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Bronchoscopy for the diagnosis of pulmonary tuberculosis in patients with negative sputum smear microscopy results*

Broncoscopia no diagnóstico de tuberculose pulmonar em pacientes com baciloscopia de escarro negativa

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Abstract

Objective: To evaluate the diagnostic accuracy of bronchoscopy in patients with clinical or radiological suspicion of tuberculosis who were unable to produce sputum or with negative sputum smear microscopy results. **Methods:** A prospective cross-sectional study involving 286 patients under clinical or radiological suspicion of having pulmonary tuberculosis and submitted to bronchoscopy—BAL and transbronchial biopsy (TBB). The BAL specimens were submitted to direct testing and culture for AFB and fungi, whereas the TBB specimens were submitted to histopathological examination. **Results:** Of the 286 patients studied, 225 (79%) were diagnosed on the basis of bronchoscopic findings, as follows: pulmonary tuberculosis, in 127 (44%); nonspecific chronic inflammation, in 51 (18%); pneumocystis, fungal infections, or nocardiosis, in 20 (7%); bronchiolitis obliterans organizing pneumonia, alveolites, or pneumoconiosis, in 14 (5%); lung or metastatic neoplasms, in 7 (2%); and nontuberculous mycobacterium infections, in 6 (2%). For the diagnosis of tuberculosis, BAL showed a sensitivity and a specificity of 60% and 100%, respectively. Adding the TBB findings significantly increased this sensitivity (to 84%), as did adding the post-bronchoscopy sputum smear microscopy results (total sensitivity, 94%). Minor post-procedure complications occurred in 5.6% of the cases. **Conclusions:** Bronchoscopy is a reliable method for the diagnosis of pulmonary tuberculosis, with low complication rates. The combination of TBB and BAL increases the sensitivity of the method and facilitates the differential diagnosis with other diseases.

Keywords: Bronchoscopy; Tuberculosis, pulmonary; Sputum; Bronchoalveolar lavage; Biopsy.

Resumo

Objetivo: Avaliar a acurácia diagnóstica da broncoscopia em pacientes com suspeita clínica ou radiológica de tuberculose, com baciloscopia negativa ou incapazes de produzir escarro. **Métodos:** Estudo transversal prospectivo de 286 pacientes com suspeita clínica/radiológica de tuberculose pulmonar e submetidos à broncoscopia — LBA e biópsia transbrônquica (BTB). As amostras de LBA foram testadas por pesquisas diretas e culturas de BAAR e de fungos, e as de BTB por exame histopatológico. **Resultados:** Dos 286 pacientes estudados, a broncoscopia contribuiu para o diagnóstico em 225 (79%): tuberculose pulmonar em 127 (44%); inflamações crônicas inespecíficas em 51 (18%); pneumocistose, infecções fúngicas ou nocardiose em 20 (7%); bronquiolite obliterante com pneumonia em organização, alveolites ou pneumoconioses em 14 (5%); neoplasias pulmonares ou metastáticas em 7 (2%); e micobacterioses não tuberculosas em 6 (2%). Para o diagnóstico de tuberculose, o LBA mostrou sensibilidade e especificidade de 60% e 100% respectivamente, havendo um aumento importante da sensibilidade quando associado à biópsia (84%) e à baciloscopia após a broncoscopia (94%). Complicações controláveis decorrentes do procedimento ocorreram em 5,6% dos casos. **Conclusões:** A broncoscopia representa um método diagnóstico confiável para pacientes com tuberculose pulmonar, apresentando baixos índices de complicações. A associação de biópsia transbrônquica ao lavado broncoalveolar elevou a sensibilidade diagnóstica do método e permitiu o diagnóstico diferencial com outras doenças.

Descritores: Broncoscopia; Tuberculose pulmonar; Escarro; Lavagem broncoalveolar; Biópsia.

