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# Nonclotted Blood Patch Technique Reduces Pneumothorax and Chest Tube Placement Rates After Percutaneous Lung Biopsies

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**Purpose:** The aim of this study was to determine whether autologous nonclotted blood patch decreases pneumothorax and chest tube placement rates in computed tomography–guided biopsies of the lung.

**Materials and Methods:** Percutaneous computed tomography–guided lung biopsies performed over a period of 6 years were retrospectively reviewed to determine the overall rates of pneumothorax and chest tube placement and rates before and after the autologous nonclotted blood patch procedure was instituted as a departmental policy. The effect of the intervention was only assessed in patients in whom a blood patch could be applied, therefore only when the needle traversed an aerated lung and only when the needle remained in the lung at the end of the study.

**Results:** There was a statistically significant decrease in both the rate of pneumothorax [28% (69/245) vs. 42% (80/189); $P = 0.002$] and chest tube placement [4% (10/245) vs. 16% (30/189); $P < 0.001$] in patients who received nonclotted blood patch versus those who did not. Blood patch was performed in 222/312 (71%) eligible patients after the introduction of the blood patch policy. After policy introduction, there was a decreased rate of pneumothorax, with a rate of 32% (101/312) versus 40% (49/122) ($P = 0.12$) and a statistically significant decrease in departmental chest tube placement rates of 6% (20/312) versus 16% (20/122) ($P = 0.001$).

**Conclusions:** Nonclotted autologous blood patch for percutaneous lung biopsy resulted in significantly decreased pneumothorax and chest tube placement rates in our patient population.

**Key Words:** percutaneous lung biopsy, lung biopsy, pneumothorax, chest tube, blood patch, autologous blood patch, sealant

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Pneumothorax remains the most common complication of percutaneous lung biopsies. Reducing this risk is a goal of those who perform these procedures, particularly reduction in large pneumothoraces requiring intervention (eg, pleural drainage) and hospitalization. Various interventions have been considered to reduce the risk for pneumothorax including avoiding or reducing the number of passes through the pleura, avoidance of areas of emphysema, varying needle size, depth and angle of trajectory, and postprocedural patient positioning (patient supine, puncture side down, etc.).[1–8]

Sealant techniques have been an area of debate since their initial description. Many sealant materials have been studied, with autologous clotted blood being the most commonly described agent. Given the mixed results in the literature regarding clotted blood and paucity of information regarding nonclotted blood, we aimed to further evaluate the nonclotted blood patch technique. First, we sought to observe the overall effect on pneumothorax and chest tube placement rates in cases in which a blood patch was successfully used versus cases in which it was not. Second, we wanted to assess feasibility in clinical practice; specifically, we sought to assess the proportion of cases in which the technique was used after a departmental policy change to include nonclotted blood patch as standard practice. Third, we wanted to evaluate the effect of the policy change on pneumothorax and chest tube placement rates in the routine clinical setting, given incomplete use of blood patch after policy introduction, as the ultimate decision to use the technique in each case was left to the individual practitioners.

We hypothesized that use of nonclotted blood patch would result in a significant decrease in overall pneumothorax and chest tube placement rates compared with the nonclotted blood patch group. We postulated that in practice approximately 80% of patients would receive the patch once it was the "standard" for the department. Finally, we believed that despite incomplete utilization of the technique, the net effect of the blood patch policy would be a statistically significant reduction in pneumothorax and chest tube placement rates.

## MATERIALS AND METHODS

### Patients

This is a HIPPA-compliant, institutional review board–approved, retrospective study. Informed consent was waived. Our institutional lung biopsy database includes all chest biopsies performed, including those for diagnostic and research purposes, at both a tertiary care medical center and a Veterans Affairs medical center, and is maintained by the biopsy operators. All biopsies from October 2009 through January 2015 were identified, resulting in 999 consecutive potentially eligible procedures.

Biopsies were included if it was a procedure in which a blood patch could have been theoretically applied. Therefore, biopsies were excluded if:

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- the biopsy tract did not cross aerated lung, including consolidations and lesions with broad pleural contact of > 1 cm,
- pneumothorax developed before needle removal, which resulted in needle displacement from the lung into the pleural space.

