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Fibrin Glue for Sealing the Needle Track in Fine-Needle Percutaneous Lung Biopsy Using a Coaxial System: Part II—Clinical Study

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Abstract

Purpose: Following percutaneous lung biopsy (PLB), we used fibrin glue as a sealant in 26 patients for the purpose of decreasing the incidence of pneumothorax.
Methods: All 26 patients (group A) had chronic obstructive pulmonary disease (COPD). The results for group A were compared with a control group of 32 patients (group B), also with COPD and in whom fibrin glue was not used. All biopsies were conducted under computed tomography (CT) using a coaxial needle system consisting of 19-gauge and 22-gauge needles.
Results: Pneumothorax developed in five patients (19.2%) in group A and in one instance, drainage was required (3.8%). In group B, pneumothorax developed in 13 patients (40.6%) and in six instances (18.8%) drainage was required. Comparing the use of chest-tube drainage in the two groups, a statistical significance was observed, $p < 0.025$. No adverse reactions related to the fibrin glue were observed.
Conclusion: Our results indicate that fibrin glue is a safe sealing material for lung PLB and serves to decrease the incidence and, in particular, the severity of pneumothorax, especially in high-risk patients.

Key words: Percutaneous lung biopsy—Fibrin glue—Chronic obstructive pulmonary disease

Percutaneous lung biopsy (PLB) is a recognized procedure in the diagnosis of pulmonary lesions [1]. Pneumothorax is the most common complication and is observed in approximately 25% of all cases [2]. In patients with chronic obstructive pulmonary disease (COPD), the frequency of pneumothorax following PLB rises to 46% and tube drainage is required in 19% [3].

A variety of materials have been used to seal the needle track in order to reduce the incidence of pneumothorax [4–7]. To date, none of these materials has been successful for this purpose [8–10]. However, some promising results have been reported using compressed collagen foam plugs [6].

In this study, the usefulness of fibrin glue was evaluated following PLB, relative to the incidence of pneumothorax, mainly in COPD patients, and to the response observed following its use. To the best of our knowledge, this material has not been previously studied for this indication.

Materials and Methods

From September 1989 to February 1994, computed tomography (CT)-guided PLB was performed in a total of 58 patients with suspected malignancy who presented with COPD in previously performed pulmonary function tests. In 26 of these, fibrin glue was administered following PLB (group A); whereas in the remaining 32 (group B), no sealant was used. The patients were prospectively randomized into either group A or group B; 41 males and 17 females were studied, ranging in age from 53 to 78 (mean 68.2 years). This randomization included the size and location of the lesions from which a biopsy specimen was obtained, as well as the stage of the COPD in the two groups. All patients studied had given previous informed consent.

All PLBs were conducted under CT guidance (Somatom DRH Siemens, Aktiengesellschaft, Erlangen, Germany). The patients of both groups presented with moderate to severe COPD, evaluated by presentation of at least one of the following criteria: FEV1/FVC (forced expiratory volume in first second/forced vital capacity) <0.65 and/or FEV1 <60% of predicted value. Patients with severe COPD

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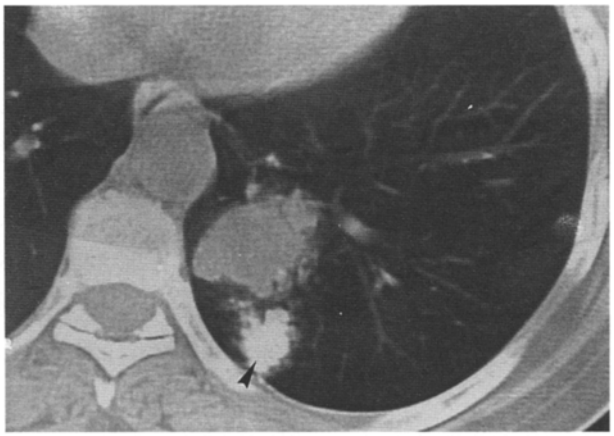

Fig. 1. In this patient with lung carcinoma, the fibrin glue (arrowhead) injected after the biopsy (intense white due to the contrast medium) occupies and seals the needle tract from the parietal pleura to the tumor.

numbered 5 of 26 (19.2%) in group A and 6 of 32 (18.8%) in group B. All had pulmonary lesions (masses or infiltrations) suspected to be malignant. In all cases the lesions were peripheral, the distance between the pleura and the edge of the lesion being in the range of 0.5–3 cm (Fig. 1).

