minimally invasive techniques

Lower Risk and Higher Yield for Thoracentesis When Performed by Experienced Operators*


(A position paper by the American College of Physicians states, “Thoracentesis is relatively uncomplicated technically, well tolerated, and quite safe.” This conclusion is reflected in current practice patterns in university hospitals, where house officers routinely perform thoracenteses. Prospective studies of house officer thoracenteses do not support the concept that the procedure is easy and benign; they have reported major complication rates ranging from 11.6 to 30.3 percent for thoracenteses performed without direct imaging guidance. Most of the studies reporting complication rates have not specifically addressed the issue of the operator and have looked instead at different methods of performing thoracentesis, with the type of needle or catheter used the most frequent variable. Our goal was to evaluate the issue of the operator performing thoracenteses. We looked prospectively at “routine thoracenteses” performed by pulmonary fellows and pulmonologists at our institution and compared our complication rates with those reported in prospective studies of thoracenteses performed by house officers.2-4

METHODS

Patients and Criteria

We studied the results of 50 consecutive thoracenteses. There were three major inclusion criteria: First, a thoracentesis could be included in the study only if a member of the pulmonary division (attending physician or pulmonary fellow) was the only operator; any procedure in which house officers played an operant role was ineligible. Second, each thoracentesis had to be done “blindly” at the bedside; thoracenteses for which an ultrasound or chest computed tomographic study was used to mark an entry site were excluded. Third, a follow-up chest radiograph had to be obtained; the presence or absence of postprocedure pneumothorax was a radiographic, not a clinical, determination. Pleural biopsies were included if they met other criteria. If the same patient had undergone two thoracenteses at different times, each thoracentesis was considered eligible for the study and was included as a separate event provided the criteria had been met.

Supervision of Fellows

Two pulmonary fellows were involved in the study. Before the study, each had to first watch a pulmonary attending physician perform several thoracenteses, then to perform a minimum of six thoracenteses under direct supervision, and finally to be certified before being allowed to operate independently.

Clinical Data

For each thoracentesis, the following data were recorded: pain at the time of the procedure, pain a day after the procedure, local hematomas, cough, dyspnea right after and a day after the thoracentesis, pneumothorax, any other complications (eg, liver laceration, hemothorax), and any interventions performed solely to treat complications of the thoracentesis. The total amount of fluid collected was also recorded, as was the adequacy of specimen volume for desired testing. Any thoracentesis that did not yield quantities of fluid adequate for all desired analyses was prospectively defined as having an “inadequate yield.”

RESULTS

Between Oct 11, 1990, and March 20, 1992, 50 consecutive thoracenteses that met criteria were performed. Thirty-five thoracenteses were performed by fellows (21 by one fellow and 14 by another). Fifteen thoracenteses were performed by attending pulmonologists (10 by 1, 2 each by 2 others, and 1 by a fourth. The thoracenteses qualifying for our study represented approximately one fourth of the total
This number of thoracenteses in which we were involved during the study interval; those excluded involved supervision of house officers or imaging guidance. The 50 thoracenteses were performed on a total of 33 patients (21 women, 12 men; mean age, 64 years; range, 34 to 83 years). All 33 patients were either on our service or were seen in consultation for evaluation of pleural effusion. One patient had 6 separate thoracenteses, 1 had 4, 2 had 3, and 5 had 2. The patient who had 6 thoracenteses was a 75-year-old man with asbestos pleural disease and severe heart disease whose thoracenteses were for symptom relief; his attending physician did not want to perform sclerosis. The patient who underwent four thoracenteses was another elderly gentleman. He had a metastatic pleural effusion and refused sclerosis. He, too, underwent thoracentesis for symptom relief. Of the studies, 17 were diagnostic, 17 were therapeutic, and 16 were both diagnostic and therapeutic. Pleural biopsy was part of the procedure in 6 cases.

The sizes of the effusions were noted before thoracentesis; 19 occupied from 10 to 25 percent of the involved hemithorax, 24 occupied from 25 to 50 percent, and 7 occupied more than 50 percent. Lateral decubitus films, although they were not a requisite, were obtained before thoracentesis in 27 cases.

