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ORIGINAL ARTICLE

Active Tuberculous Endobronchitis: Computed Tomography Findings and Implications

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ABSTRACT

Objective: *To describe the pattern of bronchostenosis revealed by computed tomography and virtual bronchoscopy in patients with active tuberculous endobronchitis and associated pulmonary manifestations.*

Methods: *This retrospective study was conducted in Hong Kong, which is an endemic region for tuberculosis, where tuberculous endobronchitis remains a noteworthy clinical entity, with reported frequency of 10 to 40% in patients with active pulmonary tuberculosis. Medical records of a series of 18 patients with active endobronchial tuberculosis (without acquired immunodeficiency syndrome), having acid-fast bacilli in sputum smears, underwent computed tomography and virtual bronchoscopy in two regional hospitals between January 2007 and October 2009 were reviewed. The location, morphology, length, and percentage of luminal bronchostenotic narrowing were evaluated by such imaging and compared with fibre-optic bronchoscopy findings. Associated parenchymal manifestations, namely tree-in-bud nodules, cavitary lesions, segmental atelectasis and enlarged mediastinal lymph nodes, were assessed.*

Results: *Involvement of tuberculous endobronchitis at a single major lobar bronchus with contiguous spread along ipsilateral bronchial tree was observed in most patients (n = 16, 89%). A mural cause of bronchostenosis remained the most frequent finding (n = 12, 67%), with irregular circumferential thickening predominating (n = 8, 44%). Regarding associated parenchymal manifestations, tree-in-bud nodules occurred in all patients (n = 18, 100%); cavitary lesions (n = 9, 50%) and segmental atelectasis (n = 7, 39%) were less frequent. Mediastinal lymph node enlargement was a rare finding (n = 3, 17%). Fibre-optic bronchoscopy performed during the same admission showed confirmatory results in all available cases (n = 14).*

Conclusion: *Centripetal spread of tuberculous endobronchitis from distal small airways to proximal central airway was observed in the majority of our patients. This could correlate with probable pathogenic mechanisms including the submucosal lymphatic spread of tuberculous bacilli and the implantation of bacilli by infected sputum along the bronchial tree. Relative left-sided predominance of bronchial involvement was observed, possibly related to intrinsic anatomical difference in lymphatic drainage between left- and right-sided bronchi. Irregular circumferential and eccentric mural thickening was the most common morphological pattern of bronchostenosis with mural thickening. Mediastinal lymph node enlargement was rare.*

Key Words: *Bronchitis; Tomography, X-ray computed; Tuberculosis, pulmonary*

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中文摘要

支氣管內膜結核活躍期：電腦斷層掃描結果和啟示

宋咸東、岑承輝、關永豪

目的：描述支氣管內膜結核活躍期的病人電腦斷層掃描和虛擬支氣管鏡檢查顯示的支氣管狹窄的模式，及相應的肺部變化。

方法：回顧研究於香港完成。結核是香港的地方病，其肺結核患者中有一至四成為支氣管結核，所以此病仍然是值得關注的臨床疾病。本文回顧香港兩間分區醫院於2007年1月至2009年10月期間收治的18名支氣管內膜結核活躍期（並無愛滋病）病人的病歷，病人的檢查包括痰塗片抗酸桿菌測試、電腦斷層掃描和虛擬支氣管鏡。評價支氣管腔狹窄的位置、形態、長度及百分比；並與纖維支氣管鏡顯示結果比較。同時評估相應的肺實質表現：樹芽徵、空洞、肺段不張及縱隔淋巴結腫大。

結果：大多數患者（n = 16，89%）的支氣管結核病灶累及單支葉主支氣管，並沿同側支氣管樹播散。最常見的仍是管壁因素引致的支氣管狹窄（n = 12，67%），同時以管壁不規則環形增厚為主（n = 8，44%）。相應的肺實質表現為：所有患者均有樹芽徵（n = 18，100%）；空洞性病變（n = 9，50%）和肺段不張（n = 7，39%）相對較少。縱隔淋巴結腫大更為罕見（n = 3，17%）。所有該次入院的纖維支氣管鏡檢查（n = 14）均證實相應的影像表現。

