Spontaneous Pneumothorax*
Comparison of Thoracic Drainage vs Immediate or Delayed Needle Aspiration

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In the first part of this study, 61 patients admitted for the first episode or the first recurrence of a spontaneous pneumothorax (SP) were randomly treated with thoracic drainage (TD; 28 patients) or with simple needle aspiration (NA; 33 patients). Success rate of therapy was significantly higher with TD than with NA (93%; CI 84 to 100 vs 67%; CI 51 to 83; p=0.01). Hospital stay was similar between the two groups (7±4.6 vs 7±5.6 days), mainly because NA was delayed by 72 h in 26 patients. Recurrence rates at 3 months were 29% (CI 11 to 47%) after TD, and 14% (CI 0 to 29%) after NA (p=0.20, NS). In the second part of the study, an additional population of 35 patients was treated by immediate NA, with a success rate of 68.5% (CI 53.5 to 83.5%), and a recurrence rate at 3 months of 30% (CI 10 to 50%). Taken together, our results indicate that NA may be proposed as a first-line treatment of SP, with a successful result in two thirds of patients and recurrence in one fifth of patients. In patients who do not heal with NA, a combined risk of TD failure and short-term recurrence of 50% may be an incentive for undelayed surgical procedures. (CHEST 1995; 108:335-40)

Key words: aspiration; spontaneous pneumothorax; thoracic drainage

Spontaneous pneumothorax (SP) is commonly observed in young, tall, thin subjects without apparent underlying lung disease and in elderly patients with chronic lung disease. Short-term therapy of pneumothorax is primarily aimed at evacuation of air from the pleural space, thereby allowing reexpansion of the lung. Various noninvasive and more aggressive medical methods have been described for this purpose, among which thoracocentesis with needle aspiration (NA) and thoracic drainage (TD) via a chest tube remain most frequently used. Needle aspiration is simple and nearly noninvasive, but may not be effective if the parenchymal tear is large enough, and theoretically carries a high risk of short-term recurrence because it does not promote pleural symphysis. Conversely, thoracic drainage is supposed to allow complete reexpansion of the lung and promote pleural symphysis due to the irritating effect of the tube, thereby reducing the risk for recurrent ipsilateral SP.

However, this method may be more painful and carries the risk of lung or intercostal vessel laceration during tube insertion and of infection of the pleural cavity. Although specific guidelines and one controlled study have been published recently, choosing the former rather than the latter method is mainly governed by physician’s personal preference.

The present prospective study was designed to evaluate the efficacy and complications of NA vs TD and to delineate their elective indications. In the first part of the trial, patients with SP were randomly assigned to one of two therapeutic methods, ie, delayed NA or immediate TD. In the second part, an additional group of patients was treated by immediate NA, performed as soon as possible after hospital admission. Four medical ICUs, three of them in university teaching hospitals, participated in this clinical trial.

METHODS

Patients

Patients older than 18 years were considered for the present study if they were suffering from a first episode or first recurrence of a complete SP. Patients were not included when presenting any of the following: posttraumatic, iatrogenic, or bilateral pneumothorax; third ipsilateral episode or more; moderate-to-major associated pleural effusion or hemothorax; contralateral emphysematous bullae; suspected or proven lung cancer, lung abscess, or consolidated pneumonia; diffuse interstitial pneumonitis; body temperature above 38.5°C; moderate-to-severe hemostasis defects; need for mechanical ventilation; prior ipsilateral thoracotomy; and proven or
suspected HIV infection. Patients were classified according to the presence (group A) or absence (group B) of signs of poor clinical tolerance.

Assessment of tolerance was based on clinical findings and results of arterial blood gases; poor tolerance was defined by the presence of at least one of the following: systolic blood pressure <90 mm Hg or >170 mm Hg after 1 h of bed rest, in the absence of previous systemic hypertension; diastolic blood pressure >110 mm Hg; heart rate >130 beats/min on arrival or >110 beats/min after 1 h of rest; respiratory rate >35 cycles/min on arrival or >25 cycles/min after 1 h of bed rest; arterial SO2 <85% during room air breathing or <90% despite supplemental oxygen of 3 L/min via nasal prongs; arterial pH <7.35; and diaphoresis, agitation, or encephalopathy. Patients with radiologic evidence of pleural adhesions were also included in group A.

Primary pneumothorax was defined as occurring in a patient without underlying lung disease.