There were only 2 pneumothoraces (4 percent). One was small (1 to 2 percent, barely visible) and followed some audible air entry through a pleural biopsy sheath. The other occupied approximately 10 percent of the hemithorax. Neither pneumothorax produced symptoms, and neither required intervention.

Yield was adequate in 49 of 50 cases. Quantities ranged from 0 to 1,800 ml (mean ± SD = 773 ± 516 ml).

Several complications were recorded (Table 1). Pain during the procedure was described as marked in 2 cases (4 percent) and moderate in 11 (22 percent). At follow-up 24 h after the procedure, 1 patient (2 percent), who had no pain during the thoracentesis, had chest wall pain, which might have been due to the procedure. Cough occurred during thoracentesis in 12 cases (24 percent). The acute effect of thoracentesis on dyspnea was varied; it worsened in four cases (8 percent), was the same in 22 (44 percent), was better in 18 (36 percent), and was much better in 6 (12 percent). The day after thoracentesis, dyspnea was rated as worse in 1 case (2 percent), the same in 22 (44 percent), better in 20 (40 percent), and much better in 7 (14 percent). One patient (2 percent) had a small hematoma at the needle entry site, but it did not require treatment. One patient (2 percent) became light-headed and bradycardic during the thoracentesis and later had dry heaves.

**DISCUSSION**

**Complications**

Our prospective study of bedside thoracenteses performed by pulmonary fellows and pulmonary attending physicians has documented a low major complication rate (4 percent). This rate compares favorably with those documented in prospective studies of bedside thoracenteses performed by house officers: Collins and Sahn reported 11.6 percent, Seneff et al reported 15.5 percent, and Grogan et al reported 30.3 percent (Fig 1).

Collins and Sahn did a prospective study of 129 thoracenteses, 123 of which were performed by medical house staff (n = 103) and supervised medical students (n = 20). Complications were as follows: pneumothorax in 11.6 percent of cases, vasovagal reaction in 3 percent, retching in 2 percent, pain (chest wall, chest, shoulder, or abdomen) during the procedure in

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**Table 1** — Minor Complications in This and Other Studies

<table>
<thead>
<tr>
<th>Complication</th>
<th>Collins and Sahn</th>
<th>Seneff et al</th>
<th>Grogan et al</th>
<th>Bartter et al</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate yield</td>
<td>12.4</td>
<td>14.7</td>
<td>12.1</td>
<td>2</td>
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<tr>
<td>Marked pain</td>
<td>. . .</td>
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<td>. . .</td>
<td>4</td>
</tr>
<tr>
<td>Mild to moderate pain</td>
<td>28</td>
<td>15.5</td>
<td>21.2</td>
<td>22</td>
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<tr>
<td>Persistent or late pain</td>
<td>. . .</td>
<td>9.1</td>
<td>6.0</td>
<td>2</td>
</tr>
<tr>
<td>Cough</td>
<td>9</td>
<td>12.7</td>
<td>. . .</td>
<td>24</td>
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<tr>
<td>Hematoma</td>
<td>. . .</td>
<td>2.7</td>
<td>6.1</td>
<td>2</td>
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</table>

**Major Complications vs. Literature**

![Figure 1](http://journal.publications.chestnet.org/pdftools.ashx?url=data/journals/chest/21672/)
28 percent, cough during the procedure in 9 percent, and dry tap or (for various other reasons) inadequate yield in 12.4 percent. Pneumothorax (15 cases total) was considered small and clinically unimportant in 8 cases and large in 7, with 5 chest tube insertions (3.9 percent intervention rate). No other complications required intervention. Two of the 5 patients with chest tubes, both of whom were elderly and severely ill, died within 5 days of the pneumothorax.

Seneff et al. identified 125 thoracenteses, most of them prospectively; 109 were performed by house officers at the bedside without imaging guidance. Complication rates for the 109 thoracenteses were as follows: pneumothorax in 12.7 percent, splenic laceration in 0.9 percent, sheared-off catheter in the pleural space in 0.9 percent, pneumohemothorax in 0.9 percent, pain requiring analgesia in 9.1 percent, pain not requiring analgesia in 15.4 percent, persistent pain in 9.1 percent, cough in 12.7 percent, insufficient fluid in 14.5 percent, and hematomas in 2.7 percent. Interventions required as a result of complications of thoracentesis included 3 chest tube insertions, transfusion of 5 U of packed blood cells in 1 case, and thoracotomy in 1 case (4.6 percent intervention rate). (From the wording, we presume that a chest tube would have been placed in the case of the patient with pneumohemothorax had the patient not been terminally ill. This case is not, however, included in their intervention rate calculation.)

