A New Versatile Transbronchial Cytology Needle for the Staging and Diagnosis of Bronchogenic Carcinoma*  
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A new versatile transbronchial needle, the modified type 2B retractable needle, was used for the staging and diagnosis of bronchogenic carcinoma. It combines the advantages of its predecessors, the fixed type 1A needle and the retractable type 2A needle, such as convenience of usage and the added ability to sample peripheral as well as central lesions. The new modified type 2B retractable needle provides better protection of the airways and bronchoscope than the fixed type 1A needle and eliminates the type 2A needle's requirement for total removal of the guidewire before aspiration. The new type 2B needle was compared with either the original fixed type 1A or the retractable type 2A needle in 20 patients at 34 transbronchial sites and found a similar diagnostic yield. The modified type 2B retractable needle was the most versatile needle of those studied and can be used for transbronchial needle aspiration of both central and peripheral lesions. (Chest 1988; 94:561-65)

Transbronchial needle aspiration (TBNA) performed through the flexible fiberoptic bronchoscope has become an established procedure in the staging and diagnosis of bronchogenic carcinoma.1-12 Access to the mediastinum less invasively without the potential morbidity of mediastinoscopy and mediastinotomy has played a major role in the ever growing popularity of TBNA. In addition to the sampling of mediastinal sites, TBNA has also been shown to be efficacious in diagnosing peripheral pulmonary nodules and masses.5,11 Because of its broad applicability, we have placed considerable emphasis on improving TBNA in terms of its safety, yield, and ease of administration.

Traditionally, two transbronchial needles (Millrose, Mentor, Ohio) have been used for obtaining cytologic specimens. The type 1A single lumen fixed needle is suited best for sampling central mediastinal nodes.1,3 The type 2A double lumen retractable needle can also be used for the diagnosis of peripheral nodules or masses.5,11 Recently, a new versatile needle, the type 2B double lumen retractable needle, has been developed which combines the advantages of the type 1A and type 2A needles while eliminating some of their disadvantages. We discuss the design and use of this new needle and its performance (in clinical trials) when compared to the two traditional needles. Further design modifications to improve suction capability (type 1B retractable needle) or to prevent tissue plugging (type 3 retractable needle) are discussed, and the effect of these changes on diagnostic yield is examined. We conclude with recommendations regarding the selection of needles for TBNA for the staging and diagnosis of bronchogenic carcinoma.

**MATERIAL AND METHODS**

**Traditional Transbronchial Needles**

The type 1A single lumen fixed needle consists of a 1.3 cm long 22-gauge needle mounted on the tip of a 120 cm long flexible single lumen catheter. A metal guidewire with a rounded tip passes through the needle and protects the bronchoscope from laceration during passage through the channel. The guidewire provides some rigidity to the catheter. Once the site of aspiration is located, the guidewire is withdrawn into the needle and the bronchial wall is pierced. After penetration is achieved, the guidewire is further withdrawn into the catheter and suction is applied with a 20 ml syringe attached to a sideport at the proximal end of the catheter. The cytologic specimen is then flushed out of the catheter and needle with several milliliters of normal saline solution.

The type 2A double lumen retractable needle is composed of two flexible catheters and a removable metal guidewire. A 1.3 cm 22-gauge needle is mounted on the tip of the inner catheter and can be retracted into the outer catheter. At the distal end of the outer catheter is a smooth metal hub which provides maximum protection to the bronchoscope during passage through the channel. After the needle is advanced through the hub, the bronchus is pierced. The guidewire is then completely removed prior to aspiration of the specimen.

The advantages and disadvantages of the two traditional bronchial needles are summarized in the first two columns of Table

| Table 1—Comparative Features of Modified Type 2B Needle and Traditional Transbronchial Needles* |
|------------------------------------------|---|---|---|
|                                        | 1A | 2A | 2B |
| Convenience                             | +  | -  | +  |
| Protection                              | -  | +  | +  |
| Flexibility                             | -  | +  | +  |

* +++, most; +, moderate; - , least.
1. The type 1A fixed needle is more convenient to use than the type 2A retractable needle since its guidewire does not need to be completely removed prior to suctioning. The metal hub of the type 2A retractable needle provides more protection of the bronchoscope and peripheral airways than the rounded guidewire which protrudes through the type 1A needle. Because of its retractable needle and removable guidewire, the type 2A retractable needle is more flexible than the type 1A fixed needle. The latter two features make the type 2A needle the instrument of choice for aspirating peripheral mass and coin lesions. Both needles are equally well suited for approaching and aspirating central lesions. On the rare occasion that the drainage of a central cystic lesion is required, the type 1A needle may be preferable due to its greater suction capability.