結論：本研究大部份的病人均存在病灶從遠端細支氣管向近端中央型支氣管播散的「向心傳播」現象。這與可能的致病機制有關，包括結核桿菌沿黏膜下淋巴道播散，以及含菌痰液中的細菌沿支氣管樹種植播散。相對來說，以左肺支氣管受累為主，這可能與左右支氣管之間淋巴引流的差別有關。管壁不規則環形增厚和偏心型增厚是最常見的支氣管狹窄形態。縱隔淋巴結腫大則屬罕見。

INTRODUCTION

Tuberculous endobronchitis was reported to occur in 10 to 40% of patients with active pulmonary tuberculosis.[1] Among these patients, up to 90% suffered from a certain degree of bronchostenosis.[1] Fibre-optic bronchoscopy played its essential role in clinical management, through which the mucosal erythema, ulcerations and fibrotic scarrings within the stenosed bronchus could be directly visualised and biopsied. On many occasions, however, the bronchial lumen more distal to the stenosed airways could not be readily assessed by this means. By contrast, computed tomography (CT) and virtual bronchoscopy provide prime complementary investigation tools to evaluate the degree and morphology of stenosis in the bronchial tree and associated parenchymal and mediastinal manifestations of pulmonary tuberculosis in detail. Thus, the purpose of this study was to describe CT and virtual bronchoscopy findings and associated pulmonary manifestations among patients with active tuberculous endobronchitis and bronchostenosis, who also underwent confirmatory fibre-optic bronchoscopy.

METHODS

We conducted a retrospective analysis of the CT and virtual bronchoscopic findings of 18 patients (16 females) with active endobronchial tuberculosis (without acquired immunodeficiency syndrome) from January 2007 to October 2009. Patient ages ranged from 14 to 82 (mean, 33) years. All of them had sputum smear microscopy positive for acid-fast bacilli (AFB), implying active disease.

All CTs were obtained with a Toshiba Aquilion 16-slice CT scanner (Toshiba, Tochigi-ken, Japan) using helical and a single breath-holding technique, both before and after intravenous contrast administration. A dose reduction protocol with 120 kVp and variable mAs was employed. The axial image thickness for pre- and post-contrast scans after reconstruction was 5 mm and 1 mm, respectively. A bolus of 70 ml of Iopamiro 370 (Bracco s.p.a., Milan, Italy), and after the contrast scan 20 ml of a saline flush was injected at 2.5 ml/s.

All of the axial, reconstructed 3D, multi-planar reformat

and virtual bronchoscopic images were analysed for location, extent, and morphology of the bronchostenosis. The length and degree of luminal narrowing (in terms of percentage reduction in expected diameter) were noted. Intra- and extra-luminal pathologies around the stenosed bronchi, as well as associated parenchymal manifestations, namely, tree-in-bud nodules, cavitary lesions, segmental atelectasis, and enlarged mediastinal lymph nodes were also looked for.

Among the 18 patients in our series, 14 of them had fibre-optic bronchoscopy performed in the same admission. Findings from the fibre-optic bronchoscopy were compared with corresponding findings from CT.

RESULTS

The location and morphology of the stenosed bronchi derived from imaging are summarised in Tables 1 and 2, respectively. Fibre-optic bronchoscopy performed in the same admission showed confirmatory results for all available cases (n = 14).

The majority of patients (n = 10, 56%) presented with left upper lobe bronchostenosis. The most common combined involvement (n = 6, 33%) also involved the left upper lobe bronchus, along with the left main bronchus. Unilateral predominance was observed in our study, with bilateral involvement only noted in one patient. Involvement of a single major lobar bronchus with contiguous spread along the ipsilateral bronchial tree was the most common manifestation (n = 16, 89%)

Table 1. Anatomical pattern of bronchostenosis.

	Single*	Combined*
Left	LUL bronchus (3)	LMB + LUL bronchus (6) LMB + LLL bronchus (1)
Right	RUL bronchus (2) BI (1) RLL bronchus (3)	RMB + RLL bronchus (1)
Bilateral	RUL bronchus + LUL bronchus (1)	

Abbreviations: BI = bronchus intermedius; LLL = left lower lobe; LMB = left main bronchus; LUL = left upper lobe; RLL = right lower lobe; RMB = right main bronchus; RUL = right upper lobe.
* No. of patients is shown in brackets.