**First Protocol: Delayed NA vs Immediate TD**

Chest tube insertion was performed after local anesthesia, using blunt dissection of the fourth or fifth intercostal space, on the midclavicular line;28 the chest tube (caliber 20F) was directed toward the lung apex and connected to the vacuum source via a two-bottle regulated system adjusted to create a depression of 20 to 25 cm H2O. After 24 h without bubbling in the water seal bottle, the tube was clamped for an additional 24-h period,1,25 and then withdrawn if the chest radiograph revealed no recurrent pneumothorax. Whatever the classification in groups A or B, the chest tube was inserted promptly after arrival in patients randomized to this procedure. Needle aspiration was performed after local anesthesia, using a plastic catheter (caliber 16 or 18F) inserted in the second anterior intercostal space on the midclavicular line, with patients lying in a semirecumbent position; the catheter was connected to a one-bottle water seal vacuum system, regulated to generate a depressurization of 10 to 15 cm H2O. Aspiration was performed until cessation of bubbling in the water seal bottle or for a maximum of 30 min. The plastic catheter was then withdrawn. Needle aspiration was performed immediately in group A patients, and after 3 days of bed rest in group B patients. This arbitrary delay of 72 h was chosen to facilitate healing of the parenchymal tear, thereby increasing the success rate of the method and reducing the possibility of immediate recurrence of pneumothorax.

The study protocol prespecified that a second NA procedure could be performed 24 h after a first attempt leading to unsatisfactory results. In case of failure of this second NA, a chest tube was inserted as described above.

**Second Protocol: Immediate NA**

This protocol was an open nonrandomized study on the efficacy of immediate NA. Needle aspiration was performed as previously described, with the exception that all patients were treated on the day of hospital admission, whatever their classification in groups A or B.

All patients gave written informed consent before starting therapy. The protocols received the approval of the ethics committees of the Henri Mondor and Louis Mourier Hospitals.

**Evaluation of Therapy**

The major end points of this study were the success rate of the two methods, and the recurrence rate of pneumothorax in a follow-up of 3 months. Failure of TD was defined as persistence of bubbling at the end of an aspiration period of 10 days or short-term recurrence of pneumothorax requiring insertion of a second chest tube. Failure of NA was defined as incomplete lung reexpansion (<50% of its total surface) or recurrence of a complete pneumothorax within the first 24 h after the last procedure.

The secondary end points included daily recordings of pain and dyspnea scores using visual analog scales, ranging from 0 (no pain and normal breathing) to 10 (extreme pain or dyspnea).

**Statistics**

Results are given as mean±SD for quantitative values, and mean with 5% confidence interval (CI) for qualitative values; comparisons between quantitative values were made with the Student's t test for unpaired data; comparisons between qualitative parameters were made with the χ2 test.

**RESULTS**

**First Protocol**

Sixty-one patients were included in this protocol, 33 of them randomized to NA and 28 to TD. Some relevant clinical data for these two populations are depicted in Table I. There were no significant differences between these two groups.

**Short-term Efficacy of Therapy:** Twenty-two and 26 patients were successfully treated with NA alone and with TD, respectively. This led to a significantly higher success rate for TD when compared with NA (93%, CI 84 to 100%, vs 67%, CI 51 to 83%; p=0.01). Nine of 11 NA failure patients were successfully treated with

**FIGURE 1. Pain (upper panel) and dyspnea (lower panel) scores recorded in patients randomly treated with TD (light columns) or with NA (dark columns), during the first days of hospitalization. No difference was observed at any time of the study between the two treatments.**

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TD. One 81-year-old patient initially randomized to NA was then unsuccessfully treated with TD, and eventually died of nosocomial pneumonia.

Mean durations of hospital stay were not significantly different between patients allocated to NA or TD (7.0±5.6 days and 7.0±4.6 days, respectively). Figure 1 depicts the dyspnea and pain scores observed in these patients.

Recurrence Rate During Follow-up: Fifty-three of the 61 patients could be followed up as clinic outpatients or by mail, including 29 patients randomized to the NA procedure and 24 patients randomized to the TD procedure. Based on an intention-to-treat analysis, 6 of the 29 patients (21%, CI 6 to 36%) and 7 of the 24 (29%, CI 11 to 47%) had a relapsing pneumothorax during the 3-month follow-up period. These recurrence rates were not significantly different (p>0.45). Among 21 patients successfully treated by NA alone and followed up, three had a recurrent pneumothorax during the 3-month follow-up period. This recurrence rate was not statistically different from that observed in patients successfully treated with TD (14%, CI 0 to 29%, and 29%, CI 11 to 47% respectively; p>0.20). Eight of the nine patients with NA failure and TD success could be included in follow-up, three of them having a relapsing pneumothorax.