The biopsy technique was identical in both groups and consisted of a coaxial needle system with a 19-gauge introducing cannula in conjunction with a 22-gauge aspiration needle (Green, Cook Inc., Europe AS, Copenhagen, Denmark). Following the local administration of 5 ml Xylocaine 2% solution, the needle was guided into the pulmonary lesion, penetrating the pleura only at the initial point of entry and avoiding the pulmonary fissures. The aspiration of the biopsy material was performed by a single radiologist with an average of three attempts using the internal needle. After the procedure the patients remained on the CT examination table with the biopsy site in a downward position for 10 min and then for another 50 min in a bed in the same position. In group A, after the removal of the internal needle, via the cannula during its withdrawal as well as in the peripheral section of the biopsy tract, we administered 1 ml fibrin glue (Tissucol 0.5^{TM}, Immuno AG, Vienna, Austria) combined with 0.3 ml Omnipaque 300 (Schering AG, Berlin, Germany) so as to permit the radiological visualization of the administered sealant (Fig. 1).

All patients were evaluated clinically and under CT for the presence, extent, and development of pneumothorax at the conclusion of and at 10 min, 60 min, and 24 hr after the PLB using four 8-mm slices at the site of the biopsy. Also 4 hr after the procedure a routine chest radiogram following exhalation was performed. The pneumothoraces, where observed, were classified as mild (<20%), moderate (20%–50%) or severe (>50%), in order to quantify their extent. The CT findings were used to calculate the ratio of the diameter of the hemithorax to the diameter of the collapsed lung. The criteria for placing a chest tube, as defined by Scott [11], were a pneumothorax of >20% expanding with time, determined by serial scans at 10-min intervals, or the presence of pneumothorax accompanied by dyspnea or persistent severe cough following the PLB. The post-biopsy rates and severity of pneumothorax were compared for the two groups using χ^2 analysis. Values of $p < 0.05$ were accepted as achieving statistical significance.

Results

In all 26 patients in whom the fibrin glue was used, clinical examination showed no subjective or objective adverse effects up to 48 hr following the procedure. In group A, pneumothorax developed in 5 of 26 patients (19.2%) and in 1 patient, tube drainage was required (3.8%). In group B, pneumothorax developed in 13 of 32 patients (40.6%) and of these, 6 patients required tube drainage (18.8%). These results are summarized in Table 1. Analysis of the pneumothorax rate in these two groups yielded $\chi^2 = 3.511, p > 0.05$. The analysis on chest tube drainage was $\chi^2 = 5.687, p < 0.025$. The severity of pneumothorax in group A was mild in three patients (11.5%), moderate in one (3.8%) and severe in one (3.8%). In group B, the severity was mild, moderate, and severe in five (15.6%), five (15.6%), and three (9.4%) patients, respectively. These results are summarized in Table 2.

Table 1. The incidence of pneumothorax and chest-tube drainage after PLB

Biopsy complications	Group A Fibrin glue (n = 26)	Group B No fibrin glue (n = 32)	Statistical significance
Pneumothorax	5 (19.2%)	13 (40.6%)	$p > 0.050$
Chest tube drainage	1 (3.8%)	6 (18.8%)	$p < 0.025$

Table 2. Comparison of the severity of pneumothorax in the two groups

Severity of the pneumothorax	Group A Fibrin glue	Group B No fibrin glue
Mild (<20%)	3 (11.5%)	5 (15.6%)
Moderate (<50%)	1 (3.8%)	5 (15.6%)
Severe (>50%)	1 (3.8%)	3 (9.4%)

In six of the patients, the fibrin-glue infusion was not deposited satisfactorily, having been injected slightly deeper than the lesion (n = 2) or injected into only a part of the needle track (n = 4) and thus sealing only a part of the track. The possible technical difficulties in the application of the sealant are shown in Figure 2. Pneumothorax was observed in two of these six patients.

In three other cases we observed a small leak into the pleural region (Fig. 3) which was not visualized at 24 hr and was due to an excess of sealant having been injected in the pleural cavity. In fact, the latter case is regarded as satisfactory as the tamponading at the point of entry was desirable.

We noted no complications, local or otherwise, relative to the sealant deposition during the 24-hr follow-up period and the patients' clinical course. The biopsy material was adequate and diagnostic in 21 patients from group A (80.8%) and in 27 patients from group B (84.4%).