In addition, biopsies were excluded if:

- the target was a mediastinal or chest wall lesion,
- an indwelling chest tube was present,
- an alternative sealant technique was used,
- the use or nonuse of a blood patch was insufficiently documented.

## Biopsy Technique

All biopsies were performed by an attending thoracic imaging radiologist or by a thoracic imaging fellow/resident under the direct supervision of an attending radiologist. Biopsies were performed or supervised by 6 attending physicians over the course of the study with experience ranging from 6 to 30 + years. The biopsies were performed with conventional computed tomography (CT) guidance, predominantly on a GE Lightspeed VCT 64 multidetector CT, utilizing biopsy mode with 120 kVp, low mAs (typically 10 to 80) at 2.5 mm slice thickness. Diagnostic CT scans were obtained before procedure scheduling and were reviewed for feasibility. On the date of the biopsy, the patient was positioned according to the chosen biopsy tract, with an attempt to avoid fissures and regions of emphysema when possible, and a limited field CT of the region of interest was performed. Subsequent CT images were obtained after coaxial manipulation until the needle was positioned satisfactorily within the lesion. All biopsies were performed utilizing a 19 G coaxial system (6 to 15 cm in length) with corresponding 20, 22, or 23 G fine-needle aspiration (Chiba) and/or 20 G core (spring loaded, Tenmo) biopsies. After an adequate biopsy was obtained as determined by consultation with an on-site cytopathologist, the needle was removed during suspended respiration, either with or without a blood patch (described below). Postprocedural low-dose CT was performed immediately after coaxial needle removal. The patient was then observed for a minimum of 2 hours, and at least 1 repeat chest radiograph (CXR) was performed at this time before discharge.

## Autologous Nonclotted Blood Patch Technique

Use of a nonclotted blood patch, whenever possible, was made a departmental policy in March of 2011. Although the benefits of the technique remained controversial in the literature, it was our belief that such a technique offered the promise to improve patient care with minimal increased procedure time and little risk.

Depending on the length of the tract from the tip of the needle to the pleura, 5 to 10 mL of blood was sterilely aspirated from the patient's intravenous line. The blood-filled syringe was then passed to the performing radiologist who ensured lack of air within the syringe. After suspension of patient respiration, the radiologist connected the syringe to the coaxial system and gently injected the autologous blood while removing the needle over a period of several seconds. In shorter tracts, the injection began from the site of biopsy, whereas in longer tracts the injection began several centimeters from the pleura. This injection was continued to just past the edge of the pleura, the distance of which was calculated beforehand. Figure 1 demonstrates a normal CT appearance after nonclotted blood patch with small patch tract extending to the pleural surface.

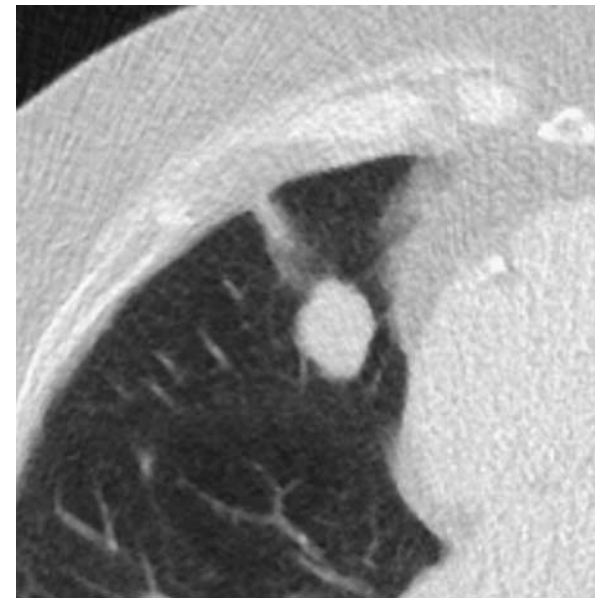

**FIGURE 1.** Linear groundglass opacity corresponding to non-clotted blood patch tract.

## Determination of Pneumothorax

A postbiopsy pneumothorax was defined as any amount of pleural air seen on either postprocedural CT or follow-up CXR that was not present *before needle withdrawal*. Therefore, pneumothoraces that developed before needle removal that did not cause significant needle displacement were not counted as a *postprocedural* pneumothorax for the purpose of the study, as blood patch was still able to be performed. In these cases, *postprocedural* pneumothorax was defined as a pneumothorax that increased in size on postbiopsy imaging.

