Transbronchial Needle Aspiration: A Diagnostic Tool in Routine Bronchoscopy

Semra Bilaceroglu*, P Chhajed**

Abstract
The fifty six-year-old Transbronchial Needle Aspiration (TBNA) has proved its efficacy, safety and cost-effectiveness particularly in diagnosing and staging lung cancer as well as in diagnosing benign granulomatous disease: sarcoidosis and tuberculous lymphadenitis. Although highly specific, the sensitivity and accuracy of TBNA may vary depending on the study methods, patient population (severity of disease) and prevalence of mediastinal metastasis. Conventional “blind” TBNA should be a “sine quo non” of routine bronchoscopy. However, it has not been used as extensively as it deserves to be owing to a multitude of factors ranging from concerns about its efficacy and safety to cost. Cost of the transbronchial aspiration needle might have an important impact on underuse of TBNA particularly in developing countries and therefore cost of the needles should be either adapted to the income of the countries or should be manufactured locally. Experience and training will, no doubt, improve TBNA performance and yield considerably.

Transbronchial needle aspiration (TBNA) is a method mainly used to obtain diagnostic samples from a peribronchial or submucosal lesion by using a needle attached to a catheter which is introduced through a rigid1 or flexible bronchoscope.2 Rigid TBNA performed through rigid bronchoscope was introduced to medical practice 56 years ago by an Argentinian thoracic surgeon Schieppati,1 and flexible TBNA performed through flexible bronchoscope 22 years ago by the American pulmonologists Wang and Terry.2 However, this noninvasive, efficient, cost-effective and safe method has not been used as frequently as expected.3-5 The clinical value, safety and experience with conventional TBNA make a clear argument for its adoption as a routine diagnostic procedure in the bronchoscopy suite along with other procedures such as bronchial washings, brushings, endobronchial biopsy and transbronchial biopsy.

EXPERIENCE OF THE WORLD
There are relatively, a limited number of reports in the literature on the use of TBNA in the whole world suggesting that this technique is not used extensively. A search in Pubmed and the Journal of Bronchology with each of the keywords: “transbronchial needle aspiration,” “transbronchial fine needle aspiration,” “bronchial needle aspiration,” “bronchoscopic needle aspiration,” “transstracheal needle aspiration,” “transcarinal needle aspiration” and “carinal needle aspiration biopsy” gives only 264 articles on this issue as of August 4, 2005. About 55 (21%) of these TBNA-related articles come from Asian-Pacific countries: Japan (19), Turkey (15), China (7), India (3), Taiwan (3), Nepal (2), New Zealand (2), Israel (2), Thailand (1), Singapore (1).3 In Europe, articles from Italy (19), Germany (12), Spain (10), Switzerland (7), United Kingdom (6), Denmark (4), Poland (3), Belgium (2), Netherlands (3), Hungary (2), France (1), Sweden (1), Ireland (1), Greece (1), Czech Republic (1) and Portugal (1) constitute 74 (28%) of these articles. Only 2 (0.7%) articles are from Africa, specifically from South Africa, and one (0.3%) from South America. The latter is the original TBNA article by Schieppati from Argentina. The remaining 132 (50%) of the pertinent articles come from North America: mainly the United States (131), and Canada (1). Although half of the articles comes from North America, a survey performed by the American College of Chest Physicians in the 1990s showed that only 11.8% of North American pulmonologists routinely used TBNA in malignant disease, and only 2.3% in benign disease.4 Unfortunately, it still remained to be an underused diagnostic modality approximately 10 years after this survey.

Underutilization of TBNA
Underuse of TBNA is due to a multitude of factors including lack of training, suboptimal technique, faulty site selection, incomplete penetration of the needle, kinking of the transbronchial catheter, a confusingly

*Department of Pulmonary Medicine, Izmir Training and Research Hospital for Thoracic Medicine and Surgery, Izmir, Turkey. **Pulmonary Medicine, University Hospital, Basel, Switzerland.