**Type 2B and its Modified Versions**

A natural consequence of the use of the two traditional transbronchial needles has been the development of a single new needle which combines the advantages of its predecessors while eliminating some of their disadvantages. The importance of having one cytologic needle for TBNA would be the simplification of the training required for bronchoscopists and their assistants, as well as the avoidance of confusion when choosing from among several needles at the time of bronchoscopy.

The type 2B modified double lumen retractable needle (Fig 1) has a design similar to the original type 2A needle described previously except that a small opening was created at the side of the needle and a side port was added at the proximal end of the outer catheter for suctioning (Fig 2). This allows transmission of the negative suction pressure to the lumen between the inner and outer catheters. Since the lumen of the inner catheter is not used for suctioning, it is not necessary to remove or even retract the guidewire during aspiration. The guidewire, however, can still be partially retracted to increase the flexibility of the catheter when approaching peripheral lesions.

In the third column of Table 1, the features of the type 2B modified retractable double lumen needle are listed. It is more convenient to use than its predecessors since its guidewire does not need to be removed prior to aspiration. Other advantages built into the original type 2A needle such as protection of the bronchoscope and the ability to safely reach peripheral as well as central lesions, have been maintained. Its only theoretic disadvantage when compared to the type 1A single lumen fixed needle is the decrease in suction capability which is the result of the double lumen design. Whether or not this actually decreases the diagnostic yield will be addressed later.

**Improving Suction Capability—Type 1B Retractable Needle:** Further modifications were made to the type 2B needle to improve its suction capability while still maintaining the protective features of a retractable needle. The type 1B retractable needle consists of a single flexible catheter and 1.3 cm long, 22-gauge needle mounted on the tip of a 120 cm long metal guidewire. The needle can be retracted into the flexible catheter for passage through the bronchoscope. The needle is advanced prior to piercing the bronchus and suction is applied at the side port at the proximal end of the catheter.

Because of its single lumen construction, the type 1B needle has improved suction capability. This feature would clearly be advantageous when aspirating large amounts of fluid as in the drainage of a bronchogenic cyst but it is unclear whether suction capability would increase the cytologic yield when aspirating cellular material from mediastinal nodes. The major disadvantage of the type 1B needle is its decreased flexibility when compared to the type 2B needle, since its guidewire cannot be retracted when approaching peripheral lesions. We hypothesized that this problem would manifest itself mostly in apical segments of the upper lobes or superior segments of the lower lobes where acute angulation of the catheter is required.

**Preventing Tissue Plugging—Type 3 Retractable Needle:** One concern in TBNA is the possibility that tissue plugging of the needle might occur when the cartilagenous bronchus or tracheal wall is pierced, thus decreasing the diagnostic yield. To prevent this from occurring, the type 2B needle was further modified by adding a beveled trocar which passes through and extends beyond the needle during penetration of the bronchial wall. This new needle, designated the type 3 double lumen minitrocar retractable needle, has a flattened needle tip with an inward tapering cutting edge. Because the needle and trocar are retractable, maximum protection is still afforded to the bronchoscope and airways. However, since the trocar must be retracted after the bronchial wall is penetrated, this new type 3 needle is somewhat less convenient to use than the type 2B needle. For peripheral lesions, the trocar of the type 3 needle offers no advantage over the type 2B needle and may even decrease the flexibility of the catheter.

Clinical trials were designed to determine the efficacy of the type 2B modified retractable needle when compared to the two traditional transbronchial needles. First, the type 2B needle was compared to the type 1A single lumen fixed needle in ten consecutive patients at a total of 17 sites. Each of the two needles was used once to aspirate 13 mediastinal nodes (seven paratracheal, four carinal, two subcarinal), two hilar nodes, and two nodes at the right upper lobe spur. Next, the type 2B needle was compared to the original type 2A retractable needle in ten consecutive patients at 17 sites. Each of the two needles was used once to sample 14 mediastinal nodes (eight paratracheal, four carinal, two subcarinal), one node at the right upper lobe spur, one right middle lobe nodule, and one right upper lobe anterior segment mass. In each pair of aspirations, the two needles were used in a random order. The slides were reviewed blindly by a single cytopathologist if the initial cytologic diagnosis for members of a pair differed.

