INTRODUCTION

Endobronchial ultrasound-guided transbronchial needle aspiration (EBUS-TBNA) is a standard of care modality for evaluating mediastinal lymphadenopathy and mediastinal lesions in adults and children. Ever since EBUS-TBNA was introduced into the realm of clinical pulmonology in 2003, it has revolutionized the approach towards evaluating...

KEY WORDS: Anesthesia, bronchoscopy, endobronchial ultrasound, endobronchial ultrasound-transbronchial needle aspiration, transbronchial needle aspiration
mediastinal lymphadenopathy and other mediastinal lesions. However, like flexible bronchoscopy, there is variability in the performance technique in different settings. Although a few international guidelines have attempted to provide guidance aimed at standardization of the procedure, there are many unaddressed issues related to the procedural aspects of EBUS-TBNA.

Open-ended anonymous surveys are helpful to study the prevalent practices of various medical procedures. However, online surveys are preferred and feasible, as demonstrated in India’s recent nationwide bronchoscopy study and a recent study of pleuroscopy practice in India. The current survey was designed to study the prevalent practices of EBUS-TBNA in India. We aimed to explore the multiple aspects of the linear EBUS-TBNA procedure, including demographics, topical anesthesia and sedation, technical factors, complications, and infection control related to the procedure.

METHODS

This survey was an online survey based on the Google forms interface. It was designed in the Department of Pulmonary, Critical care, and Sleep Medicine at the All India Institute of Medical Sciences, New Delhi, India. The survey included multiple questions related to demographic characteristics, sedation and anesthesia, technical aspects, and infection control practices associated with EBUS-TBNA. The responses were completely anonymous, and identifying personal details were not required.

The responses to the questions required either a descriptive answer or they were multiple option type. The survey was E-mailed using the available E-mail database of the various pulmonology societies of India. These included the Indian association for Bronchology and the Indian Chest Society. The authors also E-mailed the survey questionnaire to their contact database to increase the response rate.

The authors performed a trial run of the survey, and edits were performed. The survey was finalized in the 1st week of January 2021. E-mails were sent to the respondents during the 3rd week of January 2021. Reminder E-mails were subsequently sent over the next month, and the survey link was kept open for the subsequent 3 months to gather responses. The participation of the respondents in the survey was voluntary, and no financial incentives were offered. There was no involvement of any equipment manufacturer in the survey data design, conduct, and analysis.

Statistical analysis

The Google forms interface allows the responses to be downloaded as an excel spreadsheet file. Initially, the preliminary data extracted were screened, and only the operators performing EBUS-TBNA were included. We used the STATA statistical analysis package (Version 14), STATA Corp, LLC, Texas, USA, for performing the statistical analysis. The continuous variable data are presented as mean (standard deviation), median (interquartile range [IQR]), and minimum-maximum as appropriate. The categorical data are presented as number percentages.

RESULTS

We received responses from 140 participants. Out of these, 134 responded affirmative for performing EBUS-TBNA and the data from these 134 participants was used for analysis. More than half, 53%, were from seven cities, including Delhi, Bengaluru, Hyderabad, Mumbai, Chandigarh, Coimbatore and Rishikesh.

Baseline characteristics

The respondents’ mean age was 42.2 years, and a majority (84.3%) were male, 82.1% had performed conventional TBNA, and 59.7% were performing radial EBUS. Most (97.8%) were pulmonologists or physicians. A majority (96.3%) were consultants, while the remaining were trainee pulmonologists. Nearly three-fourths (73.9%) were working in the northern and southern parts of the country. 61.9% had been performing EBUS-TBNA for 1–5 years, while nearly a fourth (27.6%) performed the procedure for 6–10 years. The average number of EBUS-TBNA procedures performed annually was 75 (35–120) (median, IQR). For most (94.8%), the practice was either a private multi-specialty hospital or a medical college. The most common learning modes to perform the procedure were either a formal training program within India (40.3%) or a short term observation at an EBUS facility (32.8%). The Olympus EBUS bronchoscope was the most common type of bronchoscope used (75.2%), followed by the Pentax (17.0%) and Fujifilm (7.8%) EBUS bronchoscope. More than three-fourths (79.9%) performed the procedure in a bronchoscopy room, while 17.9% performed the procedure in an operation theatre. 36.6% responded performing EBUS-TBNA in children 12 years or younger. Nearly a half (54.5%) responded having received training on an EBUS simulator. The median procedure cost was 20,000 International Normalized Ratio (INR) (approximately 270 US Dollars) The baseline characteristics are summarized in Table 1.