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Introduction

Tuberculosis is one of the leading causes of infectious disease-related mortality, pulmonary tuberculosis being the most common form. According to the World Health Organization, the estimated worldwide incidence was 9.4 million new cases (137 cases/100,000 population) in 2009, the proportion of cases being higher in Asia (55%) and Africa (30%) and lower in the Mediterranean region (7%), Europe (4%), and the Americas (3%).[1] In Brazil, tuberculosis it the third leading cause of death from infectious diseases, accounting for 4,800 deaths/year. In 2010, 70,000 new cases were reported. The pulmonary forms account for 85% of all cases (53% with positive sputum smear microscopy results and 32% without bacteriological confirmation).[2]

Surveillance of cases and effective treatment are the cornerstones of disease control. The surveillance strategy consists of performing smear microscopy of two or three samples of sputum from individuals who have had cough and expectoration for more than 2 weeks; sputum smear microscopy is the main diagnostic method because it is inexpensive, collection is easy, and results are rapidly available.[2,3] Although sputum smear microscopy has a high positive predictive value (PPV) in Brazil (95%), the mean sensitivity of the method is 40-60%. In addition, the test is positive in only 20% of patients with minimal lung injury, and approximately 30% of patients cannot spontaneously expectorate, especially in the initial phases of the disease.[3] Other factors affect the diagnostic yield of smear microscopy: collection and analysis technique; secretion volume; and storage conditions. Sputum culture can increase the diagnostic yield by 20-40%, although the time needed for obtaining the final result—2-8 weeks when solid media are used or 10-40 days when automated non-radiometric systems are used—is a limiting factor.[3] Chest X-ray is also an important method for diagnosing tuberculosis. However, it has limitations: in up to 15% of cases, signs of the disease might not be shown, determining disease activity or sequelae is difficult, and the changes found are similar to those found in other diseases, such as neoplasia, pulmonary mycosis, and sarcoidosis.

Smear-negative tuberculosis cases are defined as those in which the patient presents with at least two negative sputum samples, X-ray findings suggestive of tuberculosis, no clinical response to treatment with antimicrobial agents (except fluoroquinolones), or any combination of the three. In cases in which it is impossible to collect spontaneous sputum or in which smear microscopy results are negative, induced sputum or bronchoscopy with collection of BAL specimens, with or without transbronchial biopsy (TBB), can be used.[4]

The objective of the present study was to evaluate the diagnostic yield of bronchoscopic methods, i.e., BAL, TBB, and the combination of the two, in patients with clinical or radiological suspicion of tuberculosis who were unable to produce sputum or with negative sputum smears. We also investigated the impact of the TBB findings and the post-bronchoscopy sputum smear results on the overall diagnostic yield of the procedure.

Methods

This was a prospective cross-sectional study conducted between January of 2006 and December of 2008. The study involved patients who were over 18 years of age and presented with suspected tuberculosis (main diagnostic hypothesis), having been referred for bronchoscopy. Those patients had been referred from the Pulmonology Outpatient Clinic of the *Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo* (HC-FMUSP, University of São Paulo School of Medicine *Hospital das Clínicas*), where they had undergone initial tests, including sputum smear microscopy (with negative results), or had been unable to produce sputum. The radiological changes were not uniformly reported on the data collection forms for all patients, which precluded a detailed analysis and correlating radiological findings with bronchoscopic findings.

The study was approved by the local research ethics committee, and all of the patients or their legal guardians gave written informed consent.

Bronchoscopy with collection of BAL and TBB specimens was performed at the Respiratory Endoscopy Department of the HC-FMUSP. Patients with contraindications to bronchoscopy, such as coagulation disorders, thrombocytopenia, uremia, single lung, and severe pulmonary hypertension, were excluded. We used 4.9/5.0-mm fiberoptic bronchoscopes with a 2.2-mm working channel (Pentax® FB-15V; Asahi Optical Co., Tokyo, Japan, or Olympus® P20D; Olympus Corp., Tokyo, Japan). All of the patients underwent the procedure in

the supine position, on spontaneous ventilation, and under intravenous sedation with midazolam and fentanyl citrate. We used 1% topical lidocaine without vasoconstrictor (up to 7 mg/kg) for topical airway anesthesia during the procedure. All of the patients received oxygen supplementation through a nasal catheter and were monitored by pulse oximetry, cardioscopy, and noninvasive arterial pressure measurement.

