Original Article

Tract injection of autologous blood (intraparenchymal blood patching) in percutaneous transthoracic CT-guided lung biopsy and the incidence of pneumothorax: a retrospective analysis

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Background: Pneumothorax is a common complication following percutaneous transthoracic computed tomography (CT)-guided lung biopsy. The purpose of this study is to determine if intraparenchymal blood (IPB) patching following the lung biopsy procedure causes a significant decrease in the incidence of post-biopsy pneumothorax, chest tube placement, and hospitalization.

Methods: Retrospective analysis was performed on all percutaneous CT-guided lung biopsies completed between January 2013 and January 2020 at two hospitals. 309 patients received IPB and 227 did not. Cases were excluded if patients were younger than eighteen years-of-age, if an alternative method to seal the tract was utilized, an indwelling chest tube was already in place, or aerated lung parenchyma was not traversed by the needle. Retrospective review of records was performed to determine the overall incidence of post-biopsy pneumothorax, chest tube placement, and hospitalization when IPB was and was not administered.

Results: Patients who received post-biopsy IPB had a statistically significant lower incidence of pneumothorax [45 of 309 (14.6%) *vs.* 84 of 227 (37.0%); P<0.0001], chest tube placement [12 of 309 (3.9%) *vs.* 39 of 227 (17.2%); P<0.0001], and hospital admissions [9 of 309 (2.9%) *vs.* 37 of 227 (16.4%); P<0.0001] than those who did not.

Conclusions: Autologous IPB following percutaneous transthoracic CT-guided lung biopsy significantly decreases the incidence of pneumothorax, chest tube placement, and hospital admission.

Keywords: Lung biopsy; pneumothorax; intraparenchymal blood patching (IPB patching); iatrogenic complication

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Introduction

Percutaneous transthoracic computed tomography (CT)-guided lung biopsy is a common procedure performed in the diagnostic evaluation of lung lesions. One of the most common complications of this procedure is pneumothorax. This exposes patients to the possibility of requiring a chest tube with an extended hospital stay, serial radiological imaging, and in some cases, evaluation and treatment for bronchopleural fistula. A meta-analysis of 32 studies investigating complications of lung biopsy reported pneumothorax incidence rates between 22.2% to 28.6% in patients undergoing core lung biopsy, with 4.3% to 7.3% of the patients requiring either manual aspiration or chest tube placement and/or hospitalization (1).

There have been mixed results in the literature from studies investigating the efficacy of blood patching. Bourgouin *et al.* (2), did find a decrease in the incidence of pneumothorax with blood patching from 34.1% to 28.8%, along with a decrease in the incidence of pneumothorax requiring chest tube placements from 9.1% to 7.7%. Similar results were demonstrated by Herman and Weisbrod (3), with a decrease in incidence of pneumothorax with blood patching from 30% to 24%, however an insignificant increase was noted in patients needing chest tube placement in the blood patching group (2.2%, 1/46 *vs.* 2.1%, 1/47), but the findings were not statistically significant in both studies (2,3). A randomized controlled trial published in 2013 consisting of 242 patients found reduction in the incident rate of pneumothorax from 35% to 26% (P=0.12) and significant reduction in the rate of pneumothorax requiring a chest tube from 18% to 9% (P=0.048) (4).

A recent retrospective review has showed promise for the efficacy of blood patching (5). Graffy *et al.* [2017] (5) found that with use of intraparenchymal blood (IPB) they had a significant reduction in pneumothorax from 44% to 30% (P<0.0001), and a reduction in pneumothorax related interventions, 24.1% to 8.9% (P<0.0001), including chest tube placement, 6.8% to 3.1% (P<0.0001), and hospital admission, 7.7% to 3.7% (P<0.0001).

Current standard of care guidelines and recommendations do not warrant the instillation of autologous blood routinely, likely due to lack of enough evidence, but does mention the benefit noted in the literature (6). The goal of this retrospective review is to compare the rates of post-biopsy pneumothorax, chest tube placement, and hospitalization when IPB is used. We present the following article in accordance with the STROBE reporting checklist (available at https://pcm.amegroups.com/article/view/10.21037/pcm-22-9/rc).

Methods

Patient selection

This retrospective study is compliant with the Health Insurance Portability and Accountability Act and approved by the Institutional Review Board of Ascension St. John Hospital (IRB No. 1589530). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Individual consent for this retrospective analysis was waived. Patients were identified using ICD-9 and ICD-10 codes. All percutaneous CT-guided biopsies performed at two hospitals from January 1st, 2013 through January 1st, 2020 were collected summing to 848 potentially eligible studies.

