Bacteriologically confirmed pulmonary tuberculosis in childhood

Clinical and radiological features

P. R. DONALD, J. B. BALL, P. J. BURGER

Summary

Over a 4-year period 185 cases of pulmonary tuberculosis in children were confirmed by culture of *Mycobacterium tuberculosis*, usually from gastric aspirate. The majority of cases occurred in boys (62%) and the younger age groups were more commonly affected — 26% of patients were less than 1 year old and 65% less than 3 years of age. At the time of presentation 40% of the 151 children tested had a negative tuberculin test. A chest radiograph was available in 136 cases. The commonest changes seen were lymphadenopathy (63%) and segmental lesions (56%). The latter affected mainly the right lung and in particular the right middle lobe. Cavitating tuberculous disease was present in 19 children, including 5 aged less than 1 year.

S Afr Med J 1985; **67**: 588-590.

Tuberculosis remains the most common notifiable infectious disease in the RSA. While certain pointers indicate a reduction in the rate at which infection is taking place, the actual number of cases of tuberculous disease seems certain to increase for the foreseeable future.[1]

Most medical practitioners are familiar with the radiographic appearance of adult or post-primary tuberculosis and the diagnosis can often be confirmed by sputum microscopy and culture. In children, however, the radiographic appearance of primary pulmonary tuberculosis (PTB) and the spectrum of its complications and sequelae are different and the disease may initially pass unrecognized. Bacteriological confirmation of the diagnosis is not easily obtained and circumstantial evidence must often be relied upon when initiating specific antituberculosis therapy.[2]

We present our experience with some of the clinical and radiological features of bacteriologically confirmed childhood PTB.

Patients and methods

During the period 1979-1982 185 cases of PTB confirmed by culture of *Mycobacterium tuberculosis* from gastric aspirate, sputum or pleural fluid were seen in the Department of Paediatrics, Tygerberg Hospital. Specimens were examined microscopically for acid-fast bacilli after auramine staining[3] and cultured on Löwenstein-Jensen medium[4] according to a standard procedure. Colonies were identified as *Myco. tuberculosis* by the niacin and nitrate reduction tests.[3]

Certain clinical details including age, sex, mass, percentile of mass for age, results of tuberculin tests and prominent symptoms or signs were recorded retrospectively from patients' folders upon confirmation of the diagnosis.

Tuberculin testing is performed as a routine in all paediatric inpatients and outpatients. The multiple-puncture Heaf test is used as a screening test in the outpatient department and is administered and read by nursing or medical staff according to conventional criteria.[5] In cases where tuberculosis is strongly suspected the Mantoux test is administered and read by specially trained nursing staff using 5 units of purified protein derivative.[6] (In this article a positive tuberculin test means a Heaf test of grade II, III or IV or a Mantoux test with more than 5 mm induration.)

In 136 cases (74%) a chest radiograph had been taken within 2 weeks of the time at which the specimen positive on culture for *Myco. tuberculosis* was obtained; these films were analysed and abnormalities tabulated.

Results

Details of age, sex and race were available in all cases. Of the 185 children, 114 (62%) were boys and 71 (38%) girls. The majority of children — 147 (79%) — were coloured (mixed race) and the remaining 38 (21%) were black. The children's ages ranged from 2 months to 12 years 11 months with a median age of 23 months; 48 (26%) were less than 1 year old and 73 (39%) were 1-3 years old. Mass was not recorded in 4 cases. Of the remainder, 82 children (45%) were above the 3rd percentile mass for age and 99 (55%) below the 3rd percentile; 15 (8%) had a mass of less than 60% of the 50th percentile.

Tuberculin testing was carried out and the result read in 151 cases (82%). In 48 of 84 of these cases (57%) a Mantoux test was positive. In the remaining 67 cases a Heaf test had been done and was positive in 43 cases (64%). Thus 40% of the patients tested had a negative tuberculin test at the time of presentation.

A tuberculin test (either Mantoux or Heaf) was done in 65 of the 82 children with a mass above the 3rd percentile and was positive in 41 children (63%). A tuberculin test in 85 of the 99 children with a mass below the 3rd percentile was positive in 51 children (60%).

Similarly a tuberculin test done in 36 of the 48 children aged less than 1 year was positive in 17 cases (47%); the test in 62 of the 73 children aged 1-3 years was positive in 40 cases (65%). Of the 64 patients aged 3-13 years 53 were tuberculin tested and 34 (64%) had a positive result.