After inspection of the bronchial tree and description of the endoscopic findings, BAL and TBB specimens were collected in the lung segments that had previously been selected on the basis of the chest X-ray or CT findings. For the collection of BAL specimens, we used a 0.9% saline solution volume of 100-150 mL, at room temperature. The recovered volume was submitted to direct examination (Gram staining and smear microscopy for AFB and fungi) and culture. The TBB was performed with flexible forceps (Radial Jaw 3; Boston Scientific®, San Jose, USA), and three to six lung parenchyma fragments were collected for histopathological examination. During the biopsy procedure, some of the patients had moderate bleeding, which was controlled with local measures, such as pressing the device onto the segment and maintaining continuous suction, instilling cold saline, or instilling a solution containing epinephrine.

After completion of the procedure, the patients were maintained in the recovery room, where they were monitored and received oxygen supplementation until full recovery of consciousness. Subsequently, they were referred to the outpatient clinic of origin. Routine chest X-ray was performed one hour after completion of the procedure in the patients with clinical suspicion of pneumothorax,[5] i.e., those presenting with pleuritic chest pain ipsilateral to the TBB site, as well as those presenting with significant dyspnea or significant dry cough.

For the diagnosis of tuberculosis, we used the following criteria: positive BAL culture for *Mycobacterium tuberculosis*, presence of granulomatous chronic inflammatory process (despite the presence of caseous necrosis or the presence of AFB in the TBB specimens), or a combination of the two criteria.

After bronchoscopy, all patients were instructed to collect a sputum sample, which was sent for direct examination and culture for mycobacteria.

Descriptive analysis consisted of calculating the frequencies of the study variables. The continuous variable age is expressed as mean and standard deviation. Sensitivity was calculated on the basis of the ratio of the number of true-positive results to the total number of positive results. Specificity was calculated on the basis of the ratio of the number of true-negative results to the total number of negative results. Sensitivity and specificity were calculated for each diagnostic method (direct examination of BAL specimens, BAL culture, and histopathological examination of TBB specimens, as well as bronchoscopy as a whole).

Results

A total of 286 patients (154 men and 132 women; mean age, 46.7 ± 16.0 years) underwent bronchoscopy because of clinical and radiological suspicion of tuberculosis, the disease having been confirmed in 135 (47%).

Of the 286 patients studied, 225 (79%) were diagnosed on the basis of bronchoscopic findings, as follows: pulmonary tuberculosis, in 127 (44%); nonspecific chronic inflammation, in 51 (18%); pneumocystis pneumonia, fungal infections, or nocardiosis, in 20 (7%); bronchiolitis obliterans organizing pneumonia, alveolitis, or pneumoconiosis, in 14 (5%); lung or metastatic neoplasms, in 7 (2%); and nontuberculous mycobacterial infections, in 6 (2%).

Inspection of the larynx and bronchial tree revealed endoscopic changes in 126 patients (44%), as follows: enanthem, bronchial stenosis, bronchial fissure, granulomatous inflammatory process, malacia, fistula, and inflammatory changes in the laryngeal mucosa in 43%, 21%, 17%, 10%, 5%, 3%, and 3%, respectively.

Direct examination of BAL fluid yielded positive results in 31 cases (10.8%). *M. tuberculosis* and nontuberculous mycobacteria were identified in 26 (84%) and 5 (16%) of those cases, respectively. The sensitivity, specificity, PPV, and negative predictive value (NPV) of direct examination of BAL specimens for AFB detection for the diagnosis of tuberculosis were 19%, 96%, 84%, and 54%, respectively (Table 1).

Culture for mycobacteria was positive in 75 patients, *M. tuberculosis* having been detected in 68 and other nontuberculous mycobacteria (*M. kansasii, M. gordonae,* and *M. avium*) having been detected in 7. The sensitivity, specificity,

Table 1 - Performance of the bronchoscopic diagnostic techniques in isolation and in combination.[a]

Bronchoscopic sampling methods	Sensitivity	Specificity	PPV	NPV
Direct examination, BAL	19	96	84	54
Culture, BAL	50	100	100	63
Direct examination + culture, BAL	60	100	100	70
Histopathological examination, TBB	42	92	88	53
Direct examination, BAL + culture, BAL + histopathological examination, TBB	84	97	95	82

PPV: positive predictive value; NPV: negative predictive value; and TBB: transbronchial biopsy. [a]Values expressed as %.