Patients were required to be eighteen years-of-age or older to be included. Studies were excluded if an alternative sealant method was used, an indwelling chest tube was already in place, and/or if lung parenchyma was not traversed by the guiding needle to reach the lesion of concern. For patients who had undergone multiple biopsies, only the first study was included in statistical analysis. Studies were also excluded if procedural images were unavailable for review. There were 536 total studies included for analysis; 227 had not received blood patching, 309 had received IPB.

Biopsy technique

Out of the 536 biopsies, 528 were performed using a 19-G introducer needle with an associated 20-G core biopsy needle. A 17-G introducer needle was used on the eight other biopsies. The patients were appropriately placed on the CT table and biopsies were performed under CT guidance. All safe techniques were utilized in the biopsy. If possible, the side being biopsied was kept dependent. Traversing through the fissures was avoided unless the lesions were not otherwise accessible. Bullae, blood vessels, and airways were avoided. The time for which the needle was within the patient was kept to the minimum. If there were multiple possible tracts, the tract that required traversing through the least amount of lung tissue was selected.

Blood patching technique

The utilization of blood patching was determined by

manual review of procedural records. Blood patching was not performed in patients from 2013–2015; however, all patients who underwent CT-guided lung biopsy from 2016 to 2019 received blood patching.

At the time of intravenous (IV) access, approximately 10 mL of venous blood is withdrawn from the patient into a syringe. The syringe is left undisturbed throughout the procedure to allow for the blood to clot or separate. The distance of the pleura from skin is calculated on the pre-biopsy planning scan. After the biopsy specimens are obtained and immediately before the coaxial introducer needle is removed, plasma is slowly separated from the blood/clots in the syringe and the remaining blood/clots are injected into the tract as the guiding needle is slowly removed. The injection is continued up to and just past the pleura. Typically, 4–6 mL is injected, depending on the tract length.

Pneumothorax

Patients with a large pneumothorax found immediately after biopsy on CT-imaging, even before removal of the biopsy needle, were excluded from the study. Pneumothorax size was calculated using the equation $Y = 4.2 + (4.7 \times (A + B + C))$, $r=0.98$, ($P<0.0001$), developed by Collins *et al.* (7). The post-procedural CT scan images and follow-up chest radiographs were evaluated for pneumothorax. If post-biopsy pneumothorax was identified, serial chest radiographs were performed hourly for 2 hours until pneumothorax stability was confirmed, or a chest tube was placed for an enlarging pneumothorax or if the patient was becoming symptomatic. Patients with chest tubes were admitted for 24-hour observation. The chest tube was removed if there was no pneumothorax on the morning chest radiograph with clamping of the tube.

Chest tube placement

The decision for chest tube placement was determined by the patient's symptom severity and pneumothorax chest radiograph. Patients with a symptomatic pneumothorax, enlarging pneumothorax, or pneumothorax >25% volume were treated with 8.5 Fr Cook multi-purposed chest tubes that were placed under CT guidance. The patients receiving chest tubes were admitted and were managed by either the in-house thoracic surgery team or an interventional radiologist.

Statistical analysis

Descriptive statistics were given for all data collected. Missing data were not replaced by substitutions or computations. Categorical variables were provided as counts and % frequencies. All continuous variables were provided as either means ± the standard deviation or median and 25th and 75th percentiles, followed by the minimum to maximum dependent on the normality of the data. All analyses used SAS® System for Windows version 9.4 or higher, Cary, NC.

Baseline and demographic data were compared between patients receiving autologous blood patch and those that did not receive autologous blood patch injections. Univariate analyses were done using Chi-square tests for categorical variables where appropriate (expected frequency >5 in 80% of cells), otherwise Fisher's Exact tests were used. Continuous variables were examined using Wilcoxon rank-sum tests or *t*-tests dependent on the normality of the data.

The primary outcomes of post-biopsy pneumothorax, the need for chest tube placement and hospital admission were each examined separately between the patients receiving autologous blood patch injections and those that did not receive autologous blood patch injections using Chi-square tests where appropriate (expected frequency >5 in 80% of cells), otherwise Fisher's Exact tests were used.

Results

Approximately half of the subjects were males. The average age was 69 years. The most common indication for biopsy was the characterization of a new lesion at 81.5%, while 11% was for a prior lung lesion that had changed in size. 82.8% of the total subjects reported a history of cigarette smoking. There was a higher percentage of patients who reported a history of chronic obstructive pulmonary disease (COPD) in the control group (46.7% *vs.* 35.4%; $P<0.008$), however, this was obtained from patient chart review and not by radiological evidence of emphysema. The presence of emphysema has a notable impact on the likelihood of developing a pneumothorax and a pneumothorax necessitating chest tube placement (8). Refer *Table 1* for patient demographics and baseline characteristics.