© JAPI • VOL. 53 • SEPTEMBER 2005 www.japi.org 797
large number of needles, failure in obtaining high diagnostic yields, concerns about the safety of TBNA, inadequate cytopathological assessment, fear of bronchoscopic damage, and specific objections about usefulness of this method. 6,7 Cost of the transbronchial aspiration needle might also have an important impact on the underutilization of TBNA particularly in developing countries. 3,6-8

Efficacy and Indications of TBNA

However, TBNA has proved its usefulness in diagnosing and staging lung cancer, 7,8-10 identifying inoperable carcinomas, 6,11 and diagnosing peripheral nodules/masses 12-14 and various other diseases, including sarcoidosis 15-18 and tuberculosis. 18-21 The sensitivity, specificity and accuracy of the technique in lung cancer are: 60-90%, 98-100% and 60-90%, respectively. Although highly specific, the sensitivity and accuracy of TBNA may vary depending on the study methods, patient population (severity of disease) and prevalence of mediastinal metastasis. It is less invasive and costly than surgical procedures, and few complications have been reported. Overall major complication rate is approximately 0.26%. 7,22-27 In benign granulomatous disease, its sensitivity, specificity and accuracy have been reported to be: 53-66%, 100%, 54-65% for sarcoidosis, 15-18 and 45-83%, 100%, 50-85% for tuberculosis, respectively. 7,18-21

For mediastinal and hilar lymphadenopathy, 22- or 19-gauge TBNA can be used. For benign disease, 19-gauge histology needle should be used whereas for diagnosis and staging of lung cancer, 22-gauge needle is sufficient. In all cases of submucosal and peripheral disease, 22-gauge TBNA should be routinely performed. For visible endobronchial disease, 22-gauge TBNA is optional. In necrotic and hemorrhagic endobronchial disease and in the presence of bleeding, TBNA can be helpful. Finally, in type III (compressed bronchus sign) and IV (narrowed and thickened bronchus sign) peripheral nodules, TBNA should be the procedure performed first. 7,12,22,28

There remains no doubt that training with the TBNA technique and experience will improve TBNA results. Collaboration among thoracic surgeons, pulmonologists, oncologists, and pathologists will help to establish a sound TBNA program. Only in this way can TBNA be optimized as a nonsurgical, cost-effective, and safe procedure. 3,7,13,22,28,31

How to Obtain Better Results with TBNA

Better results can be obtained with TBNA by giving careful attention to anatomy, TBNA technique and specimen acquisition, reviewing TBNA instruction tapes, having hands-on experience with TBNA and practice with lung models, reviewing patients’ computed tomography (CT) scans before TBNA, getting familiar and expert with one cytology and histology needle, and working with a trained assistant and experienced cytopathologist trained in TBNA interpretation. 7,22,23,28 Thus, one should pay attention to the issues mentioned subsequently, before, during and after the TBNA procedure to obtain better results. 7,22,23,29,30

Before performing TBNA, attend hands-on courses, practice with lung models, review TBNA instruction tapes, review CT scans, and develop expertise with one or two cytology and histology needles. During TBNA, identify the TBNA site accurately, place the needle with an angle at least 45° to the airway, ensure complete penetration of the needle up to the hub, use the channel of the scope to support the TBNA catheter, and stop aspiration before pulling the needle into the airway. For specimen acquisition, smear the specimen and place slides in alcohol immediately, obtain at least two adequate samples, use the smear method for cytology and analyze all flush solution and cell block sample. After TBNA, cooperate and review pathology slides with an experienced cytopathologist, and review your TBNA procedure by video.

Increasing education and experience can also improve TBNA performance and yield. 4,7,22,28,31 After serial educational interventions directed toward bronchoscopists and their technical staff, it has been shown that the yield with TBNA significantly increased from 21% to 48% in a 3-year period. 28 More recently, a similar rate of increase has been reported in sensitivity of TBNA from 33% to 81%. 31 Furthermore, more frequent and detailed notations in bronchoscopy reports, fewer cytology specimens contaminated by endobronchial material (abundant lymphocytes for nodal TBNA), higher yields in small cell carcinoma, and fewer unsatisfactory cytologic specimens have suggested that focused education and increased experience of bronchoscopists and bronchoscopy technicians do improve TBNA performance. 28,31 Improved communication with cytotecnologists and cytopathologists and rapid on-site evaluation “ROSE” of TBNA are also helpful in increasing diagnostic accuracy and obviating costly and invasive procedures. 31-34

Methods To Adjunct Or Guide TBNA

Fluoroscopy, 35 endobronchial ultrasound (EBUS), 36,37 virtual bronchoscopy, 38 CT-guided methods, 39,40 CT fluoroscopy, 41,42 positron emission tomography (PET), 43 integrated PET and CT (PET/CT), 44 electromagnetic navigation, 45 and real-time bronchoscopy tip position technology 46 displayed on previously acquired three-dimensional CT data have been used to assist TBNA. Whether these adjunctive imaging methods are required in routine practice and which of these methods provides the most cost-effective guidance for TBNA remains to be determined by prospective comparative studies. However, EBUS, which has also been used more widely,
appears to be the most cost-effective strategy. The cost-effectiveness of endoscopic ultrasound-guided fine needle aspiration (EUS-FNA) shown in the studies assessing EUS, PET and CT in mediastinal lymph node involvement of lung cancer can lend support to the potential cost-effectiveness of EBUS.