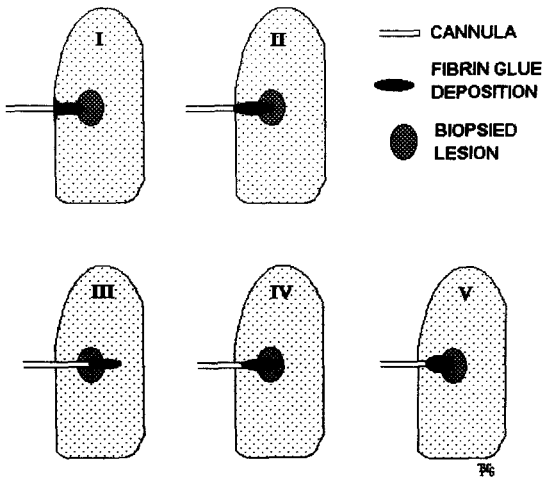

Fig. 2. Deposition of the sealant is satisfactory if the sealant completely fills the needle track and tamponades the point of entry (I), or even just the track itself (II). In the next two examples, the cannula is too deep and the deposit is beyond the lesion (III) or within it (IV) and only a small part of the sealant is in the needle track itself. Hasty injection of the sealant may also cause a blob-like deposition in only a part of the track (V). These last three examples are unsatisfactory.

Discussion

Percutaneous lung biopsy is an established method in the diagnosis of lung lesions. Pneumothorax is the most common complication of PLB, and the occurrence rates reported in literature range from 8% to 61%, averaging 25% [1, 2]. Of these, 2%–17% (average 12%) require a chest tube [1]. In patients with COPD, the incidence of pneumothorax is much higher. Fish et al. [3] found a 46% incidence of pneumothorax in patients with COPD and only 19% in patients without COPD; of those with COPD, 19% required a chest tube, whereas a chest tube was not required in any of the patients without COPD. Bourgouin et al. [8] and Poe et al. [12] reported a 44.4% and a 44% incidence of pneumothorax, respectively, in emphysema patients. In the latter study, tube drainage was required in 13% of the patients.

The rationale behind the use of a lung-patch technique was first implemented by McCartney et al. [4], who used clotted blood to decrease the incidence of pneumothorax as a complication following PLB. With this technique, some authors have reported a decrease in incidence, whereas others observed no decrease of any significance [8, 9, 13]. Recently, Bourgouin et al. [8] and Herman and Weisbrod [9], in their respective large scale retrospective studies, reported that there was no significant decrease in the incidence or severity of pneumothorax following the use of this technique. Our personal experience with a modified technique using contracted clotted blood has shown no significant decrease in the incidence of pneumothorax [10]. In a concurrent experimental study however, we found a statistically significant decrease in the severity of the pneumothorax, although the decrease in incidence was insignificant [7]. The shortcomings of this method have since led to the development of similar techniques using different sealants to try to improve the efficacy and decrease the possibility of side effects. The experimental use of isobutyl-2-cyanoacrylate did reduce the incidence of pneumothorax, but this material was considered unsuitable for use in humans [5]. However, this study did serve to show that, with the use of an appropriate sealant, the desired effect was feasible.

Engeler et al. [6] reported the use of 4-cm-long compressed collagen plugs across the pleural space and lung after PLB with promising results.

The successful use of fibrin glue as a plug for the post-liver biopsy needle track has been reported by Rodriguez-Fuchs and Bruno [14] and Chisholm et al. [15]; based on these results we proceeded to use this sealant in lung biopsies. We studied the efficacy of the sealant in COPD patients, as it is in this group that the severity of pneumothorax is most significant. All of the patients presented with moderate to severe COPD [16].

The present clinical study, as well as our primary experimental study, revealed no adverse effects following the intrapulmonary administration of fibrin glue in the 26 patients with COPD. In particular, no cases of pulmonary embolism were recorded. With regard to the comparison of the incidence of pneumothorax observed in the patients who received fibrin glue (group A) and those who did not (group B), although there is a difference between the two groups (pneumothorax rate 40.6% in group B vs 19.2% in group A), it is not statistically significant, ($p > 0.05$), possibly due to the small statistical sample. There was, however, a significant difference between the two groups in patients where chest intubation was required: 18.8% in group B vs. 3.8% in group A, ($p < 0.025$). The small number of patients with severe COPD (group A/B = 5/6) does not permit further evaluation of the correlation between the stage of the COPD and the pneumothorax.

A possible explanation of the process is that the glue seals the needle defect in the visceral pleura as well as in the immediately adjacent lung parenchyma, thus preventing the formation of pneumothorax, and where pneumothorax does occur, its magnitude appears to be reduced by the presence of the sealant (Fig. 4). The fluid nature of the sealant prior to its coagulation leads us to believe that fibrin glue may have superior properties when compared with more compact plugging materials. However, this remains to be confirmed by further studies.