PPV, and NPV of BAL culture for the diagnosis of tuberculosis were 50%, 100%, 100%, and 63%, respectively. The combination of direct examination and culture increased the sensitivity and NPV to 60% and 70%, respectively (Table 1).

The TBB procedure was performed in 232 patients (81%) and was contraindicated in 54 (19%). In 167 cases (72%), the TBB findings established the diagnosis, which included tuberculous and nontuberculous granulomatous disease, lung or metastatic neoplasms, lymphoma, fungal disease, pneumoconiosis, and nonspecific inflammatory conditions, as previously described. In 57 (25%) of those patients, TBB was positive for tuberculosis. For the diagnosis of tuberculosis, TBB alone showed a sensitivity, specificity, PPV, and NPV of 42%, 92%, 88%, and 53%, respectively (Table 1).

Direct examination and culture of BAL specimens used in combination with TBB increased the sensitivity and NPV of bronchoscopy to 84% and 82%, respectively. The specificity and PPV obtained by combining the three methods of analysis (direct examination of BAL specimens, BAL culture, and histopathological examination of TBB specimens) were 97% and 95%, respectively (Table 1).

Post-bronchoscopy sputum samples were collected from 169 patients (59%). Culture was positive for *M. tuberculosis* in 57 (34%) of those patients. Other mycobacteria were detected in 3 (2%). It is of note that, in 13 patients (10%), the diagnosis of tuberculosis was based exclusively on the post-bronchoscopy sputum smear results.

In 61 patients (21%), it was impossible to establish the final diagnosis by bronchoscopy. Of those, 14 (23%) underwent invasive surgical procedures (lymph node excision, mediastinoscopy, video-assisted thoracoscopy, or open lung surgery), a histopathological diagnosis of tuberculosis having been made in 8 (57%) and a diagnosis of fungal disease and neoplasm having been made in 6 (43%).

Considering all of the diagnostic procedures performed in the 286 patients with clinical or radiological suspicion of tuberculosis, the diagnosis of tuberculosis was confirmed in 135 patients (47%), whereas other diagnoses were established in 104 (36%). Consequently, the diagnostic hypothesis of smear-negative pneumonia was confirmed by bronchoscopic or surgical methods (or both) in 239 patients (84%).

Bronchoscopy-related complications were observed in 17 patients (6%), as follows: syncope, in 1 (0.3%); laryngospasm, in 1 (0.3%); bronchospasm, in 1 (0.3%); pneumothorax after TBB, in 8 (3%); and moderate bleeding after TBB, in 6 (2%). The bleeding was controlled with local measures, with no need for bronchial blockade or surgical intervention.

Discussion

The present study showed that bronchoscopy, in addition to being a diagnostic method with low morbidity for patients with suspected tuberculosis whose diagnosis was impossible to establish by sputum smear microscopy, allows the collection of a greater quantity of material for analysis, increasing the chances of diagnosing the disease (Table 2). Bronchoscopic methods confirmed the presence of tuberculosis in 114 (40%) of the 286 patients with clinical or radiological suspicion of the disease. We also observed that, alone, each of these diagnostic methods (direct examination of BAL specimens for AFB, BAL culture, and histopathological examination of TBB specimens) has low diagnostic sensitivity (19%, 50%, and 42%, respectively); however, when used in combination, the diagnostic sensitivity significantly increases (to 84.4%).

Previous studies have shown the benefits of bronchoscopy in the diagnosis of tuberculosis in

Table 2 - Patients diagnosed with tuberculosis by different diagnostic methods.

