

Tennis Racket sign – an underacknowledged sign of active tuberculosis

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SUMMARY

World Health Organization (WHO) has reported tuberculosis as the thirteenth leading cause of death worldwide. Tuberculosis (TB) is also the second leading infectious killer after COVID-19, surpassing acquired immunodeficiency syndrome (AIDS).¹ Therefore, it is only prudent that clinicians are equipped with adequate knowledge to diagnose tuberculosis. Cavitation is recognised as a common finding of active pulmonary TB on chest radiographs. However, the 'Tennis Racket' sign which is made up of a cavity, is less frequently acknowledged as a sign of active TB. We present a case series of five patients who visited our TB clinic between January 2021 and January 2022. They presented with various symptoms such as fever, chronic cough, shortness of breath and constitutional symptoms. The chest radiographs of all these patients showed the 'Tennis Racket' sign. We then proceeded with sputum for Ziehl Neelson stain to look for acid-fast bacilli (AFB). Four out of five patients had positive sputum for AFB. The patient with the negative sputum AFB underwent bronchoscopy. This patient's bronchial washing for AFB direct smear and mycobacterial tuberculosis (MTB) Gene Xpert were positive. Hence, all patients were diagnosed with pulmonary TB and started on antituberculosis treatment. They showed significant improvement. The 'Tennis Racket' sign is a feature of active pulmonary TB. The identification of this sign should initiate a search for pulmonary TB and its subsequent management. We hope this article will shed light on how to recognise the 'Tennis Racket' sign and its importance in diagnosing active pulmonary TB.

INTRODUCTION

Since the discovery of *Mycobacterium tuberculosis* in 1882, tuberculosis (TB) has become a global concern, claiming many lives each year, especially in developing nations. The diagnosis of pulmonary TB is conclusively established by demonstration of *Mycobacterium tuberculosis* from sputum, body fluid or tissue. However, chest radiograph remains a crucial tool in suggesting a diagnosis of pulmonary TB. Furthermore, obtaining a positive specimen from patients often takes more time compared to performing a chest radiograph. Hence, it is important that clinicians are well versed with the radiological signs associated with this treatable disease. One of these signs is the underacknowledged, 'Tennis Racket' sign, which will be further discussed in detail in this case series.

Cavitation is frequently seen in post-primary tuberculosis, as much as in 20 to 45% of cases. In post-primary TB, cavity has

a predilection for the apical and posterior segments of the upper lobes as well as the superior segments of the lower lobes.¹ Pulmonary cavitation is associated with high bacillary burden.^{2,3} The 'Tennis Racket' sign is a damaged bronchus connecting the cavity to the hilum. It has not gained much attention over these years, except for being mentioned in a few case reports and case series.

CASE REPORT

We presented case reports of five patients who visited the TB clinic at our centre between January 2021 and January 2022. These patients were chosen by virtue of their chest radiographs showing the 'Tennis Racket' sign. A total of 285 patients were registered at our TB clinic throughout that time duration. We went through their chest radiographs and those with the 'Tennis Racket' sign were identified.

Case 1

A 40-year-old Rohingya male with no known medical illness previously, presented with non-productive chronic cough for 3 months with loss of appetite and weight. He lived in a crowded house with other foreigners but denied any history of TB contact. Physical examination revealed bronchial breath sound and crepitations over left upper zone. His total white blood cell (TWBC) count was elevated at $14.5 \times 10^9/L$. There was no anaemia or thrombocytosis. His renal profile and liver function tests were normal. Erythrocyte sedimentation rate (ESR) was not available for this patient. The chest radiograph showed 'Tennis Racket' sign on left upper lobe (Figure 1a). Anti-TB treatment was started immediately and later sputum for AFB came back as positive (3+).

Case 2

A 70-years-old Malay woman with underlying type II diabetes mellitus, which was poorly controlled with HbA1c of 10.5%, presented with fever for one week which was associated with productive cough and loss of appetite. Clinically, there were bronchial breath sounds and crepitations at the right upper and middle zones. Her TWBC count and ESR both were elevated, $17 \times 10^9/L$ and 105 mm/hour, respectively. There was also normochromic, normocytic anaemia with haemoglobin (Hb) of 9.7 g/dl. Other blood investigations were within normal limits. Chest radiograph revealed 'Tennis Racket' sign at the right upper zone as well as patchy consolidation over bilateral lung fields (Figure 1b). Anti-TB medications were started right away, and her sputum AFB resulted in a positive result (3+).