## Determination of Chest Tube Placement

Chest tube placement was performed in symptomatic pneumothoraces of significant size and/or in pneumothoraces that rapidly increased in size over time of follow-up. This decision was made by the biopsy operator and consulted interventional radiologists. The presence of a postbiopsy chest tube procedure was determined by review of the medical record.

# RESULTS

A total of 434 biopsies were eligible for inclusion over the given time period; 565 biopsies were excluded due to: 264 chest wall/pleural/broad pleural attachment with no crossing of normal pleura or lung, 175 insufficient reporting on blood patch status, 65 intraprocedural pneumothoraces with needle displacement, 47 mediastinal lesions, 6 procedures terminated before biopsy, 6 indwelling chest tube, 2 saline patch. Patient and lesion characteristics are listed in Table 1.

There was a statistically significant decrease in both pneumothorax and chest tube placement rates in patients receiving a nonclotted blood patch compared with those who did not. Pneumothorax rates were 28% (69/245) versus 42% (80/189) ($P = 0.002$) and chest tube placement rates


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**TABLE 1.** Demographics

| Biopsy Characteristics | Blood Patch (N = 245) | Nonclotted Blood Patch (N = 189) | *P* |
|---|---|---|---|
| Sex | 60% male | 66% male | 0.23 |
| Age [mean (SD)] (y) | 67 (12.6) | 66 (13.7) | 0.4 |
| Lesion diameter [mean (SD)] (cm) | 2.3 (1.3) | 2.3 (1.1) | 1.0 |
| Emphysema, presence of (%) | 47 | 49 | 0.7 |

were 4% (10/245) versus 16% (30/189) ($P < 0.001$) comparing modified blood patch with nonclotted blood patch groups overall. Of note, these are the pneumothorax and chest tube placement rates in the study population, *not of all biopsies performed at the institution*, given that biopsies not traversing an aerated lung, etc. were excluded, per the stated methods.

Before the institution of the modified blood patch policy, 122 eligible biopsies were performed, 23 with blood patch, for a blood patch rate of 19%. These blood patches were performed entirely at the discretion of the operators. After policy implementation, there were 312 eligible biopsies with 222 receiving a blood patch, corresponding to a blood patch rate of 71%.

After blood patch implementation as a departmental policy, there was a nonsignificant decrease in the pneumothorax rate [32% (101/312) down from 40% (49/122); $P = 0.12$]. There was a significant postpolicy decrease in the chest tube placement rate [6% (20/312) vs. 16% (20/122); $P = 0.001$].

## DISCUSSION

In our study, patients who received an autologous nonclotted blood patch experienced significantly fewer pneumothoraces (28% vs. 42%) and chest tube placements (4% vs. 16%). Despite incomplete usage of the technique after its adoption as a departmental policy, being performed in 71% of eligible cases, institution of the policy did result in a decrease in the pneumothorax rate and a significant decrease in the chest tube placement rate.

Sealant techniques were first described in 1974 by McCartney and colleagues utilizing both autologous clotted blood and gel foam.[9,10] Since then a variety of other materials have been used including sterile saline,[11,12] fibrin glue,[13] and specially formulated biopsy plugs.[14,15] The most commonly studied agent has been autologous clotted blood, often called a "blood patch." From its initial description in 1975, blood patch was thought to reduce pneumothorax and chest tube placement rates. This was brought into question in 1988 when a large controlled trial showed no significant benefit of the procedure[16] and was corroborated by an additional controlled study in 1990.[17] More recent research has emerged re-suggesting the effectiveness of autologous clotted blood with 2 prospective, randomized trials, 1 in 2000[18] and 1 in 2013,[19] both of which showed a significant decrease in chest tube placement rates.