Table 2. Morphological pattern of bronchostenosis.

Location	No. of patients
Mural	
Circumferential wall thickening	
Smooth	2
Irregular	8
Eccentric wall thickening	2
Intraluminal	
Low-density intraluminal material with bronchial wall thickening	4
Soft-tissue density intraluminal polypoid material	1
Extraluminal	
Extrinsic compression by adjacent enlarged lymphadenopathy	1

Regarding the morphological pattern of bronchostenosis, mural lesions with bronchial wall thickening were the most frequently encountered, and included irregular (n = 8, 44%) and smooth (n = 2, 11%) circumferential thickening, as well as eccentric thickening (n = 2, 11%). Intraluminal filling defects inside the affected bronchi were seen in five cases. Extrinsic compression onto the bronchus by adjacent enlarged lymph nodes was present in one patient only (6%). Excluding the cases with total bronchial occlusion, the length of stenosis ranged from 3.2 mm to 29.4 mm (mean, 11.3 mm). The affected bronchial lumen showed a mean reduction in diameter of 63% (range, 20-100%).

Regarding associated parenchymal manifestations, tree-in-bud nodules occurred in all patients (n = 18, 100%). Cavitary lesions (n = 9, 50%) and segmental atelectasis (n = 7, 39%) were less frequent. Mediastinal lymph node enlargement was rare (n = 3, 17%).

DISCUSSION

Tuberculous endobronchitis has been a popular area of interest in respiratory medicine. Its clinical significance stems from the fact that central airway involvement may lead to respiratory failure in the acute phase.[2] It may also lead to diagnostic problems, with bronchogenic carcinoma and bronchial asthma being common mimics in terms of clinical and radiographic findings.[3-5]

The histology in various stages of tuberculous endobronchitis has been well studied.[6-8] It begins with inflammatory oedema over the bronchial wall, associated with lymphocytic infiltration and tubercle formation at the submucosa, mucosal ulcerations, granulation tissue formation, and focal necrosis during the active phase (also known as ulceroproliferative phase). Bronchoscopy at this juncture shows granular, erythematous mucosa with patchy ulcers, caseous materials and hyperplastic changes. Along with disease progression, fibrotic healing process predominates in the chronic quiescent phase (also known as fibrostenotic phase), and results in a pale firm fibrotic mucosa with longitudinal corrugations seen via bronchoscopy.[7,8]

These late changes are irreversible despite anti-tuberculosis chemotherapy, implying a worse prognosis and may constitute an indication for bronchoplasty or bronchial stenting. Compared with fibre-optic bronchoscopy in the assessment of tuberculous endobronchitis, CT had shown merit to ascertain non-invasiveness at the location of interest, morphology and severity of involvement within the tracheobronchial tree, extrinsic lesions beyond the reach of fibro-optic bronchoscopy, and the associated parenchymal and mediastinal lesions. Notably, chest radiographs can appear normal in 10 to 20% of patients with endobronchial tuberculosis.[9,10]

Regarding the pathogenesis of tuberculous endobronchitis, there are five proposed mechanisms reported: (a) direct extension from adjacent parenchymal foci; (b) implantation of tuberculous bacilli from infected sputum along bronchial tree; (c) haematogenous dissemination; (d) dissemination via submucosal lymphatic channels from parenchyma distal to peribronchial proximal regions; and (e) direct erosion from adjacent peribronchial lymph nodes.[3,11-13]

After analysis of our CT findings, we reviewed other literature for correlations that reveal several important issues:

(1) In our study population, CT of all 18 patients showed associated tree-in-bud nodules (Figures 1 and 2). Involvement of tuberculous endobronchitis at a single major lobar bronchus with contiguous spread along the ipsilateral bronchial tree was observed in most patients (n = 16, 89%). This pattern of spread from small airway to central airway could be regarded as supportive evidence for tuberculous bacilli being implanted from infected sputum and submucosal lymphatic spread to peribronchial regions. Our observation echoes with various anatomical studies, which concurred with centripetal spread to larger proximal airways