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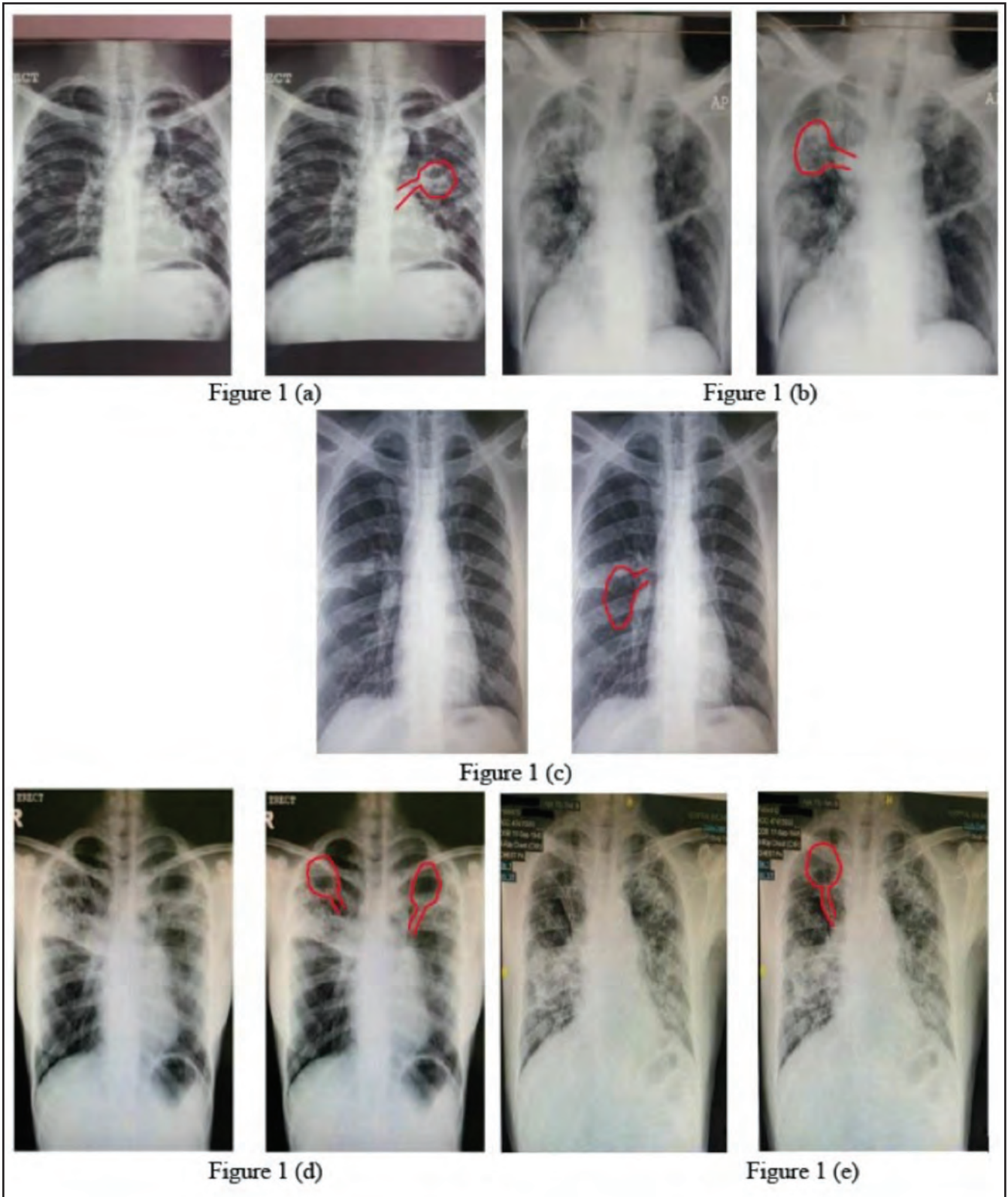


Fig. 1: (a) 'Tennis Racket' sign at left middle zone.
(b) 'Tennis Racket' sign at right upper zone.
(c) 'Tennis Racket' sign at right middle zone.
(d) 'Tennis Racket' sign at bilateral upper zones.
(e) 'Tennis Racket' sign at right upper zone.

