr. Radiol., 16 (1986) 2. — 23. HUSSEY, G., T. CHISHOLM, M. KIBEL, Pediatr. Infect. Dis. J., 10 (1991) 832. — 24. JAMIESON, D. H., B. J. CREMIN, Pediatr. Radiol., 23 (1993) 380. — 25. MILKOVIĆ, Đ., M. RANOGAJEK-KOMOR, M. KRSTIĆ-BURIĆ, A. HEBRANG, Atemwegs und Lungenkrankheiten, 17 (1991) 67.

Đ. Milković

Special Hospital for Pediatric Respiratory Disease, Srebrnjak 100, 10000 Zagreb, Croatia
e-mail: bolnica_srebrnjak@yahoo.com

RADIOGRAFSKI NALAZI PRIMARNE PLUĆNE TUBERKULOZE U DJECE

S A Ž E T A K

Radiografija prsnog koša ima izuzetno važno značenje u dijagnostici i praćenju tijekom tuberkuloze pluća dječje dobi. Cilj studije bio je istražiti vrste i raspored radiografskih nalaza u djece prigodom prve dijagnoze plućne tuberkuloze. Retrospektivno su analizirani radiogrami prsnog koša s obzirom na vrstu promjena, lokalizaciju, životnu dobi i suodnos navedenih parametara u 204 bolesnika s novootkrivenom tuberkulozom, u periodu od 1. siječnja 1991. do 30 lipnja 1994. godine. Prosječna dob bila je 6,4 godine (SD 4,2; raspon 0–14). Limfadenopatija je bila najčešća promjena (172 bolesnika, 84,3%), češće prisutna u najmlađoj dobnoj skupini od 0–4 godine i u desnom hilomedijastinalnom području. Parenhimne promjene nađene su u 125 (61,3%) bolesnika, također češće u mlađoj dobi i u desnom pluću. Ostali oblici bili su manje zastupljeni: pleuritis, atelektaza, destrukcija i milijarna diseminacija. Dobiveni podaci upozoravaju na ozbiljnost postojanja tuberkuloze u djece te važnost osjetljivosti dijagnostičara za mogućnost plućne tuberkuloze kod nalaza karakterističnih radiografskih promjena.