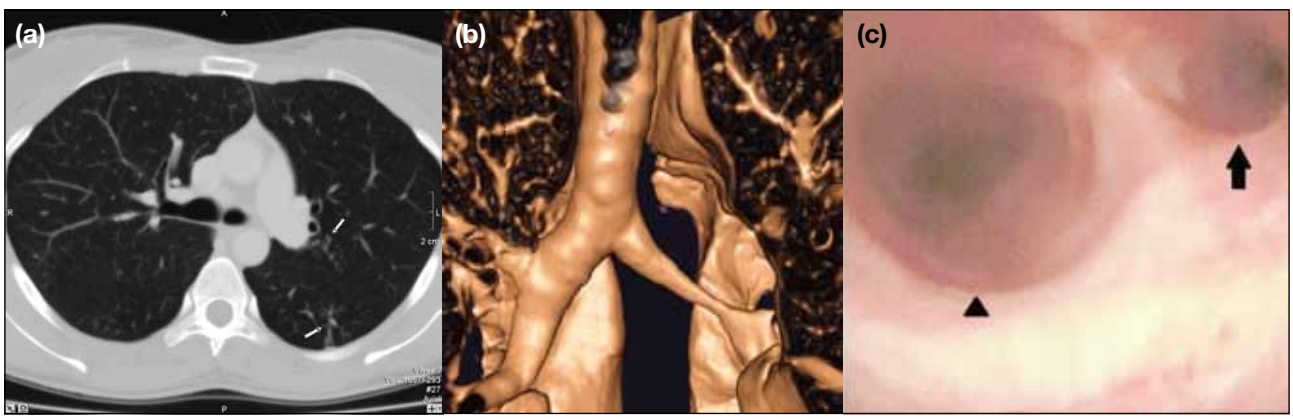

Figure 1. (a) Axial computed tomography of the thorax at carina level of a 29-year-old female patient shows several clusters of tree-in-bud nodules (arrows). (b) Reconstructed 3D virtual bronchoscopy demonstrates circumferential narrowing at the left main bronchus. (c) Fibre-optic bronchoscopy confirms moderate tapering of left main bronchus (arrow) compared with contralateral side (arrowhead).

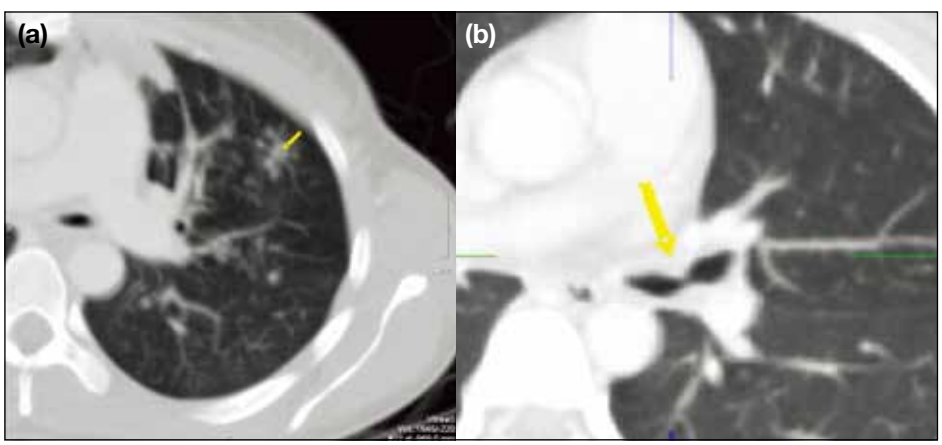

Figure 2. (a) Axial computed tomography of the thorax of a 27-year-old female patient shows diffuse tree-in-bud nodules in left upper lobe (arrow). (b) Another axial image demonstrates focal eccentric mural thickening leading to significant stenosis at left upper lobe bronchus (arrow).

from small distal airways near parenchymal lesions.[4,14] In a study by Choe et al,[7] in patients with tuberculous bronchial stenosis, on bronchial biopsies the main tuberculous lesions were confined to the submucosa, the mucosa either being intact or having only shallow ulcerations. This could imply a more important role for submucosal lymphatic spread than direct airway spread via infected sputum.