Second Protocol

Thirty-five additional patients (25 male and 10 female, with a mean age of 33±10 years) were admitted to the hospital with a mean delay from symptom onset of 2.0±1.8 days. Twenty-seven of them (71%) were current smokers. Two of these 35 patients had a history of ipsilateral pneumothorax. Chest radiograph revealed complete lung retraction in 26 of them, and three patients had pleural adhesions. The mean value of arterial oxygen saturation on arrival was 94.3±2.1%. With respect to these clinical parameters, this population was similar to that of the first protocol treated with NA.

Short-term Efficacy of Therapy: Twenty-four patients (68.5%, CI 53.5 to 83.5%) were successfully treated by NA, 5 of them requiring two successive procedures. Eleven patients who failed to respond to NA were subsequently treated by TD, 8 of them successfully. No patient died in this protocol. The mean duration of hospital stay was 4.9±3.0 days, and was significantly longer than the value observed in patients treated with NA in the first protocol (p<0.01).

Recurrence Rate During Follow-up: Follow-up could be obtained in 27 patients. Based on an intention-to-treat analysis, seven recurrent SPs were observed during the 3-month follow-up period, leading to a recurrence rate of 26% (CI 10 to 42%). Six recurrences were observed in the 20 patients successfully treated with NA alone (30%, CI 10 to 50%).

Additional Results

Combined results from the first and second protocols have been used to improve the sensitivity of some calculations.

Immediate vs Delayed Needle Aspiration: Forty-two patients (7 in the first and 35 in the second protocol) were treated with immediate NA, while 26 patients were treated by delayed NA. The observed success rates, 29 of 42 (69%, CI 55 to 93%) and 17 of 26 (65%, CI 47 to 83%) respectively, were not statistically different (p=0.90).

Recurrence Rate After NA Success: Forty-one patients (21 in the first protocol and 20 in the second protocol), successfully treated by NA alone, were included in the follow-up. Nine recurrences were observed, leading to a recurrence rate of 22% (CI 10 to 34%).

Evolution After Failure of NA Procedures: Eleven patients in each protocol received a chest tube after ineffective NA. Five of those 22 patients had a TD failure. Among the 17 remaining patients successfully treated with TD, 15 patients were included in the follow-up, 4 having a recurrent pneumothorax. In this particular subgroup of patients, the cumulative rate (50%) of either TD failure or short-term recurrence of SP seems rather high, in contrast to the cumulative rate of 36% observed in the group of patients immediately treated by TD. A summary of our results is presented in Figures 2 and 3.

Discussion

The present prospective study addressed three important issues concerning medical treatment of SP, namely short-term efficacy of NA vs TD, timing of NA (ie, immediate vs delayed thoracocentesis), and recurrence rates with both techniques.

In the randomized part of the trial, we observed that TD via a chest tube was significantly more effective in the treatment of pneumothorax than NA via a small-caliber plastic needle. It must be noted, however, that criteria for TD failure were far more tolerant than for

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<th>Table 1—Clinical Characteristics of Patients Admitted to the Hospital for Spontaneous Pneumothorax and Randomized to NA or TD</th>
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<tr>
<td>Age, yr</td>
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<td>Sex ratio, M/F</td>
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<td>History of SP, No. (%)</td>
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NA failure. Indeed, TD failure was declared after a 10-day period of continuous aspiration of the pleural space had elapsed, while NA was deemed a failure after a maximum aspiration period of the pleural space of 60 min. It is possible that repeated attempts to drain spontaneous pneumothoraces by NA may improve the effectiveness of this therapeutic method. With these limitations, the results observed in the present study are in good agreement with previous published reports that used a similar technique for NA.6-11 Indeed, success rates have been reported to range from 48%10 to 84%,6 with a mean value of 64.4% (143 of 222 patients). Unexpectedly, delayed NA was not a more comfortable therapeutic intervention than immediate TD, as shown by the pain and dyspnea scores observed in this study. Two explanations may be offered for this finding. First, the level of pain or dyspnea was generally mild to moderate in this study, and significant differences were unlikely to occur. Second, patients allocated to delayed NA likely experienced a prolonged discomfort related to the persistence of pneumothorax for 72 h, while patients allocated to TD experienced a more rapid relief of dyspnea, but endured the pain related to the presence of a chest tube. Finally, delayed NA did not reduce the duration of hospital stay when compared with TD. This was presumably related, at least partially, to the fact that patients were treated 3 days later than patients receiving chest tubes.