A recent study reported complications of thoracenteses performed by house officers at the bedside and thoracenteses performed by radiology fellows with ultrasound guidance. For those thoracenteses performed by house officers without imaging guidance (n = 33), the complication rates were as follows: pneumothorax in 31.2 percent, mild to moderate pain in 21.2 percent, persistent pain in 61.1 percent, insufficient fluid in 12.1 percent, and subcutaneous hematoma in 6.1 percent. Two of the pneumothoraces were treated with chest tube drainage (6.1 percent intervention rate).

Clarke describes 1 pneumothorax not requiring chest tube insertion in a series of 48 thoracenteses. In his report, he did not specify the method of enrollment, the operators (whether house officers or attending physicians), and whether chest radiographs were used in every case to document pneumothoraces after the procedure. Kohan et al. reported another prospective study in which the operator (house officer or attending physician) was not specified. Complication rates for the 109 thoracenteses were greater than those for our series. Retrospective reports have been published in letter form. The reports are incomplete, and the complication rates are greater than those that we encountered.

It may be clinically important to examine data with regard to how many complications mandated a major therapeutic intervention aimed solely at dealing with the complication. The intervention rate for our population was zero, compared with 3.9 percent for Collins and Sahn, 4.6 percent for Seneff et al., and 6.1 percent for Grogan et al. (Fig 2).

When we separated purely diagnostic from therapeutic thoracenteses in our study, one pneumothorax occurred in each category, with the larger pneumothorax from the therapeutic thoracentesis. Both of the pneumothoraces occurred when the pleural fluid occupied less than 50 percent of the hemithorax (<10 percent in one case and 25 to 50 percent in the second). The number of pneumothoraces was too low for a meaningful correlation between pneumothorax and size of effusion.

We encountered a higher incidence of cough (24 percent) than did the other investigators who recorded it (12.7 percent and 9 percent). Of note is the fact that 83 percent (10/12) of the time this complication occurred during therapeutic thoracenteses, almost always at the end of the procedure. In fact, cough was often used as a clinical indicator for terminating a therapeutic thoracentesis. The data with respect to other minor complications are similar to those in the major prospective studies (Table 1).

Yield

In our study, we placed emphasis on whether yield was adequate because inadequate yield means that the patient was exposed to the risk of the procedure without any benefit and thus must either undergo a repeat procedure (thus doubling the risk to that patient) or forgo the diagnostic and/or therapeutic goals that had prompted the procedure. One of our thoracenteses (2 percent) had inadequate yield. In other studies, 12.1 percent to 14.7 percent of thoracenteses performed by house officers were reported to have inadequate yield (Fig 3).
Inadequate Yield

vs. Literature

<table>
<thead>
<tr>
<th>Investigator</th>
<th>Incidence</th>
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<tbody>
<tr>
<td>Collins</td>
<td>12.4%</td>
</tr>
<tr>
<td>Seneff</td>
<td>14.7%</td>
</tr>
<tr>
<td>Grogan</td>
<td>12.1%</td>
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<tr>
<td>Bartter</td>
<td>2%</td>
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</tbody>
</table>

Figure 3. Percentages of bedside thoracenteses performed by house officers in which yield was inadequate.

We do not assert that pulmonary fellows and pulmonologists are the only operators likely to experience low complication rates. Any well-trained operator could probably do equally well. Thoracentesis, like all other procedures, has a learning curve, and previous studies2-4 have shown that the learning curve entails a clinical cost. House officers performing the procedure should be well trained. They should be repetitively supervised by an experienced operator as part of a formal certification process. This approach has been successful for other invasive procedures.1,11

Conclusions

Our results suggest that, when performed by trained and experienced operators, bedside thoracentesis is a low-risk procedure. In our study, with trained operators, major complication rates were lower and the incidence of adequate yield was higher than those reported for thoracenteses performed by house officers. The operator is an important factor in complication rates; thoracentesis should be performed by experienced operators, not relegated to medical students or inexperienced house officers.

References