Diagnostic method	n	%
Direct examination, BAL	26	19.3
Culture, BAL	68	50.4
Direct examination + culture, BAL	81	60.0
Histopathological examination, TBB	57	42.2
TBB + BAL	114	84.4
Post-bronchoscopy sputum culture	57	42.2
TBB + BAL + post-bronchoscopy sputum culture	127	94.1
Surgical method	8	5.9
Total number of diagnoses of tuberculosis	135	100.0

TBB: transbronchial biopsy.

different groups of patients. Miro et al.,[6] in a retrospective evaluation of respiratory secretion samples collected by bronchoscopy for detection of *M. tuberculosis* in HIV-positive patients, observed that adding the TBB findings increased the diagnostic yield from 96% to 100%. A similar result was observed in HIV-negative patients. Chawla et al.[7] prospectively studied a group of 50 patients who were suspected of having pulmonary tuberculosis and were submitted to bronchoscopy. In 90% of the cases, BAL cultures were positive for *M. tuberculosis*. In 72% of the patients, a rapid diagnosis was made by means of direct examination of bronchial lavage fluid, bronchial biopsy specimens, and post-bronchoscopy sputum samples. An exclusive diagnosis was made by bronchial biopsy in 20%, by post-bronchoscopy sputum smear microscopy in 6%, and by bronchial lavage in 6%. In that study, a histopathological diagnosis was made in 9 of the 30 patients submitted to TBB, whereas, in 3, the diagnosis was made exclusively by biopsy.[7] Other studies have shown the importance of the diagnostic rapidity provided by bronchoscopic (endobronchial or transbronchial) biopsy in the detection of AFB, granulomatous inflammatory processes (with or without caseous necrosis), or both in patients with clinical and radiological suspicion of pulmonary tuberculosis.[4,8-10]

Caymmi et al.,[11] in a retrospective study evaluating 52 patients, showed that the combination of BAL findings (direct examination and culture) and TBB findings increased the diagnostic sensitivity of the procedure (from approximately 50%, when each method was used in isolation, to 80%, when all of the collection methods were used in combination). In that group of patients, the differential diagnosis with other lung diseases, such as tumors, fungal infections, and nonspecific infections, as well as with inflammatory and scarring processes, was possible. Our study showed similar results, with a greater number of cases.

These data underscore the importance of BAL findings (direct examination and culture) and TBB findings (direct examination for AFB and histological pattern) for the diagnosis of pulmonary tuberculosis. Whenever the clinical condition permits, TBB specimens should be collected, TBB providing a greater quantity of material for analysis and expediting the identification of AFB in the tissue and the analysis of the pattern of tissue inflammation. The histological pattern of biopsy can suggest the diagnosis of the disease when combined with the clinical, radiological, and epidemiological profiles, allowing treatment initiation before culture results are available, i.e., 4-6 weeks on solid media (Löwenstein-Jensen or Ogawa-Kudoh) or 10-40 days (in liquid media).[3] In addition, in our study, we showed that adding the TBB findings increased the diagnostic sensitivity of bronchoscopy and allowed the final diagnosis of other diseases. We also observed that, in 34% of the cases, the diagnosis made by bronchoscopy was inconsistent with the clinical or radiological suspicion, which becomes important especially when we consider fungal diseases, nontuberculous mycobacteriosis, nonspecific infections, and neoplasms. These data suggest that empirical treatment for tuberculosis, even in patients with clinical or radiological suspicion of the disease, is susceptible to errors in a considerable number of cases.

The main risks of TBB are bleeding (in 2-5% of cases) and pneumothorax (in approximately 3% of cases), and the contraindications to TBB are coagulation disorders, use of certain drugs for underlying diseases, uremia, single lung, and

moderate to severe pulmonary hypertension.[12] In patients with severe pulmonary emphysema or multiple bullae, TBB can be performed under fluoroscopy, and the decision should be made on a case-by-case basis.

In the present study, we also showed the post-bronchoscopy sputum smear results, which, despite the fact that sputum was not collected from all patients, contributed with 5% of the total number of confirmed cases of tuberculosis. In our study, it was possible to collect adequate sputum from 169 patients (59%). In 9.6% of the patients, the final diagnosis of pulmonary tuberculosis was established exclusively by post-bronchoscopy sputum culture. In addition, we showed that the combination of the post-bronchoscopy sputum examination findings and the bronchoscopic (BAL and TBB) findings increased the final diagnostic sensitivity to 94%. Sarkar et al.,[13] in a previous study involving 30 patients with suspected tuberculosis and negative sputum smears, showed that bronchoscopic methods had a positivity rate of 86.6%, whereas post-bronchoscopy sputum smear microscopy had a positivity rate of 73.3%.