Patient preparation, topical anesthesia, and sedation

The most commonly reported duration of fasting was between 4 and 8 h before the procedure (73.1%). A majority of respondents routinely obtained coagulation studies (prothrombin time, INR, activated partial thromboplastin time), (79.9%), and hemoglobin and platelet counts (80.6%) before the procedure. 71.6% routinely screened the patients for HIV, hepatitis B, and hepatitis C before the procedure. Ten respondents (7.5%) routinely administered prophylactic antibiotics before the procedure, while 11 (8.2%) did so in select patients.
Regarding antiplatelet drug use, 29.5% stopped both aspirin and clopidogrel before the procedure, while 62.9% considered stopping clopidogrel only. A large majority (97.8%) stopped anticoagulants before the procedure if the patient was receiving them. 9.7% routinely used anticholinergic premedication. Mild-to-moderate sedation was the preferred sedation strategy (70.1%). Nearly one-fourth (26.9%) performed the procedure under deep sedation or general anesthesia. Four respondents (3%) performed EBUS-TBNA without any intravenous sedation, under only topical anesthesia. Midazolam (76.7%), Fentanyl (76.0%), followed by Propofol (46.5%), were the most frequently used drugs for sedation [Figure 1]. A majority (82.8%) preferred a combination of sedative agents for intravenous sedation. 61.9% responded affirmatively regarding the availability of naloxone or flumazenil in the bronchoscopy room. Nearly half (48.5%) had an anesthesiologist available for monitoring intravenous sedation in the procedure area. Nearly three fourths (77.6%) administered oxygen continuously during the procedure. 31.3% routinely administered nebulized lignocaine. The use of 10% lignocaine spray was the preferred method for pharyngeal anesthesia (93.7%). 26.1% used cricothyroid lignocaine injection for topical anesthesia. An equal proportion (50% each) used 1% and 2% lignocaine for spray-as-you-go administration. 19.4% used a spray catheter for lignocaine delivery. The oral route was preferred for scope insertion in the majority (93.3%). When performing the procedure under general anesthesia, the laryngeal mask airway was the most commonly employed airway conduit (87.6%), followed by the use of an endotracheal tube (8.8% respondents). These details are summarised in Table 2.

Technical aspects

The most typical indication of performing EBUS-TBNA was granulomatous mediastinal lymphadenopathy (TB/ sarcoidosis, 67.2%), followed by lung cancer (32.8%) as the second most common indication. 81.3% performed EBUS-TBNA for lung cancer staging. The frequency of various lymph node stations being sampled by respondents is summarized in Figure 2. The preferred needle for sampling was the 21G needle (64.9%), and 35.1% preferred the 22G needle. 45.5% had ever used a 19 G needle for EBUS-TBNA, while 3.4% had experience using a 25 G needle. During sampling, the use of suction was common (80.6%), while 9.4% performed most of the procedures without suction. 91% routinely used stylet during the procedure. Only a half (50.7%) routinely used the balloon application. The most commonly reported average needle revolutions inside the lymph node were 11–20 (64.2%). 55.2% routinely performed ROSE. ROSE by the pathologist was most common (73.9%). The most frequently obtained average number of aspirates per lymph node station was 3–5 (88.1%). Alcohol fixed glass slide smears were the most common method (93.1%) for cytological preparation, while 73.1% routinely prepared cell blocks [Figure 3]. 26.7% reported the use of liquid-based cytology. 94.8% routinely processed the aspirates for mycobacterial cultures in suspected tuberculosis. Nearly half of the respondents (49.3%) performed EUS-B-FNA. Among those who performed EUS-B-FNA, 26.8% used it as the primary approach, while 73.2% used it as a backup when there was a difficulty with...
Table 1: Baseline characteristics of the survey respondents