The type 2B modified retractable needle was then compared to the type 1B retractable needle, with its improved suction capability and to the type 3 retractable needle designed to prevent tissue plugging. Each of the three retractable needles was used once to...
Table 2—Design of Trials Comparing Type 2B Needle to Other Transbronchial Needles

<table>
<thead>
<tr>
<th>Trial No.</th>
<th>2B vs</th>
<th>No. of Pts</th>
<th>No. of Sites</th>
<th>No. of Aspirates per Needle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional needles</td>
<td>1</td>
<td>1A</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2A</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>Newer modifications</td>
<td>3</td>
<td>1B, 3</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1B</td>
<td>11</td>
<td>18</td>
</tr>
</tbody>
</table>

Table 2: The locations aspirated included 18 mediastinal nodes (11 paratracheal, three carinal, four subcarinal), four hilar nodes, one right middle lobe peripheral nodule, and three lesions at the upper lobe spur. At each site, the order in which the three needles were used was randomized. As before, a blinded review was performed in cases where a diagnostic discrepancy occurred among the three needles.

Aspiration was performed at 18 sites in 11 consecutive patients with the following locations: seven mediastinal nodes (one paratracheal, five carinal, one subcarinal), four hilar nodes, five upper lobe lesions, and two right middle lobe or lingular lesions. Multiple aspirates with the same needle were pooled into a single cytology specimen.

An outline of the above trials is seen in Table 2.

RESULTS

Type 2B vs Traditional Transbronchial Needles

The type 2B needle was compared to the type 1A single lumen fixed needle at 17 sites in ten patients (Table 3; trial 1). Positive cytology was obtained at least one of the two needles at eight of the 17 sites. The 47 percent yield of the type 2B needle was higher but not significantly different from the 35 percent yield of the type 1A needle.

The type 2B needle and the original type 2A double lumen retractable needle were used together at 17 sites in ten patients (Table 3, trial 2). Positive cytology was detected at 11 of the 17 sites by at least one of the two needles. Malignant cells were obtained at 59 percent of the sites sampled by the type 2B needle and at 65 percent of the sites sampled by the original type 2A needle, demonstrating the diagnostic parity of the two needles.

These initial studies indicate that the type 2B needle has a comparable diagnostic yield to the traditional transbronchial needles (type 1A and type 2A) in staging and diagnosing bronchogenic carcinoma.

Type 2B Needle and Further Modifications

The type 2B needle was compared to the type 1B needle (improved suction capability) and the type 3 needle (designed to prevent tissue plugging) in 20 patients at 26 sites (Table 3; trial 3). Positive cytology was obtained by at least one of the three needles at 12 of the 26 sites. The individual yield (percentage of sites with positive cytology) of each needle was as follows: type 1B, 46 percent; type 2B, 27 percent; type 3, 31 percent. Of note, at three sites, the only needle producing positive cytology was the type 1B needle. The differences between the three needles were significant at p<0.05 (Cochran's Q statistic).

Further comparison of the type 2B needle and the type 1B needle was made in 11 patients at 18 sites using more (two to three) aspirates per needle (Table 3; trial 4). Only 15 of the 18 sites were accessible to both needles, as three upper lobe lesions could not be reached by the type 1B needle due to its lack of flexibility. Positive cytology was detected at nine of the 15 sites with either of the two needles. The type 1B and type 2B needles yielded malignant cytology in 53 percent and 60 percent of cases, respectively. There was no significant difference between the yield of these two needles when the likelihood of the sampling error was reduced by increasing the number of aspirates per needle.

Complications

In the 51 patients studied, there were no pneumothoraces or clinically significant hemorrhages resulting from TBNA with any of the five needles tested.