Wheezing was noted on presentation in 31 cases (17%), while stridor was present in 6 children and in 2 instances was severe enough to lead to tracheostomy. Two children with

Departments of Paediatrics, Radiology and Medical Microbiology, University of Stellenbosch and Tygerberg Hospital, Parowvallei, CP
P. R. DONALD, F.C.P. (S.A.), M.R.C.P., D.T.M. & H.
J. B. BALL, M.B. CH.B., *Registrar*
P. J. BURGER, M.MED. (PATH.)

particularly marked destruction of lung tissue had clubbing of the fingers.

Tuberculous meningitis was present in 17 cases (9%).

During the 4-year period under review 5 087 gastric aspirate specimens from children in the Department of Paediatrics, Tygerberg Hospital, were submitted to the Department of Microbiology for culture and microscopy. From these, 254 (5%) positive cultures for *Myco. tuberculosis* were obtained in 168 patients. In only 22 of these patients (13%) were acid-fast bacilli seen on microscopy. During the same period 39 (5%) of 832 sputum specimens from older paediatric patients were positive on culture for *Myco. tuberculosis*. These culture-positive specimens were obtained from 12 patients, in only 2 of whom (17%) acid-fast bacilli were visible on microscopy. In 3 cases *Myco. tuberculosis* was cultured from pleural aspirate and in 2 cases from tracheal aspirate.

The features observed in the 136 patients with available chest films were adenopathy, segmental lesions, bronchopneumonia, pleural effusion, cavitation, miliary appearance and calcification, singly or in various combinations; they are summarized in Tables I, II and III.

The term 'segmental lesion' refers to any radiographic opacity which clearly filled a lobe or a segment of a lobe. In many cases it was not possible to distinguish between a large Ghon's focus filling a lobe or segment and 'true' segmental lesions arising from varying combinations of lymph node enlargement and erosion with aspiration of tuberculous material into the relevant segment.

In Table I the frequencies of the relevant radiographic features identified are indicated, together with the number of patients having the particular feature as a solitary lesion. The commonest lesion encountered was adenopathy, present in 85 of the 136 cases (63%) in which films were available but appearing as a solitary feature in only 20 of these cases (15%). The second commonest feature was a segmental lesion, seen on 76 radiographs (56%) and appearing as a solitary lesion in 14 cases (10%).

TABLE I. FREQUENCY OF MAJOR RADIOLOGICAL CHANGES IN 136 CHILDREN WITH PTB

Type of change		No. of cases	Solitary lesion
Lymphadenopathy		**85 (63%)**	**20 (15%)**
Hilar	**26**		
Paratracheal	**33**		
Both	**26**		
Segmental lesion		**76 (56%)**	**14 (10%)**
Bronchopneumonia		**41 (30%)**	**7 (5%)**
Pleural effusion		**22 (16%)**	**3 (2%)**
Cavitation		**19 (14%)**	**—**
Miliary pattern		**14 (10%)**	**3 (2%)**
Normal		**3 (2%)**	**—**
Calcification		**1 (0,7%)**	**—**

In Table II the distribution of 99 segmental lesions in 76 patients is set out. The majority of lesions (70%) involved the right lung and in particular the right middle lobe (32% of the total).

Table III indicates the frequency of the radiographic features in three age groups — children aged less than 1 year, between 1 and 3 years, and 3 years and over.

Lymphadenopathy was seen more frequently in children under 3 years of age (67%) than in those over 3 years (59%), while a segmental lesion was seen with equal frequency (57%) in those above and below 3 years of age. Bronchopneumonia was present in 38% of children under 3 years of age, but in only 18% of those older than 3 years. In contrast, a pleural effusion was present in only 11% of patients under 3 years of age, but 27% of those older than 3 years. Right-sided pleural effusion was present in 12 patients (55%) and a left-sided effusion in 7 patients (32%), while 3 patients had bilateral effusions. A tuberculin test performed in 20 of the 22 patients with a pleural effusion was positive in 10 (50%).