There was a significant decrease in incidence of pneumothorax from 37.0% to 14.6% ($P<0.0001$), chest-tube placement from 17.2% to 3.9% ($P<0.0001$), and hospital admissions from 16.3% to 2.9% ($P<0.0001$) in the subjects who received post-biopsy IPB compared to those who did not. Length of hospitalization did not vary significantly

Table 1 Demographics and baseline characteristics of patients in control and experimental group

Baseline characteristics	No blood patch (N=227)	Blood patch (N=309)	P value
Males	107 (47.1%)	146 (47.3%)	0.98
Age (years)			0.25
Mean ± SD [median]	68±11 [69]	69±10 [70]	
Min to max	25–93	41–92	
Smoker			0.036
0= never	28 (12.3%)	64 (20.7%)	
1= prior	100 (44.1%)	118 (38.2%)	
2= current	99 (43.6%)	127 (41.1%)	
History of asthma	14 (6.2%)	21 (6.8%)	0.78
History of diabetes	36 (15.9%)	70 (22.7%)	0.051
History of COPD	106 (46.7%)	109 (35.4%)	0.008
Home oxygen required	16 (7.1%)	6 (1.9%)	0.003
Prior lung surgery	8 (3.5%)	10 (3.2%)	0.85
Prior lung radiation	4 (1.8%)	4 (1.3%)	0.73
Incidental findings on routine screening	99 (43.6%)	145 (46.9%)	0.45
Shortness of breath	41 (18.1%)	67 (21.7%)	0.30
Chronic cough	27 (11.9%)	34 (11.0%)	0.75
Chest pain	31 (13.7%)	35 (11.3%)	0.42
Hemoptysis	7 (3.1%)	8 (2.6%)	0.73
Reasons for biopsy			
New lesion	196 (86.3%)	241 (78.0%)	0.014
Old lesion size change	28 (12.3%)	31 (10.0%)	0.40
Old lesion negative biopsy	0	2 (0.7%)	0.51
Needle size			0.15
17 gauge	1 (0.4%)	7 (2.3%)	
19 gauge	226 (99.6%)	302 (97.7%)	

Data are presented as n (%) unless indicated otherwise. COPD, chronic obstructive pulmonary disease.

between the two groups. There were no reported adverse effects related to blood patching (*Table 2* and *Figure 1*).

In patients who did experience pneumothorax, size of pneumothorax was significantly smaller in the group who did receive IPB (*Table 3*).

Discussion

Previously, very few studies have been performed to compare the incidence rates of complications in patients undergoing CT-guided lung biopsy. Moreover, mixed results were found in previous studies, which underscores the importance of the current study (9-14). In this retrospective analysis of 536 lung biopsies, we found that autologous IPB patching significantly decreases the incidence of pneumothorax, chest tube placement, and hospital admission. There are several documented alternatives to blood patching that are utilized in effort to avoid pneumothorax complications including hydrogel plugs, fibrin glue, collagen foam plugs, absorbable haemostat gelatin powder, injection of normal saline

Table 2 Comparison of incidence of complications between the control and experimental group

Complications	No blood patch (N=227)	Blood patch (N=309)	P value
Pneumothorax	84 (37.0%)	45 (14.6%)	<0.0001
Chest tube placed	39 (17.2%)	12 (3.9%)	<0.0001
Hospitalized	37 (16.3%)	9 (2.9%)	<0.0001
Days hospitalized (N)	37	9	0.91
Median [25th, 75th]	3 [2, 5]	3 [2, 5]	
Min to max	1–21	1–9	
Lung biopsy result (malignant)	162/224 (72.3%)	207 (67.0%)	0.19

Data are presented as n (%) unless indicated otherwise.

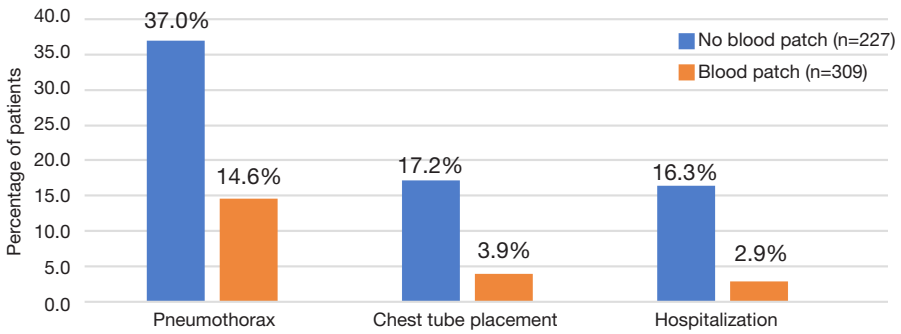

Figure 1 Incidence of pneumothorax, chest tube placement, and hospitalization between patients who received intraparenchymal blood patch *vs.* those who did not (Blue bars: patients who did not receive blood patch; orange bars: patients who received blood patch).