**Fluoroscopy:** Conventional fluoroscopy is still used to guide the bronchoscopic diagnostic procedures including TBNA usually in peripheral pulmonary lesions. However, it is unreliable in obtaining biopsies from peripheral lesions less than 2 cm in diameter and hidden behind optical barriers such as heart, infiltrates, or pleural effusion.

**CT:** Traditionally, previously obtained CT scans are used to determine the road map for the puncture sites during TBNA. Presence of a bronchus leading to a lesion (CT-bronchus sign) on thin-section CT can also be used as a guide in directing, TBNA and other diagnostic procedures to peripheral pulmonary nodules and masses. However, CT has moderate sensitivity (~57%) and specificity (~74%) owing to limitations in depicting pathological changes in normal-sized lymph nodes and lesions that do not have good contrast with the surrounding tissue.

TBNA has also been performed under direct CT guidance in the CT scan suite, however its sensitivity was not found to be higher than that of conventional TBNA. A notable limitation is the lack of real-time imaging and possibility of motion artifact due to 3-5 second processing time.

**CT fluoroscopy:** This method has been used in cases with prior unsuccessful bronchoscopy or anticipated difficulty owing to small size or inaccessibility of the lesion. TBNA is performed in a CT scan suite. The technique consisting of a spiral CT scanner, a rapid reconstruction algorithm and real-time in-room imaging provides a sensitivity of 83-87%. However, the technique is cumbersome with a CT scanning time of about one hour, and exposes patients and staff to radiation.

**Virtual bronchoscopy:** Virtual bronchoscopic images derived from routine spiral CT scans are useful for directing TBNA in a clinical setting. In addition these images may improve the yield of TBNA when 22-gauge needles are used. However, the technique has not gained wide-spread use in guiding TBNA and other diagnostic procedures. The major drawback is that images still have to be transposed mentally during the procedure, and final needle position remains uncertain.

**Real-time bronchoscopy tip position technology:** This technique coupled with previously acquired three-dimensional CT data has been used to enhance TBNA in an animal study. A miniature position sensor placed at the tip of a bronchoscope or diagnostic instruments is tracked under an electromagnetic field. A real-time position information during bronchoscopy is presented on a monitor simultaneously displaying previously acquired three-dimensional CT data. The above-mentioned study showed that TBNA specimens revealed successful aspiration of target material, and distances between target lesions and CT-generated targets varied insignificantly. The technique may aid with TBNA of nonvisible extrabronchial lesions.

**Ultrasound:** Compared with conventional TBNA (58%), EBUS has been shown to increase the yield of TBNA significantly in all mediastinal lymph node stations (84%) except in the subcarinal region (76% and 86%, respectively). It appears to be that real-time EBUS increases the sensitivity of TBNA more than the sequential one (95% vs 85%).

EBUS or EUS guidance has been comparably successful (85% vs 78%) for transbronchial and transesophageal needle aspiration, respectively. Combining both approaches provides a yield similar to that of mediastinoscopy (94%) in mediastinal staging of lung cancer. In mediastinal lymph nodes previously staged tumor-negative by “blind” TBNA, additional staging by EUS-FNA confirms metastasis in about ¼ of the cases.

Furthermore, an 82% diagnostic yield provided by EUS-guided needle aspiration in stage I and II sarcoidosis may possibly be achieved also by EBUS-guided TBNA in sarcoidosis and tuberculosis.

**PET:** PET scanning is a molecular whole-body imaging modality based on the biological activity of neoplastic cells. Thus, it is a metabolic imaging technique depending on the function of a tissue rather than on its anatomy. Compared with the normal cells, neoplastic or inflammatory cells demonstrate increased cellular uptake of glucose and higher rate of glycolysis. The radiolabeled glucose analog 18F-FDG undergoes the same level of uptake as glucose but is not further metabolized after phosphorylation and becomes trapped preferentially in the neoplastic or inflammatory cells. Accumulation of the isotope then can be identified using a PET camera.