DISCUSSION

Transbronchial needle aspiration has been shown to be a valuable technique in the staging and diagnosis

Table 3—Results of Trials Comparing Type 2B Needle to Other Transbronchial Needles (% of Sites with Positive Cytology)*

<table>
<thead>
<tr>
<th>Trial No.</th>
<th>IA</th>
<th>2A</th>
<th>2B</th>
<th>1B</th>
<th>3</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>35</td>
<td>65</td>
<td>47</td>
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</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
</tbody>
</table>

*2B, variable flexibility; 1B, better suction; and 3, prevents plugging.
†Cochran's Q statistic.
of bronchogenic carcinoma. Ultimately, the general acceptance of this technique will be based on the ability of most bronchoscopists to achieve the yields reported in the literature while maintaining a low complication rate. For this to occur, TBNA must first be a procedure which is convenient and efficient to perform. The technical aspects should be simple enough so that a minimal amount of additional training is required for both the bronchoscopist and his assistant. Since TBNA is applicable to mediastinal nodes, peripheral pulmonary nodules, and endobronchial lesions, ideally one transbronchial needle should be suitable for all sites. Finally, safety must be maintained both in terms of protecting the patient’s airways and preventing laceration of the bronchoscope. The results presented herein demonstrate that the type 2B double lumen retractable needle, a new versatile transbronchial cytology needle, fulfills all of the above criteria and represents a significant technical improvement in TBNA.

The traditional transbronchial needles each have specific technical drawbacks. Because the type 1A needle is fixed to its catheter and is not retractable, it provides less protection to the bronchoscope and the patients’ airways. The fixed needle is also less flexible than the retractable needle and is not well suited for approaching peripheral pulmonary nodules. Since the guidewire must be retracted before piercing the bronchus and again prior to aspiration, the type 1A needle is somewhat inconvenient to use. The original type 2A needle is even more inconvenient. Its guidewire must be fully removed and reinserted for each transbronchial aspiration. This process is time consuming and the withdrawn 120 cm metal guidewire may recoil and disseminate respiratory secretions, a theoretic but important consideration.

The new modified type 2B retractable needle eliminates the disadvantages of the traditional transbronchial needles without sacrificing diagnostic yield. The type 2B needle is convenient to use, demonstrates the safety of a retractable needle, and is well-suited for TBNA of both central and peripheral sites. In clinical trials presented here, the type 2B needle’s diagnostic yield was equivalent to that of the fixed type 1A needle and the original type 2A retractable needle. It is not surprising that the new type 2B needle would perform at least as well as the type 2A needle since both are retractable and both have a double lumen design. It is less obvious, however, that the type 2B needle would do as well as the type 1A single lumen fixed needle. Their equivalent performance suggests that the size of the suction lumen does not affect diagnostic yield.

In order to fully evaluate the role of suction capability, the type 1B needle was developed which combined the single lumen feature of the type 1A needle and the retractable style of the type 2B needle. When single aspirates of the type 2B and type 1B needles were compared, the single lumen retractable needle (type 1B) was superior. A sampling error may have been responsible since when two to three aspirates per needle per site were performed, the needles were comparable. Since multiple aspirates are usually performed at each nodal site in clinical practice, we conclude that the single lumen retractable (type 1B) needle offers no advantage over the type 2B needle (double lumen) at mediastinal sites. We were able to demonstrate that the type 2B needle was able to reach three upper lobe apical sites which were not accessible to the type 1B needle. Thus, in terms of versatility, the type 2B needle has not been surpassed.

Some bronchoscopists have attributed occasional low diagnostic yields in TBNA to tissue plugging of the cytology needle. Our experience with the type 3 minitrocar needle suggests that preventing tissue plugging does not improve yield significantly. This may be true because tissue plugging does not occur frequently. We suspect that tissue plugging is a function of the gauge of the needle and is probably uncommon in 22 gauge needles.

We discussed the flexibility of the type 2B needle and its importance in reaching peripheral lesions. Recently, it has also become clear that flexibility is also helpful in aspirating some central mediastinal nodes, specifically at the aortopulmonary (A-P) window. To sample deep into the A-P node, ideally the needle should be perpendicular to the bronchial wall when piercing it. This can be accomplished with the type 2B needle by retracting the guidewire to improve flexibility of the catheter and extending the needle just beyond the tip of the flexed bronchoscope. The bronchoscope supports the needle during penetration of the wall. This technique could potentially improve the yield of TBNA at the A-P window.

In conclusion, the type 2B retractable needle is a convenient, safe, and versatile transbronchial cytology needle. Its application should be beneficial to physicians using TBNA for the staging and diagnosis of bronchogenic carcinoma.

REFERENCES
5 Wang KP, Haponik EF, Britt EJ, Khouri N, Erozan YS. Transbronchial needle aspiration of peripheral pulmonary nodules.
Shure D, Fedullo PF. The role of transcarinal needle aspiration in the staging of bronchogenic carcinoma. Chest 1984; 86:693-96