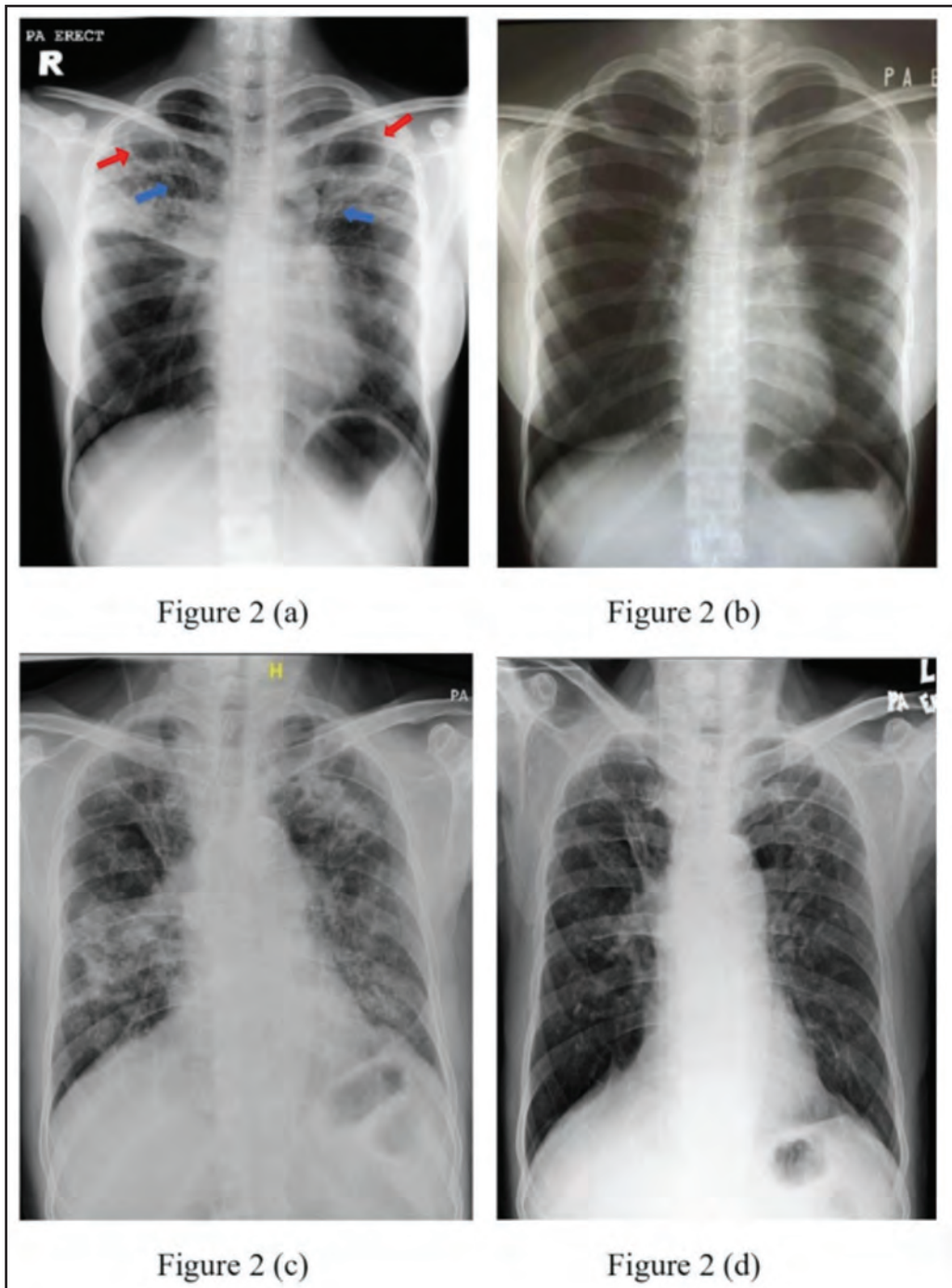


Fig. 2: (a) Pre treatment chest radiograph for Case 4
(b) Post treatment chest radiograph for Case 4
(c) Pre treatment chest radiograph for Case 5
(d) Post treatments chest radiograph for Case 5

Case 3

A 45-years-old Indian man who is an active smoker and consumed alcohol occasionally but no other significant comorbidities, presented with three months history of cough and loss of appetite and weight. There was no history of close contact with another TB patient. On examination, there were crepitations at the right middle and lower zone. His ESR was elevated at 165 mm/hour, but all other investigations were within normal limits. A 'Tennis Racket' sign was seen in the right mid zone on chest radiograph (Figure 1c). Anti TB medications were started while waiting for sputum for AFB which was positive (2+).

Case 4

A 17-years-old Malay student with no known medical illness previously presented with productive cough, fever and loss of appetite for four days. She lived at the hostel of a boarding school but unsure of any TB contact. Physical examination revealed crepitations over bilateral upper zones. Her blood investigations showed leucocytosis and thrombocytosis with TWBC of $18 \times 10^9/L$ and platelet count of $509 \times 10^9/L$. ESR was also elevated at 125 mm/hour. Other blood investigations were within normal limits. Chest radiograph showed 'Tennis Racket' sign over bilateral upper zones (Figure 1d). Her sputum for AFB was positive (3+) and anti-TB treatment was started immediately.