TABLE II. SITE OF 99 SEGMENTAL LESIONS IN 76 PATIENTS

Site	No.
Right lung — 69 (70%)	
Upper lobe	**23**
Middle lobe	**32**
Lower lobe	**14**
Left lung — 30 (30%)	
Upper lobe	**14**
Lingula pulmonis	**6**
Lower lobe	**10**

TABLE III. FREQUENCY OF RADIOLOGICAL CHANGES IN DIFFERENT AGE GROUPS IN 133* CASES OF CHILDHOOD PTB

	Age group		
Type of change	0 - 1 yr (39 cases)	1 - 3 yrs (45 cases)	3 - 13 yrs (49 cases)
Lymphadenopathy	**22 (56%)**	**34 (76%)**	**29 (59%)**
Segmental lesion	**22 (56%)**	**26 (58%)**	**28 (57%)**
Bronchopneumonia	**16 (41%)**	**16 (36%)**	**9 (18%)**
Pleural effusion	**1 (3%)**	**8 (18%)**	**13 (27%)**
Cavitation	**5 (13%)**	**8 (18%)**	**6 (12%)**
Miliary pattern	**7 (18%)**	**3 (7%)**	**4 (8%)**
Calcification	**—**	**—**	**1 (2%)**

*Of the 136 radiographs available, 3 were normal when positive culture material was obtained, although subsequently these patients' films were abnormal.

Cavitating disease was present in 19 children (14%), 5 of whom were under 1 year of age. As in the case of segmental lesions, the right lung was more commonly involved (12 children) than the left lung (5 children). In 2 children bilateral cavitation was present. The right middle lobe was involved in 8 cases, the right upper lobe in 6, the left upper lobe in 4 and the left lower lobe in 3. In several cases cavitation was accompanied by marked bulging of the adjacent interlobar fissure.[7] A tuberculin test performed in 18 children with cavitation was positive in 13 (72%). Fifteen of the patients with cavitation were coloured and the remaining 4 were black.

Calcification, in the region of the hilar and paratracheal glands, was seen on only 1 radiograph.

Three patients had a normal radiograph at the time when positive culture material was obtained. Subsequently, abnormal films were seen, and it is reasonable to assume that the initial lesions were either obscured or too small to be seen.

Discussion

The clinical features of childhood PTB and its complications revealed by this review do not differ markedly from those described by other workers in developing countries.[8-11] Thus it is not unexpected that the majority of children should be male nor that younger children should be more frequently affected.

While the majority of children had a mass less than the 3rd percentile for age it should be borne in mind that recent surveys have shown that 30-66% of non-white children in

South Africa suffer from nutritional growth retardation.[12] Under these circumstances a recent falling off in the speed of gain in mass as reflected on a Child Health Card would be more relevant to the diagnosis of PTB than the evaluation of a single weighing.[13]

It is important to note that a relatively large percentage of children had a negative tuberculin test, despite the fact that the majority would have received BCG at least once. Failure to respond to tuberculin in the presence of active tuberculosis is a well-described phenomenon. It may result from poor nutrition,[14] recent measles or measles immunization,[15] overwhelming tuberculous infection[16] or an inherent lack of tuberculin hypersensitivity.[17] The diagnosis of tuberculosis should not be rejected merely because the tuberculin test is negative. Conversely, in certain circumstances a positive tuberculin test may be all the more significant despite the fact that the child might have had BCG.

Respiratory illnesses resulting from a variety of allergies and infections represent a large proportion of paediatric work, and wheezing is therefore a common complaint. Seventeen per cent of our patients were wheezing on presentation. In the appropriate setting, tuberculosis must be considered in the differential diagnosis of wheezing.

Clubbing has been described in association with PTB, but as in the case of the 2 children in this series usually only in the presence of gross destruction of lung tissue.[18] In at least one series,[9] however, clubbing in children was noted in the absence of cavitating disease. Cavitating tuberculous disease in young children has been reported previously in black children[7,11,19,20] and is now shown to affect coloured children. It is of interest that the children with cavitation had a higher percentage (73%) of positive tuberculin tests than the overall incidence (60%) in the 151 patients who had these tests. Hypersensitivity T cells may be responsible for tissue damage and necrosis rather than immunity.[21]

In contrast with adults, the diagnosis of PTB in childhood is infrequently confirmed by culture. Much more reliance must therefore be placed on radiographic appearances in combination with the results of tuberculin testing, a history of contact with PTB, and other circumstantial evidence. This series of bacteriologically confirmed cases emphasizes the importance of lymphadenopathy and the segmental lesion in indicating the possible presence of PTB.