Table 3 Comparison of size of pneumothorax between the control and experimental group

Pneumothorax size	No blood patch (n=227)	Blood patch (n=309)	P value
Median	16%	9%	0.004
First quartile	8%	7%	0.004
Third quartile	29%	13%	0.004
Minimum to maximum	5–55%	4–49%	0.004

tract sealant and even techniques like patient breath-hold after deep exhalation before needle extraction; however widespread use of a particular method has not yet been adopted.

A study comparing 318 patients who received hydrogel to 1,956 patients who received no intervention found that the treated group had a significantly lower incidence of pneumothorax (20.8 *vs.* 32.8%, P=0.001) and chest tube placement (8.2 *vs.* 20.8%, P<0.0001) (9). Fibrin glue has been studied as well, showing a decrease in the incidence of pneumothorax (40.6% to 19.2%) and chest tube placement from (18.8% to 3.8%, P<0.0025) (10). A prospective study of 50 patients utilizing collagen foam found a reduction in the incidence of pneumothorax with 8% (2 of 25) in the treated group compared to 28% (7 of 25) in the control group (11). A retrospective study investigating the efficacy of absorbable hemostat gelatin powder has demonstrated a reduction in the incidence of pneumothorax (8.8% *vs.* 21%; P=0.007) and chest tube placement (4% *vs.* 8.1%; P=0.195) in the treated group compared to the control (12). A prospective, randomized, controlled trial enrolling 322 patients studying normal saline intraparenchymal patching found a decrease in the incidence of pneumothorax (6.2% *vs.* 26.1%; P<0.001) and chest tube placement (0.6% *vs.* 5.6%: P=0.010) (13). A prospective, randomized controlled trial consisting of 407 patients undergoing lung biopsy also demonstrated noninferiority of the use of IBP compared to hydrogel with 2 hours post-biopsy pneumothorax rates being 21% and 29% and chest-tube placement rates as

9% and 13% for the blood patching and hydrogel groups, respectively (14).

Though alternatives have shown to decrease the rate of pneumothorax, blood patching has unique advantages with very little cost. As the blood is autologous, there is no risk of introduction of exogenous material into the patient's body. Autologous blood is readily available if the patient is consenting and venous access is possible. Moreover, our study shows a decrease in not only the incidence (37% to 14.6%) of pneumothorax, but also in the severity (16% to 9%), need for chest tube placement (17.2% to 3.9%), and the hospitalizations rate (16.4% to 2.9%) suggesting that blood patching is a safe and effective technique that can be considered when performing percutaneous CT-guided lung biopsies.

A few limitations of this retrospective analysis should be noted. Firstly, some factors with a possible impact on the pneumothorax rate were not compared between the two groups, including lesion size, lesion location, and patient positioning. Secondly, all CT-guided lung biopsies using blood patching were performed by the same interventionist, whose level of expertise may differ from other interventionalists' in the study. Thirdly, evaluation of subpleural emphysema or honeycomb formation in patients without COPD was beyond the scope of this study and may influence the likelihood of developing pneumothorax after CT guided needle biopsy (CTNB). Another point to consider is that this is a retrospective study and any differences found could be due to the reason the patient received the blood patch and not necessarily to the blood patch itself. Caution should be exercised when drawing conclusions from retrospective, observational, and non-controlled studies. Lastly, additional multivariate analyses maybe needed to perform to adjust for any potential imbalances which were beyond the scope of this study.

Conclusions

This study demonstrates that tract injection of autologous blood following images guided lung biopsy is a safe and effective method of reducing the incidence and severity of pneumothorax, and incidence of chest tube placement and hospitalization.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://pcm.amegroups.com/article/view/10.21037/pcm-22-9/rc

Data Sharing Statement: Available at https://pcm.amegroups.com/article/view/10.21037/pcm-22-9/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://pcm.amegroups.com/article/view/10.21037/pcm-22-9/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by Institutional Review Board of Ascension St. John Hospital (IRB No. 1589530) and individual consent for this retrospective analysis was waived.

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