(2) With respect to the anatomical distribution of tuberculous endobronchitis, we observed predominantly left-sided involvement (11/18, 61%). This finding was consistent with other studies on tracheobronchial tuberculosis.[8,15,16] Intrinsic anatomical differences in lymphatic drainage of bronchial wall on the left and right side have been postulated for this relationship,[8] but the exact reason remains unclear.

(3) The morphology of bronchostenosis in our study frequently indicated mural involvement (n = 12, 67%) rather than an intraluminal (n = 5, 28%) or extraluminal (n = 1, 6%) cause. Irregular circumferential (n = 8; Figure 3) and eccentric (n = 2; Figure 2) wall thickening predominated in 86% of all cases of bronchostenosis with mural thickening. As bronchostenosis in active disease manifests as inflammatory oedema and hyperplastic changes during the early ulceroproliferative phase, it fits with active tuberculous since all our cases yielded sputum smears positive for AFB. This echoes with the observation by Moon et al,[16] in which irregular luminal narrowing with wall thickening was commonly seen in patients with active tracheobronchial tuberculosis.

(4) Mediastinal lymph node enlargement was a rare finding (n = 3, 17%) in our study; only one patient showed extrinsic bronchial compression by an enlarged adjacent lymph node, which suggests that direct bronchial erosion from adjacent peribronchial lymphadenopathies was an uncommon pathogenic mechanism. Another explanation for the rarity of extrinsic nodal compression could be the relatively large airway calibres in our adult patients, rendering them less vulnerable to significant bronchostenosis.

Arguably, a focused study on active tuberculous endobronchitis should have also recruited patients with chronic manifestations (fibrostenotic stage) based on sputum microscopy results. Nonetheless, various stages of endobronchial tuberculosis are well known to co-exist in some patients.[4,14] Another drawback of our study could be the small sample size, with a skewed mean age of patients (mean, 33; range, 14-82) years, rendering it less representative. This could be explained by possible underdiagnosis in elderly patients, as the diagnosis was often solely dependent on clinical and microscopic evidence in routine practice without CT.

CONCLUSION

Centripetal spread of tuberculous endobronchitis from distal small airways to proximal central airway was observed in a majority of our study patients. This could correlate with probable pathogenic mechanisms,