This finding led us to plan the second part of our study to determine whether a reduction in the delay of treatment by NA could be offset by a reduced success rate of the technique. Although we did not implement a randomized protocol of immediate vs delayed NA, the two populations of patients studied were quite similar with respect to all clinical parameters at entry in the study. Because of the importance of the resulting inferences, we thought that some limited comparisons and combinations could be validly performed between the two groups. With these limitations, we observed that immediate NA had a success rate similar to delayed NA, thus obviating the need for a period of bed rest in most patients. This finding also confirms the fact that in many patients, parenchymal tears may heal quickly, as previously suggested by the results of the gas tracer technique used by Seaton et al.10 However, many of our patients were not treated in the first hours after the onset of symptoms. In particular, the mean delay of hospital admission after symptoms was 2 days in patients treated with immediate NA. Whether NA performed within hours after the occurrence of pneumothorax would result in a similar success rate is unknown and remains to be investigated. Besides, the precise delay after which definitive success of NA could be ensured could not be determined. Owing to the failure rate observed after NA (roughly one fifth of patients), it is likely that some patients suffer relapses several hours after an apparent success. Although we observed no tension pneumothorax after failure of NA, this possibility still exists, and outpatient management of SP by immediate NA remains questionable.

The present prospective study reported recurrences of pneumothorax in 22% and 29% of patients treated by NA and TD, respectively, in a follow-up of 90 days. Although these recurrence rates may appear rather high, it must be emphasized that few other prospective studies are available, to which our results can be compared. The Veterans Cooperative Study18 observed recurrence rates of 27% and 33% at 30 and 90 days, respectively, in patients treated with simple TD. Because recurrence is more likely to occur in the first months after the pneumothorax,18 our results remain also highly consistent with the findings of the British Thoracic Society Research Committee11 that reported recurrence rates of 17% and 29% 1 year after NA and
TD, respectively. Long-term recurrence rates for simple TD have been variable, ranging from 36%\textsuperscript{17} to 41%\textsuperscript{18} in prospective studies, and from 23%\textsuperscript{14} to 52%\textsuperscript{3} in retrospective studies. Despite some discrepancy, these observations indicate that the irritating effect of the chest tube on the pleural surfaces is not sufficient to promote symphysis capable of preventing short-, medium-, or long-term recurrence. Because of these high recurrence rates, some authors have recommended that instillation of sclerosing agents be considered for patients with spontaneous pneumothorax treated by chest tubing.\textsuperscript{17,19} This recommendation, however, has not met with general agreement,\textsuperscript{24} notably in patients with a first episode of SP,\textsuperscript{3} and the long-term consequences of sclerosant-induced symphysis on future thoracic surgical procedures is not yet clarified.\textsuperscript{25} Moreover, parenteral tetracycline, the only well-documented beneficial and safe sclerosing agent,\textsuperscript{3,25} is no longer available in our country. These remarks explain why our study used no sclerosant at the time of chest tube insertion.

A particular subgroup of patients deserves attention, namely patients who failed to heal with simple NA. From our data, these patients seem to have a high risk of combined TD failure and recurrence, slightly exceeding the same rate observed in the general population of patients directly treated with TD. Although our number of observations is limited, these results suggest that invasive procedures such as thoracoscopy\textsuperscript{22,23} may be preferred to chest tube insertion in these patients. This point remains speculative and should be addressed by specific studies.

In summary, our results confirm that immediate simple NA is a safe treatment for SP, and is successful in roughly two thirds of patients, with a risk of recurrence at 3 months similar to the recurrence rate following chest tube insertion of roughly one fifth of patients. Needle aspiration may thus be proposed as a first-line therapy for the first episode of pneumothorax in most patients. In patients who do not heal with NA, a combined risk of TD failure and short-term recurrence of 50% may be an incentive for undelayed surgical procedures. These suggestions do not apply to smaller pneumothoraces, which represent less than 15% of all SPs in our experience, and which are usually managed by conservative strategies.

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