| Characteristic                                             | n (%)       | Total n (total number of respondents) |
|-----------------------------------------------------------|-------------|---------------------------------------|
| Total number of respondents performing EBUS-TBNA (n)      | 134         |                                       |
| Age (years), mean (SD)                                    | 42.2 (8.1)  |                                       |
| Males/females                                             | 113 (84.3)/21 (15.7) |                                       |
| Performing c-TBNA                                         | 109 (82.1)  |                                       |
| Performing radial EBUS                                     | 80 (59.7)   |                                       |
| Primary specialty                                          |             |                                       |
| Pulmonologist/physician                                    | 131 (97.8)  |                                       |
| Pediatrician                                              | 2 (1.5)     |                                       |
| Surgeon/thoracic surgeon                                  | 1 (0.7)     |                                       |
| Current position                                           |             |                                       |
| Consultant                                                | 129 (96.3)  |                                       |
| Trainee                                                   | 5 (3.7)     |                                       |
| Location                                                  |             |                                       |
| North India                                               | 65 (48.5)   |                                       |
| South India                                               | 34 (25.4)   |                                       |
| West India                                                | 22 (16.4)   |                                       |
| East India                                                | 7 (5.2)     |                                       |
| Central India                                             | 6 (4.5)     |                                       |
| Duration since performing EBUS-TBNA (years)                |             |                                       |
| Less than a year                                          | 8 (6)       |                                       |
| 1-5 years                                                 | 83 (61.9)   |                                       |
| 6-10 years                                                | 37 (27.6)   |                                       |
| >10 years                                                 | 6 (4.5)     |                                       |
| Approximate average number of EBUS-TBNA procedures performed annually (excluding 2020), median (IQR) | 75 (35-120) |                                       |
| Place of practice                                         |             |                                       |
| Private Multi-Specialty Hospital                          | 78          |                                       |
| Medical college                                           | 49          |                                       |
| Private clinic                                            | 3           |                                       |
| Government hospital                                       | 4           |                                       |
| Mode of learning EBUS-TBNA                                |             |                                       |
| Formal training program within India                      | 54 (40.3)   |                                       |
| Short term observation at EBUS facility                   | 44 (32.8)   |                                       |
| Formal training program outside India                     | 19 (14.2)   |                                       |
| Attending EBUS workshop at a conference                   | 14 (10.4)   |                                       |
| Self-learning                                             | 3 (2.2)     |                                       |
| Type of EBUS bronchoscope available at facility (n=141)   |             |                                       |
| Olympus medical                                           | 106 (75.2)  |                                       |
| Pentax medical                                            | 24 (17.0)   |                                       |
| Fujifilm                                                  | 11 (7.8)    |                                       |
| Place of performing EBUS-TBNA                             |             |                                       |
| Bronchoscopy room                                         | 107 (79.9)  |                                       |
| Operation theater                                         | 24 (17.9)   |                                       |
| Endoscopy room                                            | 3 (2.2)     |                                       |
| Perform EBUS-TBNA in children (<12 years age)             | 49 (36.6)   |                                       |
| Ever received training on EBUS simulator                  | 73 (54.5)   |                                       |
| EBUS-TBNA procedure cost, median (IQR), minimum-maximum   | 20,000 (1500-30,000), Nil - 150,000 |                                       |

TBNA: Transbronchial needle aspiration, C-TBNA: Conventional TBNA, EBUS: Endobronchial ultrasound, SD: Standard deviation, IQR: Interquartile range

the endotracheal approach. 76.9% routinely performed endobronchial biopsy (EBB) and transbronchial lung biopsy (TBLB) in patients with suspected sarcoidosis along with the EBUS-TBNA. The routine use of elastography was uncommon (7.5%). 65.7% reported having encountered any complications during EBUS-TBNA. 38.8% had performed EBUS-TBNA guided therapeutic aspiration from a mediastinal cystic lesion. 3.4% reported having performed EBUS-guided intranodal forceps biopsy. 21.6% had performed transvascular (transpulmonary artery or transaortic) sampling of lesions during EBUS. Eight respondents (6.0%) had performed EBUS-guided transbronchial needle injection. Among other anatomical sites sampled during linear EBUS, thyroid aspiration was performed by 1.4%, pericardium space 6%, pleura 5.2%, paravertebral lesion 1.5%, liver 0.75%, and retropharyngeal abscess aspiration 0.75%. The details of technical aspects are summarised in Table 3.

Complications and infection control
The most frequently encountered complications were bleeding (64.5%), respiratory depression (52.7%), needle breakage (23.7%), arrhythmia (21.5%), and damage to the EBUS bronchoscope (17.2%). Most operators reported the availability of a specifically designated area for bronchoscope cleaning (96.3%). Nearly three-fourths (77.6%) reused EBUS needles. A majority (81.3%) stored the EBUS bronchoscope hanging in storage cabinets. 80.6% reported routine FFP2/N95 mask use, while nearly a half (53.7%) used eye protection.
DISCUSSION

Advanced bronchoscopy has evolved rapidly over the last decade in India. The number of EBUS installations in the country has witnessed a steady increase. Also, an increasing number of research articles were published related to EBUS-TBNA from India. The current survey is comprehensive, covering multiple aspects of the procedure and outlining India’s prevalent practices.