Conclusion

In the absence of bacteriological confirmation certain radiological features may be confidently ascribed to childhood PTB. This is particularly true of adenopathy in association with a variety of segmental lesions and a strongly positive tuberculin test. It must, however, be emphasized that many features of childhood PTB are not specific, that adenopathy is not always recognizable on the radiograph and that the tuberculin test may often be negative. A high degree of suspicion must be maintained at present in southern Africa. Any pneumonia that does not respond to appropriate antibiotic therapy must be suspected of being tuberculous, even if bacteriological confirmation of the diagnosis cannot be obtained.

The bacteriologically confirmed cases in this series should be seen as the tip of the childhood PTB iceberg in the Western Cape. It may well be that the disease is responsible for considerably more morbidity and mortality than is at present generally appreciated.[22]

The authors would like to thank Professor J. A. Beyers for helpful advice and criticism, Dr L. E. van Zyl for assistance with the compilation of statistical data, and the Medical Superintendent of Tygerberg Hospital for permission to publish.

REFERENCES

1. Fourie PB. The prevalence and annual rate of tuberculous infection in South Africa. *Tubercle* 1983; **64:** 181-192.
2. Rosen EU. The problems of diagnosis and treatment of childhood pulmonary tuberculosis in developing countries. *S Afr Med J*; Special Issue, 17 November 1982: 26-28.
3. Vestal AL. *Procedures for the Isolation and Identification of Mycobacteria* (DHEW No. (CDC) 77-8230). Atlanta, Ga: Centers for Disease Control, 1977: 35-37.
4. Kleeberg HH, Koornhof HJ, Palmhert H. *Laboratory Manual of Tuberculosis Methods.* 2nd rev. ed. Pretoria: Tuberculosis Research Institute, 1980: 84.
5. Collins TFB. Interpretation of the multiple puncture tuberculin reaction. *S Afr Med J* 1970; **44:** 1287-1289.
6. American Thoracic Society. Diagnostic standards and classification of tuberculosis and other mycobacterial diseases (14th ed.). *Am Rev Respir Dis* 1981; **124:** 343-358.
7. Joffe N. Cavitating primary pulmonary tuberculosis in infancy. *Br J Radiol* 1960; **33:** 430-439.
8. Carter FS. Primary tuberculosis in African children. *Arch Dis Child* 1954; **29:** 213-219.
9. Soboyejo OA. Tuberculosis in Nigerian children. *West Afr Med J* 1959; **8:** 220-225.
10. Aderele WI. Pulmonary tuberculosis in childhood. *Trop Geogr Med* 1979; **31:** 41-51.
11. Freiman I, Geefhuysen J. Tuberculosis in Black children. *S Afr Med J* 1975; **49:** 1591-1594.
12. Medical Association of South Africa. Wanvoeding is meer as net 'n hongermaag. *SA Medical News* 1983; **3** (1): 1.
13. Morley DC, Woodland M. The growth curve in specific diseases. In: Morley DC, Woodland M, eds. *See How They Grow.* 1st ed. London: Macmillan 1979: 89-115.
14. Lloyd AVC. Tuberculin test in children with malnutrition. *Br Med J* 1968; **3:** 529.
15. Starr S, Berkovich S. Effects of measles, gamma-globulin modified measles and vaccine measles on the tuberculin test. *N Engl J Med* 1964; **270:** 380-391.
16. Kent DC, Schwartz R. Active pulmonary tuberculosis with negative tuberculin skin reactions. *Am Rev Respir Dis* 1967; **95:** 411-418.
17. Steiner P, Rao M, Victoria MS *et al.* Persistently negative tuberculin reactions. *Am J Dis Child* 1980; **134:** 747-748.
18. Macfarlane JT, Ibrahim M, Tor-Agbidye S. The importance of finger clubbing in pulmonary tuberculosis. *Tubercle* 1979; **60:** 45-48.
19. Solomon A, Rabinowitz L. Primary cavitating tuberculosis in childhood. *Clin Radiol* 1972; **23:** 483-485.
20. Aderele WI. Radiological patterns of pulmonary tuberculosis in Nigerian children. *Tubercle* 1980; **61:** 157-163.
21. Crowle AJ, Douvas LS, May MH. The cellular and molecular nature of human tuberculo-immunity. *Bull Int Union Tuberc* 1983; **58:** 72-80.
22. Dommisse J. Undiagnosed primary tuberculosis as a possible major cause of a high infant/child mortality rate. *J Trop Pediatr* 1975; **21:** 307-310.