To our knowledge, our intervention is the first known evaluation of the nonclotted technique in humans, which was previously documented in an equine model by Moore et al.[20] In our study population, we noted a relative reduction in pneumothorax and chest tube placement rates of approximately 33% and 75%, respectively. This is similar to the reduction in pneumothorax and chest tube placement rates described by 2 relatively recent prospectively performed studies using autologous clotted blood. Lang et al[18] demonstrated a similar statistically significant decrease in both pneumothorax and chest tube placement in a prospective study of 100 patients. Malone et al,[19] in a larger prospective trial including 242 patients, reached statistical significance in chest tube reduction and noted a nonstatistically significant decrease in the pneumothorax rate. These reductions are similar to that seen in evaluations of other sealants including gel foam,[9,10] fibrin glue,[13] biopsy plugs,[14,15] and normal saline.[11,12]

The benefits of the *nonclotted* blood patch procedure (as opposed to the more common clotted blood patch) are multiple. First, it requires less time to implement, given no delay is needed for blood clotting. Any reduction in time on the biopsy table, particularly once the pleura has been crossed, is beneficial to both the patient and provider. No additional CT images to document needle position relative to the pleura are required, as the blood patch was placed in a tract extending from the peripheral lung to just beyond the pleura. The use of nonclotted blood also theoretically decreases the risk for embolization into small pulmonary vessels that the biopsy tract may have crossed, as no preformed particles are present. Compared with other sealants, the use of blood is advantageous as it is essentially free and highly unlikely to cause an adverse reaction.

The complication rates in our study population are not an estimate of the overall complication rates for our lung biopsies, as we only included lesions having traversed aerated lung therefore excluding a large number of low-risk lesions.[1] This resulted in a higher complication rate than the rate for our biopsies overall; nevertheless, the rates in our study are comparable to those published in the literature. Pneumothorax rate has been reported as low as 20%[5] to as high as above 40% by multiple studies,[2,4,8] with a similar large range of chest tube placement rates described from 2%[5] to 14% to 15%.[2,7] This discrepancy can be attributed to multiple variables in each individual study including: patient characteristics, that is, presence of emphysema and size and location of the lesions, lesion inclusion criteria, and the method of diagnosing pneumothorax, be it CT and CXR or CXR alone, among multiple other factors.[1–8]

A blood patch rate of 71% during the postpolicy period was less than our expected rate of 80%. Insufficient information was available in the records to indicate why the blood patch technique was not used in all patients. Anecdotally, the technique was not used in some patients with difficult intravenous access, as intermittent IV function and lack of sites for IV replacement resulted in termination of some biopsies without a patch. In addition, lack of use was described in cases in which patients were in significant discomfort, often positional, and terminating the procedure in a timely manner was important. Also in the few cases of significant peribiopsy hemorrhage, blood patches were occasionally deferred, as sufficient blood was already observed around the need track. Finally, some providers may have neglected the policy, particularly immediately after enactment.

Our study is limited due to its restrospective design. In addition, the experience of this intervention is limited to a single institution and group of practitioners. The exclusion of cases due to insufficient/incomplete reporting of blood patch status was unavoidable; however, the loss of such cases in the analysis is less than ideal. Incomplete reporting

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occurred despite a policy requiring complete documentation, likely related to unfamiliarity with new dictation templates and reporting protocols. No reliable method was available to assess whether or not these cases received a blood patch without such documentation.

In summary, our study demonstrated significant reduction in pneumothorax and chest tube placement rates resulting from a simple-to-use nonclotted autologous blood patch technique. Despite incomplete usage, which is to be expected in real-world practice, the decreased rate of complications, particularly in chest tube placement, is likely to decrease overall patient morbidity from percutaneous lung biopsy.