The findings of the study bring out specific interesting observations. Like the observations from the “Indian Bronchoscopy Survey-2017,” the EBUS-TBNA facilities are concentrated in few cities. Routinely during the procedure. 17.2% reported routine use of coverall based personal protective equipment [Table 4].
evident from the observation that most respondents were working in multispecialty settings or medical colleges. There is an unmet need for increasing the EBUS-TBNA training avenues, as only 40% of respondents had received training as part of a formal training program. An encouragingly high number (36.6%) were performing EBUS-TBNA in children (younger than 12 years). This is an important finding because EBUS-TBNA and EUS-B-FNA have revolutionized the approach toward evaluating mediastinal lymph nodes and masses in the pediatric population. The diagnostic yield is acceptable and may avoid the need for invasive biopsy procedures in majority.\textsuperscript{[2,4,9-14]} EUS-B-FNA may be performed in children even 3 years and younger for sampling the esophageal accessible lymph nodes.\textsuperscript{[15]} However, one needs to highlight that performing EBUS-TBNA and EUS-B-FNA in children requires reasonable expertise and experience with EBUS-TBNA.

Nearly one-fourth of respondents used general anesthesia for performing EBUS-TBNA. Available data indicates that both moderate sedation and deep sedation/GA may be acceptable and may be chosen based on the operator and patient preference.\textsuperscript{[16,17]} Nearly one-fourth of respondents were using the cricothyroid injection technique for lignocaine delivery. Evidence

Table 3: Technical aspects of endobronchial ultrasound-transbronchial needle aspiration

| Description                                                                 | n (%)        |
|----------------------------------------------------------------------------|--------------|
| The most common indication of EBUS-TBNA in practice                        |              |
| Granulomatous mediastinal lymphadenopathy (TB/sarcoidosis)                  | 90 (67.2)    |
| Lung cancer                                                                | 44 (32.8)    |
| Perform EBUS-TBNA for lung cancer staging                                   | 109 (81.3)   |
| Preferred needle for performing EBUS-TBNA                                   |              |
| 21 G                                                                       | 87 (64.9)    |
| 22 G                                                                       | 47 (35.1)    |
| Ever used 19 G needle for EBUS-TBNA                                        | 61 (45.5)    |
| Ever used 25 G needle for EBUS-TBNA                                        | 18 (13.4)    |
| Perform most procedures with which suction method                           |              |
| With suction                                                               | 108 (80.6)   |
| Without suction                                                             | 26 (19.4)    |
| Routinely use the stylet during the procedure                               | 122 (91)     |
| Routinely use the balloon during the procedure                              | 68 (50.7)    |
| Average needle revolutions inside the lymph node                            |              |
| 10 or less                                                                 | 39 (29.1)    |
| 11-20                                                                      | 86 (64.2)    |
| >20                                                                        | 9 (6.7)      |
| Routinely perform ROSE during the procedure                                 | 74 (55.2)    |
| ROSE method used, when performing                                           |              |
| ROSE by pathologist                                                         | 68 (73.9)    |
| ROSE by pulmonologist                                                       | 16 (17.4)    |
| Both                                                                       | 8 (8.7)      |
| Average aspirates per lymph node station                                    |              |
| <3                                                                         | 14 (10.4)    |
| 3-5                                                                        | 118 (88.1)   |
| >5                                                                         | 2 (1.5)      |
| Routinely prepare cell blocks                                               | 98 (73.1)    |
| Routinely process aspirates for Mycobacterial cultures in suspected TB     | 127 (94.8)   |
| Perform EUS-B-FNA                                                           | 66 (49.5)    |
| Use EUS-B-FNA as a primary approach, $n=97$                                  | 26 (26.8)    |
| Use EUS-B-FNA as a backup approach when difficulty with EBUS-TBNA approach, $n=97$ | 71 (73.2)    |
| Routinely perform EBB and TBLB in patients with suspected Sarcoidosis following EBUS-TBNA | 103 (76.9)   |
| Routinely perform EBUS elastography                                        | 10 (7.5)     |
| Encountered any complications during/following EBUS-TBNA                   | 88 (65.7)    |
| Performed EBUS TBNA-guided therapeutic aspiration from a mediastinal cystic lesion | 52 (38.8)    |
| Performed EBUS-guided intranodal forceps biopsy                            | 18 (13.4)    |
| Performed transvascular (transpulmonary artery or transaortic) EBUS-TBNA    | 29 (21.6)    |
| Performed guided transbronchial needle injection (EBUS-TBNI)               | 8 (6.0)      |
| Other anatomic sites sampled                                                |              |
| Lung lesions                                                                | 76 (56.7)    |
| Thyroid                                                                    | 14 (10.4)    |
| Pericardium                                                                | 8 (6)        |
| Pleura                                                                     | 7 (5.2)      |
| Paravertebral lesion                                                        | 2 (1.5)      |
| Liver                                                                      | 1 (0.75)     |
| Retropharyngeal abscess aspiration                                          | 1 (0.75)     |