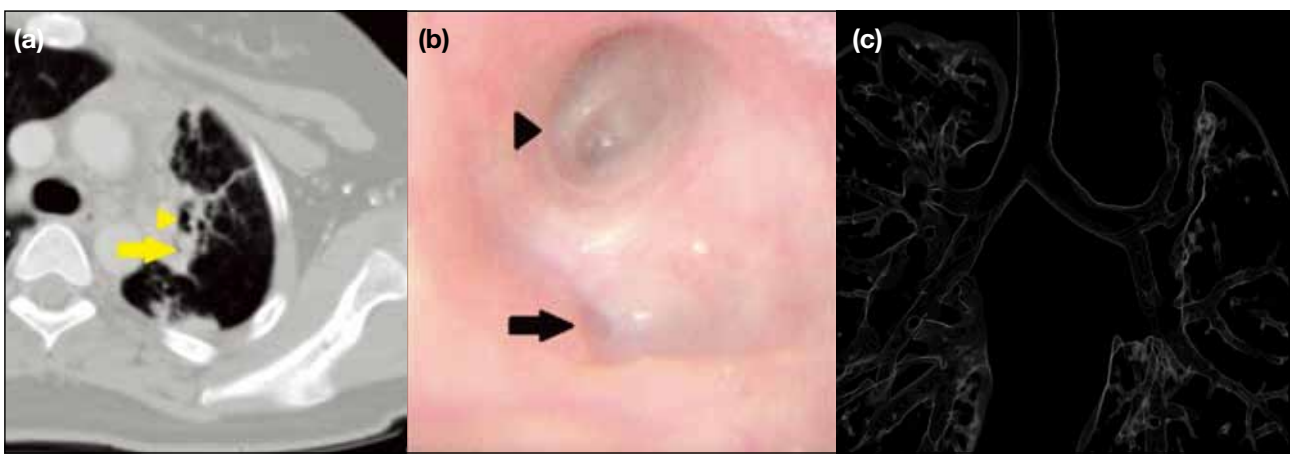

Figure 3. (a) Axial computed tomography of the thorax of an 18-year-old female patient shows irregular wall thickening with stenosis at apico-posterior segmental bronchus of left upper lobe (arrow) and the patent anterior segmental bronchus (arrowhead). (b) Fibre-optic bronchoscopy reveals fibrosis with near-total obstruction at the origin of apico-posterior segmental bronchus of left upper lobe (arrow) and the patent anterior segmental bronchus (arrowhead). (c) Reformatted 3D virtual bronchoscopy illustrates a long segment of circumferential narrowing with occasional truncation along the left upper lobe of the bronchial lumen.

including the submucosal lymphatic spread of tuberculous bacilli and implantation of bacilli by infected sputum along the bronchial tree. Relative left-sided predominance of bronchial involvement was observed, possibly due to intrinsic anatomical difference in lymphatic drainage on the two sides. Irregular circumferential and eccentric mural thickening was the most common morphological pattern in bronchostenosis with mural thickening. Mediastinal lymph node enlargement was a rare finding.

DECLARATION

No conflicts of interest are declared by authors.

REFERENCES

1. Han JK, Im JG, Park JH, Han MC, Kim YW, Shim YS. Bronchial stenosis due to endobronchial tuberculosis: successful treatment with self-expanding metallic stent. AJR Am J Roentgenol. 1992;159:971-2. cross ref
2. Natkunam R, Tse CY, Ong BH, Sriragavan P. Carinal resection for stenotic tuberculous tracheitis. Thorax. 1988;43:492-3. cross ref
3. Smith LS, Schillaci RF, Sarlin RF. Endobronchial tuberculosis. Serial fiberoptic bronchoscopy and natural history. Chest. 1987;91:644-7. cross ref
4. Salkin D, Cadden AV, Edson RC. The natural history of tuberculous tracheobronchitis. Am Rev Tuberc. 1943;47:351-69.
5. Watson JM, Ayres JG. Tuberculous stenosis of the trachea. Tubercle. 1988;69:223-6. cross ref
6. Smart J. Endo-bronchial tuberculosis. Br J Tuberc Dis Chest. 1951;45:61-8. cross ref
7. Choe KO, Jeong HJ, Sohn HY. Tuberculous bronchial stenosis: CT findings in 28 cases. AJR Am J Roentgenol. 1990;155:971-6. cross ref
8. Wilson NU. Bronchoscopic observations in tuberculous tracheobronchitis: clinical and pathological correlations. Dis Chest. 1945;11:36-59. cross ref
9. Kashyap S, Mohapatra PR, Saini V. Endobronchial tuberculosis. Indian J Chest Dis Allied Sci. 2003;45:247-56.
10. Lee JH, Park SS, Lee DH, Shin DH, Yang SC, Yoo BM. Endobronchial tuberculosis. Clinical and bronchoscopic features in 121 cases. Chest. 1992;102:990-4. cross ref
11. Lukomsky GI, Tetarchenko VE, editors. Bronchology. St Louis: Mosby; 1979. p 287-305.
12. Ip MS, So SY, Lam WK, Mok CK. Endobronchial tuberculosis revisited. Chest. 1986;89:727-30. cross ref
13. Kim YH, Kim HT, Lee LS, Uh ST, Chung HT, Park CS. Serial fiberoptic bronchoscopic observations of endobronchial tuberculosis before and early after antituberculous chemotherapy. Chest. 1993;103:673-77. cross ref
14. Medlar EH. The behavior of pulmonary tuberculous lesions; a pathological study. Am Rev Tuberc. 1955;71:1-245.
15. Kim Y, Lee KS, Yoon JH, Chung MP, Kim H, Kwon OJ, et al. Tuberculosis of the trachea and main bronchi: CT findings in 17 patients. AJR Am J Roentgenol. 1997;168:1051-6. cross ref
16. Moon WK, Im JG, Yeon KM, Han MC. Tuberculosis of the central airways: CT findings of active and fibrotic disease. AJR Am J Roentgenol. 1997;169:649-53. cross ref