Pooled sensitivity of mediastinal evaluation using PET scanning in lung cancer is 78%, and pooled specificity is 89%. PET shows a trend toward higher sensitivity and accuracy than TBNA (~88% vs ~67%) in differentiating benign and malignant mediastinal lymphadenopathy in lung cancer mainly owing to that TBNA is an operator-dependent and “blind” procedure. It has been proposed that PET should be used as a noninvasive guide and physiological roadmap as an adjunct to TBNA and other invasive procedures in the evaluation of lymphadenopathy in lung cancer. PET-guided TBNA needs to be prospectively studied to determine if PET further improves the diagnostic yield of TBNA.

Efficiency of EBUS-guided TBNA versus PET should
also be studied. That EUS-FNA has proven to be more accurate than PET (82-97% versus 50-79%) suggests that EBUS-guided TBNA may have a similar trend toward higher efficiency than PET in mediastinal lymph node staging. The combination of PET and EBUS-guided TBNA might qualify as a minimally invasive staging strategy for lung cancer since EUS-FNA in PET-positive mediastinal lesions has an accuracy of 94%.30

**Integrated PET and CT (PET/CT):** PET/CT that combine a CT scanner and a PET scanner in a single gantry provide metabolic information and spatial relationship of the lesion to the neighboring anatomic structures, dependent to a lesser extent on the size of the lesion. It has been shown to be superior to PET alone, CT alone, or visual correlation of PET with CT in staging lung cancer.45-61 Till today, PET/CT-guided TBNA has been performed in only three patients with positive mediastinal lymph nodes on PET/CT and has provided successful results and decisive management for their neoplastic diseases.44

**Electromagnetic navigation:** This is a new system using virtual bronchoscopy and three-dimensional CT images in combination with a steerable probe. It provides real-time imaging without fluoroscopic guidance, is able to track the path of the biopsy tool as it approaches the peripheral lesion and allows the biopsy tool to be navigated within the periphery of the lung. The system has the following components: 1) electromagnetic location board placed under the cephalad end of the bronchoscopy table mattress and emitting low-frequency electromagnetic waves, 2) a retractable and 360° steerable sensor probe, the position and motion of which can be displayed on a monitor in real-time and superimposed on previously acquired CT images, 3) a flexible catheter that serves as an extended working channel and through which the sensor probe is inserted, and 4) the computer software that creates a graph of the probe position in relation to preregistered anatomic landmarks superimposed on 3-dimensional CT images of the chest.48 Under the guidance of this system registration accuracy, quality and stability in locating peripheral lung lesions could have been achieved in an animal study (9/9) and conclusive biopsies obtained in a following clinical study (69%).49 By using this navigation system, a peripheral lung lesion can be successfully sampled (69-88%) by TBNA, transbronchial lung biopsy, brushing and/or curettage.49,52

**CONCLUSION**

The fifty six-year-old TBNA has proved its efficacy, safety and cost-effectiveness particularly in diagnosing and staging lung cancer as well as in diagnosing benign granulomatous disease: sarcoidosis and tuberculous lymphadenitis. Although highly specific, the sensitivity and accuracy of TBNA may vary depending on the study methods, patient population (severity of disease) and prevalence of mediastinal metastasis. Conventional “blind” TBNA should be a “sine qua non” of routine bronchoscopy. However, it has not been used as extensively as it deserves to be owing to a multitude of factors ranging from concerns about its efficacy and safety to cost. Cost of the transbronchial aspiration needle might have an important impact on undermine of TBNA particularly in developing countries and therefore cost of the needles should be either adapted to the income of the countries or should be manufactured locally. Experience and training will, no doubt, improve TBNA performance and yield considerably. The exact role and cost-effectiveness of the adjunctive methods in guiding TBNA have to be elucidated with prospective comparative trials.49,65 Lastly, TBNA which has been commonly described under the umbrella of interventional bronchoscopy should now be taught, described and promoted as a routine bronchoscopic procedure so that it is optimally utilized.

**REFERENCES**


ultrasonography with or without fine-needle aspiration. Chest 2003;123:442-51.


---

**Announcement**

The Office Bearer of Association of Physicians of India, Karnataka Chapter for the Year 2005-2006

- **Chairman**: PV Venkataramanappa, Bangalore
- **Chairman-Elect**: VG Nadagouda, Hubli
- **Vice Chairman**: V Channaraya, Bangalore
- **Vice Chairman**: Vasanth Kamath, Bangalore
- **Vice Chairman**: Gururaj B Kulkarni, Gulbarga
- **Hon. Secretary**: D Govindappa, Bangalore
- **Hon. Treasurer**: R Srinivas, Bangalore

---

**Announcement**


- **Chairman**: Pawan Gupta
- **Secretary**: SP Singh Grover