## REFERENCES


1. Haramati LB, Austin JH. Complications after CT-guided needle biopsy through aerated versus nonaerated lung. *Radiology*. 1991;181:778.
2. Kazerooni EA, Lim FT, Mikhail A, et al. Risk of pneumothorax in CT-guided transthoracic needle aspiration biopsy of the lung. *Radiology*. 1996;198:371–375.
3. Moore EH. Technical aspects of needle aspiration lung biopsy: a personal perspective. *Radiology*. 1998;208:303–318.
4. Cox JE, Chiles C, McManus CM, et al. Transthoracic needle aspiration biopsy: variables that affect risk of pneumothorax. *Radiology*. 1999;212:165–168.
5. Laurent F, Michel P, Latrabe V, et al. Pneumothoraces and chest tube placement after CT-guided transthoracic lung biopsy using a coaxial technique: incidence and risk factors. *Am J Roentgenol*. 1999;172:1049–1053.
6. Ko JP, Shepard JO, Drucker EA, et al. Factors influencing pneumothorax rate at lung biopsy: are dwell time and angle of pleural puncture contributing factors? *Radiology*. 2001;218: 491–496.
7. Saji H, Nakamura H, Tsuchida T, et al. The incidence and the risk of pneumothorax and chest tube placement after percutaneous CT-guided lung biopsy: the angle of the needle trajectory is a novel predictor. *Chest*. 2002;121:1521–1526.
8. Hiraki T, Mimura H, Gobara H, et al. Incidence of and risk factors for pneumothorax and chest tube placement after CT fluoroscopy-guided percutaneous lung biopsy: retrospective analysis of the procedures conducted over a 9-year period. *Am J Roentgenol*. 2010;194:809–814.
9. McCartney R, Tait D, Stilson M, et al. A technique for the prevention of pneumothorax in pulmonary aspiration biopsy. *Am J Roentgenol Radium Ther Nucl Med*. 1974;120:872–875.
10. McCartney RL. Further observations on the lung patch technique. With analysis of the first 50 cases. *Am J Roentgenol Radium Ther Nucl Med*. 1975;124:397–403.
11. Billich C, Muche R, Brenner G, et al. CT-guided lung biopsy: incidence of pneumothorax after instillation of NaCl into the biopsy track. *Eur Radiol*. 2008;18:1146–1152.
12. Li Y, Du Y, Luo TY, et al. Usefulness of normal saline for sealing the needle track after CT-guided lung biopsy. *Clin Radiol*. 2015;70:1192–1197.
13. Petsas T, Siamblis D, Giannakenas C, et al. Fibrin glue for sealing the needle track in fine-needle percutaneous lung biopsy using a coaxial system: Part II—clinical study. *Cardiovasc Intervent Radiol*. 1995;18:378–382.
14. Engeler CE, Hunter DW, Castaneda-Zuniga W, et al. Pneumothorax after lung biopsy: prevention with transpleural placement of compressed collagen foam plugs. *Radiology*. 1992;184:787–789.
15. Zaetta JM, Licht MO, Fisher JS, et al. A lung biopsy tract plug for reduction of postbiopsy pneumothorax and other complications: results of a prospective, multicenter, randomized, controlled clinical study. *J Vasc Interv Radiol*. 2010;21: 1235–1243 e1231-1233.
16. Bourgouin PM, Shepard JA, McLoud TC, et al. Transthoracic needle aspiration biopsy: evaluation of the blood patch technique. *Radiology*. 1988;166(pt 1):93–95.
17. Herman SJ, Weisbrod GL. Usefulness of the blood patch technique after transthoracic needle aspiration biopsy. *Radiology*. 1990;176:395–397.
18. Lang EK, Ghavami R, Schreiner VC, et al. Autologous blood clot seal to prevent pneumothorax at CT-guided lung biopsy. *Radiology*. 2000;216:93–96.
19. Malone LJ, Stanfill RM, Wang H, et al. Effect of intraparenchymal blood patch on rates of pneumothorax and pneumothorax requiring chest tube placement after percutaneous lung biopsy. *Am J Roentgenol*. 2013;200:1238–1243.
20. Moore EH, Shelton DK, Wisner ER, et al. Needle aspiration lung biopsy: reevaluation of the blood patch technique in an equine model. *Radiology*. 1995;196:183–186.



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