Case 5

A 76-years-old Chinese male with underlying hypertension which was well controlled, presented with shortness of breath and loss of appetite and weight for two months. Clinically, there were crepitations over bilateral lower zones. Blood investigations revealed an elevated ESR (98 mm/hour) and hyponatremia (sodium: 126 mmol/l), other blood investigations were normal. Chest radiograph revealed 'Tennis Racket' sign over right upper zone (Figure 1e). Three early morning samples for sputum for AFB were negative. In view of strong clinical suspicion of TB, we proceeded with bronchoscopy and bronchial washing for AFB direct smear revealed a positive result. MTB Gene Xpert was also positive and showed sensitivity to rifampicin. Anti-TB treatment was started.

Human immunodeficiency virus (HIV) test was negative for all the five patients. They were started on first line anti-TB treatment, which included 2 months of intensive phase with isoniazid, rifampicin, pyrazinamide and ethambutol followed by months of isoniazid and rifampicin. The *Mycobacterium tuberculosis* culture which came out later was sensitive to first line anti-TB medications for all patients. All patients showed remarkable improvement clinically. Sputum smears converted to negative at two months of treatment. There was resolution of the cavities seen in the post treatment chest radiographs that were available. Pre and post treatment chest radiographs of Case 4 and Case 5 are displayed in Figure 2 (a-d). We were unable to trace the chest radiographs of the patients Case 1-3.

DISCUSSION

A cavity is defined by the Fleischner Society as a gas-filled area in a pulmonary mass, nodule or consolidation. The

most common infectious cause of persistent cavitory illness is reactivation of TB. The other causes of a pulmonary cavity are pyogenic infections (*Staphylococcus*, *Klebsiella*, anaerobes), lung abscess, necrotising pneumonia, non-tuberculous mycobacterial infections, septic emboli, fungal pneumonia, primary lung malignancy (most commonly squamous cell carcinoma) and rheumatological conditions such as rheumatoid arthritis and Wegener's granulomatosis.³

A pulmonary cavity develops because of liquefactive necrosis and subsequent debris evacuation through the bronchial tree.³ The 'Tennis Racket' sign reflects TB infection of the bronchus. Narrowing or occlusion of the bronchus results in dilatation distally producing a ring shadow, which forms the cavity (Figure 2 (a), red arrow). The rest of the bronchus, which extends proximally towards the hilum, is often dilated and its wall thickened by TB involvement, resulting in a 'Tennis Racket' shadow⁴ (Figure 2 (a), blue arrow).

A cavity is known to have a higher number of TB bacilli, i.e., 100 000 times as many as in noncavitory lesions.⁵ The direct communication of the cavity with the bronchus explains the high bacterial yield observed with this sign. This is consistent with the findings in our case series, where sputum for AFB was positive in four out of five patients. Three of the patients exhibited strongly positive sputum AFB (3+, more than 60 AFB per high power field) indicating high bacterial yield. The patient in Case 5 who tested negative for sputum AFB was only able to produce a poor sputum sample despite induction with hypertonic saline, hence, explaining the negative results. Subsequently, bronchial washing AFB direct smear and MTB Gene Xpert came back as positive confirming pulmonary TB.

The ESR test is usually sent as a nonspecific test in the initial work-up for TB. It can be raised in multiple conditions such as acute and chronic infections, systemic inflammatory state and malignancy. The most common infection with raised ESR level is TB. Several studies have proven that raised ESR (typically > 100) is more commonly found in symptomatic, smear or culture positive TB.⁶⁻⁸ Four out of five of our patients had a raised ESR. The ESR value was not available for one of the patients. This shows that the findings in our case series was consistent with other studies.

Initiation of anti-TB treatment resulted in significant improvement both clinically and radiologically in the chest radiographs that were available. There was resolution of the cavities. Similar results were also observed in other case reports.⁵ We suggest that the 'Tennis Racket' sign can be used to start anti-TB treatment while awaiting definite microbiological evidence of TB, especially in rural and low resource areas.

CONCLUSION

This case series confirm that the 'Tennis Racket' sign is an important radiological feature of active pulmonary tuberculosis (TB). It is associated with a high bacillary burden. All in all, presence of this sign should instigate a search for TB and its treatment. Hence, it is crucial for clinicians to be able to acknowledge this sign.

CONFLICT OF INTEREST

None.

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