ROSE: Rapid onsite evaluation; EUS-B-FNA: Endoscopic ultrasound bronchoscopic-guided fine-needle aspiration; EBB: Endobronchial biopsy; TBLB: Transbronchial lung biopsy, TBNA: Transbronchial needle aspiration, C-TBNA: Conventional TBNA, EBUS: Endobronchial ultrasound, TB: Tuberculosis, TJNI: Transbronchial needle injection
from multiple randomized clinical trials (RCTs) and a meta-analysis indicates that the cricothyroid lignocaine injection provides superior topical anesthesia compared with the spray-as-you-go technique during bronchoscopy. A recent adequately powered RCT indicated the similar superior performance characteristics of the cricothyroid technique for lignocaine administration during EBUS-TBNA. Half of the respondents used 2% lignocaine for spray-as-you-go administration. Available evidence suggests that a lower concentration (1%) may also be equally efficacious for this indication. Delivery of lignocaine using a spray catheter may provide better topical anesthesia when using the spray-as-you-go delivery, however, its use as a routine was relatively less (19.4% of respondents used it routinely). Nearly one-third respondents used nebulized lignocaine for topical airway anesthesia. The available evidence does not support the use of nebulized lignocaine for bronchoscopy.

Although a variety of EBUS-TBNA needles have become available recently (19G, 25G, Core biopsy needle), there is no clear indication that any needle type is superior. The routine use of vacuum suction was common; however, available evidence does not indicate specific benefits with the use of ROSE on diagnostic yield during EBUS-TBNA. More research is required regarding the utility of ROSE in EBUS-TBNA as benefit has been observed with few endpoints like requirement of additional procedures or number of needle passes. Half of the respondents did not perform EUS-B-FNA. EUS-B-FNA is particularly advantageous during many situations. An RCT comparing EBUS-TBNA and EUS-B-FNA indicated that for lymphadenopathy located at the subcarinal or lower left paratracheal stations, EUS-B-FNA may provide greater patient comfort and similar diagnostic yield, as a primary approach. A recent RCT also reported a similar diagnostic yield of EUS-B-FNA compared with EBUS-TBNA in Sarcoidosis. Another advantage of EUS-B-FNA is use in patients with mediastinal masses and airway narrowing for tissue diagnosis, wherein a tracheal approach for diagnostic sampling may not be feasible.

Nearly one-fourth respondents did not obtain endobronchial biopsies and TBLB routinely in patients with suspected sarcoidosis. A combination of lymph node aspiration (TBN/EBUS-TBNA) and TBLB and EBB are required for optimal diagnostic yield in sarcoidosis.

A fairly large proportion of respondents reused EBUS-TBNA needles, and one study described the performance characteristics of reused needles. This highlights the need for reduction of EBUS-TBNA needle cost, so that needle reuse is discouraged and infection control practices are strengthened.

There are few limitations of our observations in this study. Although we received responses, the findings may not be representative of the entire country. We are unable to provide a response rate of the survey. Another possibility is the possibility of selection bias as only the registered members of various national pulmonology societies were invited, although the authors made an attempt to reach out to maximal number of EBUS-TBNA proceduralists.

**CONCLUSION**

There exists a significant variability in the technical aspects of EBUS-TBNA across India. There is an urgent need for developing evidence-based guidelines to standardize the training and real-life practice aspects of EBUS-TBNA in India.