With regard to changes in the respiratory mucosa in our group of patients, we observed signs of acute inflammation in 44% of the cases, including enanthem, fibrin ring granulomas, and adherent secretion (even in the larynx). In a previous study, the following changes in the bronchial mucosa were reported: inflammation with caseous necrosis; fibrotic stenosis; tumors; granulomas; ulcerative lesions; edema; and hyperemia.[14] In our study, we observed the presence of bronchial stenosis in 21% (26/126) of the patients. The importance of these findings suggests the need for evaluating and monitoring the course of the inflammatory process of the bronchial mucosa, especially in those patients with inflammation with caseous necrosis and tumors, because of the possibility of development of stenosis. In the evaluation of endobronchial disease, the principal indications for bronchoscopy are a reduction in lung volume, unexplained chronic cough, hemoptysis, and localized wheezing.[15] In addition, these data play an important role in the treatment planning for sequelae of bronchial lesions by means of mechanical dilation, stenting, or both.

The principal bronchoscopy-related complications (pneumothorax and bleeding) occurred in a small number of patients, and there was no need for post-procedure hospitalization in any of the cases, which shows the safety of the diagnostic procedure.[12]

In our study, we did not compare the bronchoscopy results with those of induced sputum with hypertonic saline. Previous studies have shown that the use of induced sputum is valid because it is inexpensive, has a good diagnostic yield, and has a low risk of complications; however, other studies have shown that induced sputum results are similar to those of bronchoscopy in the final diagnosis of tuberculosis.[16-20] In our study, we considered only the analysis of sputum collected immediately after bronchoscopy, cases in which the manipulation and hydration of the bronchial mucosa during the collection of BAL specimens stimulate cough and expectoration, facilitating the collection of respiratory secretion samples. We showed that there was a significant increase in the diagnostic sensitivity.

We conclude that, in this study sample, bronchoscopy proved to be a safe and effective method for the diagnosis of pulmonary tuberculosis in patients in whom diagnosis by sputum smear microscopy was impossible. The combination of TBB and BAL increases the diagnostic sensitivity of the method and facilitates the differential diagnosis with other diseases. Post-bronchoscopy sputum collection increases the overall diagnostic sensitivity. We suggest that empirical treatment for tuberculosis be avoided whenever possible, even in patients with clinical or radiological suspicion of the disease.

References

1. World Health Organization. Global Tuberculosis Control: Surveillance, Planning, Financing. Geneva: World Health Organization; 2008.
2. Portal da Saúde [homepage on the Internet]. Brasília: Ministério da Saúde [cited 2012 Jan 23]. Tuberculose no Brasil e no mundo. Available from: http://portal.saude.gov.br/portal/saude/profissional/visualizar_texto.cfm?idtxt=31109
3. Conde MB, Melo FA, Marques AM, Cardoso NC, Pinheiro VG, Dalcin Pde T, et al. III Brazilian Thoracic Association Guidelines on tuberculosis. J Bras Pneumol. 2009;35(10):1018-48.
4. Brodie D, Schluger NW. The diagnosis of tuberculosis. Clin Chest Med. 2005;26(2):247-71, vi. PMid:15837109. http://dx.doi.org/10.1016/j.ccm.2005.02.012
5. Izbicki G, Shitrit D, Yarmolovsky A, Bendayan D, Miller G, Fink G, et al. Is routine chest radiography after transbronchial biopsy necessary?: A prospective study of 350 cases. Chest. 2006;129(6):1561-4. PMid:16778275. http://dx.doi.org/10.1378/chest.129.6.1561