From a technical viewpoint, it should be noted that plugging of the peripheral section of the biopsy tract with the insertion of the sealant into the peripheral lung parenchyma 1–2 cm from the pleura is sufficient. Also,

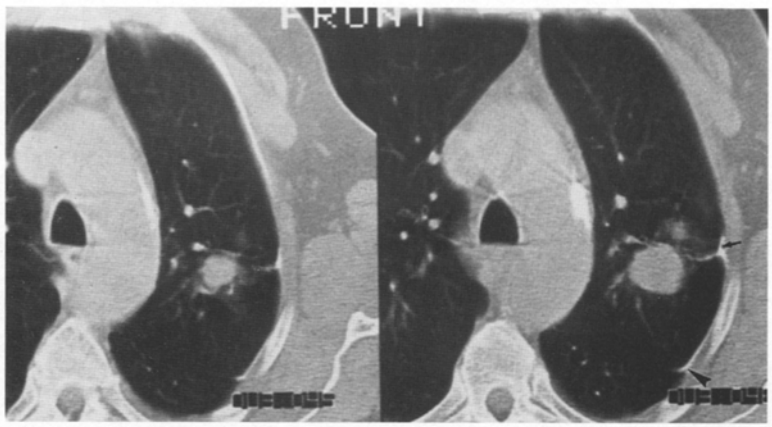

Fig. 3. Thoracic CT scans of a patient with a lung carcinoma located approximately 15 mm subpleurally. The fibrin glue is shown thread-like in the biopsy needle track leading from the pleura to the lesion. Note the fibrin-glue plug forming a triangular plug in the subpleural region (arrow). A small leak into the pleural region is observed (arrowhead).

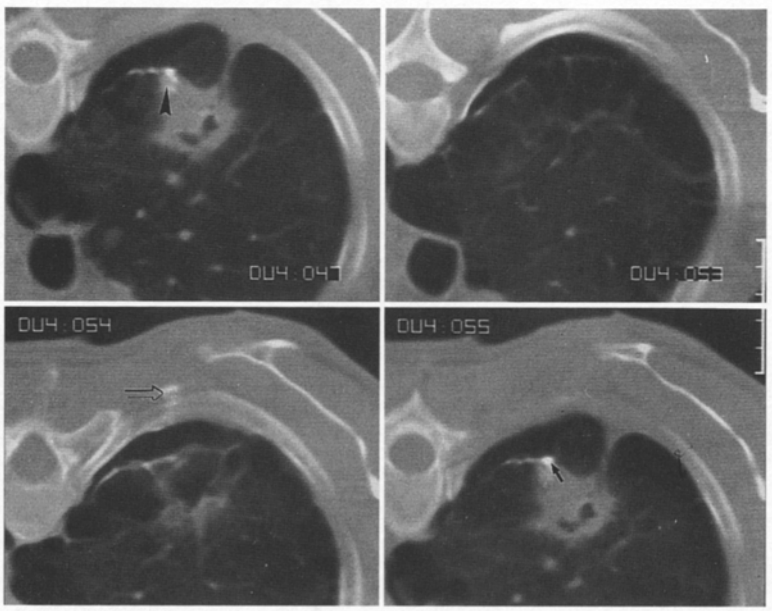

Fig. 4. Thoracic CT scans in a patient with a lung carcinoma surrounded by multiple subpleural emphysematous bullae, because of which the only possible biopsy route had to pass through the emphysematous area. Note the fibrin-glue plug (intense white due to the contrast medium) which occupies the pierced bulla (arrowhead) and also seals the point of entry (arrow). The open arrow points to residual sealant in the chest wall indicating the biopsy route. The limited pneumothorax, shown at 10 min post-biopsy, remained stable.

the infusion of the sealant into the central pulmonary segments should be avoided to minimize the possibility of the material entering central branches of the pulmonary veins. In 6 of 35 patients, where the placement was inadequate or unsatisfactory, the cause was our initial lack of experience. This becomes more obvious in that 5 of these occurred in our first 15 patients.

Hypersensitivity to bovine proteins, where allergic or anaphylactic reactions may occur on very rare occasions, is the only known contraindication to fibrin glue. The material used has been heat-treated by the manufacturers to render it free of hepatitis and HIV viruses.

In conclusion, this study indicates that the infusion of fibrin glue may be a safe procedure for decreasing the incidence and particularly the severity of pneumothorax following coaxial fine-needle aspiration biopsy. Our study also indicates that fibrin-glue sealing is an effective method in selected cases of PLB in patients at high risk of developing pneumothorax, such as those with COPD.

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