6. Miro AM, Gibilara E, Powell S, Kamholz SL. The role of fiberoptic bronchoscopy for diagnosis of pulmonary tuberculosis in patients at risk for AIDS. Chest. 1992;101(5):1211-4. PMid:1582273. http://dx.doi.org/10.1378/chest.101.5.1211
7. Chawla R, Pant K, Jaggi OP, Chandrashekhar S, Thukral SS. Fibreoptic bronchoscopy in smear-negative pulmonary tuberculosis. Eur Respir J. 1988;1(9):804-6. PMid:3147911.
8. So SY, Lam WK, Yu DY. Rapid diagnosis of suspected pulmonary tuberculosis by fiberoptic bronchoscopy. Tubercle. 1982;63(3):195-200. http://dx.doi.org/10.1016/S0041-3879(82)80030-5
9. Willcox PA, Potgieter PD, Bateman ED, Benatar SR. Rapid diagnosis of sputum negative miliary tuberculosis using the flexible fibreoptic bronchoscope. Thorax. 1986 Sep;41(9):681-4. PMid:3097866. PMCid:460430. http://dx.doi.org/10.1136/thx.41.9.681
10. Tamura A, Shimada M, Matsui Y, Kawashima M, Suzuki J, Ariga H, et al. The value of fiberoptic bronchoscopy in culture-positive pulmonary tuberculosis patients whose pre-bronchoscopic sputum specimens were negative both for smear and PCR analyses. Intern Med. 2010;49(2):95-102. PMid:20075571. http://dx.doi.org/10.2169/internalmedicine.49.2686
11. Caymmi AL, Silveira MA, Montal G, Lemos AC. Papel da fibrobroncoscopia no diagnóstico de pacientes com suspeita de tuberculose pulmonar. J Bras Pneumol. 2004;30(1):39-45. http://dx.doi.org/10.1590/S1806-37132004000100008
12. British Thoracic Society Bronchoscopy Guidelines Committee, a Subcommittee of Standards of Care Committee of British Thoracic Society. British Thoracic Society guidelines on diagnostic flexible bronchoscopy. Thorax. 2001;56 Suppl 1:i1-21. PMCid:1765978. http://dx.doi.org/10.1136/thorax.56.suppl_1.i1
13. Sarkar SK, Sharma GS, Gupta PR, Sharma RK. Fiberoptic bronchoscopy in the diagnosis of pulmonary tuberculosis. Tubercle. 1980;61(2):97-9. http://dx.doi.org/10.1016/0041-3879(80)90017-3
14. Chung HS, Lee JH. Bronchoscopic assessment of the evolution of endobronchial tuberculosis. Chest. 2000;117(2):385-92. PMid:10669679. http://dx.doi.org/10.1378/chest.117.2.385
15. Park SK, Lee CM, Heu JP, Song SD. A retrospective study for the outcome of pulmonary resection in 49 patients with multidrug-resistant tuberculosis. Int J Tuberc Lung Dis. 2002;6(2):143-9. PMid:11931413.
16. Conde MB, Soares SL, Mello FC, Rezende VM, Almeida LL, Reingold AL, et al. Comparison of sputum induction with fiberoptic bronchoscopy in the diagnosis of tuberculosis: experience at an acquired immune deficiency syndrome reference center in Rio de Janeiro, Brazil. Am J Respir Crit Care Med. 2000;162(6):2238-40. PMid:11112145.
17. McWilliams T, Wells AU, Harrison AC, Lindstrom S, Cameron RJ, Foskin E. Induced sputum and bronchoscopy in the diagnosis of pulmonary tuberculosis. Thorax. 2002;57(12):1010-4. PMid:12454293. PMCid:1758793. http://dx.doi.org/10.1136/thorax.57.12.1010
18. Anderson C, Inhaber N, Menzies D. Comparison of sputum induction with fiber-optic bronchoscopy in the diagnosis of tuberculosis. Am J Respir Crit Care Med. 1995;152(5 Pt 1):1570-4. PMid:7582296.
19. McCallister J, Chin R, Conforti J. Bronchoscopic Myths and Legends: Bronchoscopy in the Diagnosis of Pulmonary Tuberculosis. Clin Pulm Med. 2006;13(5):271-3. http://dx.doi.org/10.1097/01.cpm.0000236648.75237.ea
20. Saglam L, Akgun M, Aktas E. Usefulness of induced sputum and fibreoptic bronchoscopy specimens in the diagnosis of pulmonary tuberculosis. J Int Med Res. 2005;33(2):260-5. PMid:15790139.

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