



Successful Sealing of Post-COVID-19 Bronchopleural Fistula with Computed Tomography Scan-Guided Percutaneous Cyanoacrylate Glue Injection: A Case Series

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What's Known

- The prevalence of bronchopleural fistula in COVID-19 patients
- The relevant COVID-19 patients' comorbidities
- The necessity of bronchopleural fistula closure using the least minimal invasive method
- Because of their lung injuries, many COVID-19 patients cannot endure invasive procedures.

What's New

- It seems that COVID-19 patients require a different approach to treatment than other bronchopleural fistula cases. In this case, we successfully completed the first-ever adhesive closure of a bronchopleural fistula under the guidance of a computerized tomography scan, and the outcome was satisfactory.

Abstract

Bronchopleural fistula (BPF), a sinus tract between the bronchial system and the pleural space, is associated with COVID-19 and can lead to pneumothorax, which increases the mortality rate. Due to the analytical status of COVID-19 patients, sealing the BPF necessitates the least minimal invasive treatment. Herein, we demonstrated a technique of sealing post-COVID-19 BPF with direct injection of cyanoacrylate glue under the guidance of a computed tomography scan. Following glue injection, the BPF was completely sealed in all four patients. In conclusion, in COVID-19 patients with small and distal BPF, percutaneous glue injection is recommended for BPF closure.

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Keywords • Respiratory tract fistula • COVID-19 • Cyanoacrylate • Tomography

Introduction

Severe Acute Respiratory Syndrome Coronavirus-2 (SARS CoV-2) has led to a global pandemic with ever-increasing morbidity and mortality rate. Since the primary target of the virus is the respiratory system, there have been several reports of respiratory complications and pulmonary sequels.^{1,2}

In COVID-19 patients, bronchopleural fistula (BPF), a sinus tract between the bronchial system and the pleural space, was documented as a life-threatening complication of viral pneumonia that could lead to pneumothorax. The pathology of later complications is supposed to be due to intra-alveolar hemorrhage and subsequent necrosis.^{3,4}

Computed tomography (CT) is the preferred imaging modality for BPF diagnosis, and bronchoscopy can be a precise procedure for localizing and sealing the BPF as an established non-invasive method.⁵ The success of the conservative procedure depends on the site, morphology, and size of the fistula. However, the latter method can still cause tissue damage, particularly in COVID-19 patients, who are more vulnerable to lung tissue injury.⁶

In the present study, four patients with recent COVID-19 infection, with developed BPF with loculated pneumothorax, were referred to our center, and we provided computed tomography (CT) guided percutaneous cyanoacrylate glue injection for total

sealing of BPF in these patients.

Case Presentation

Four patients with post-COVID-19 loculated pneumothorax (mild-moderate) were referred to Faraparto Radiology Center (Shiraz, Iran) from July 2020 to April 2021. The patients were three men and one woman with a mean age of 42 ± 8.04 . High-resolution computed tomography (HRCT) was used to diagnose the loculated pneumonia. One month before the procedure, all four patients had positive COVID-19 polymerase chain reaction (PCR) tests. Patients had decreased oxygen saturation (oxygen saturation range=87-90%), pleuritic chest pain, and mild dyspnea. In the first appointment for all four patients, 10 French pneumocatheter was placed under the guidance of the CT scan and connected to a chest bottle. Two weeks later, a follow-up CT scan revealed that despite the increased oxygen saturation, the pneumothorax was not resolved or reduced in size. The presence of air bubbles in the chest tube indicated an air leak. The imaging also disclosed small distal BPF. Therefore, the closure of BPF was recommended. The patients were selected based on a recent (less than one month) positive COVID-19 PCR test, symptomatic loculated pneumothorax, confirmed bronchopleural fistula, and presence of air bubble leak in the chest tube two weeks after chest tube insertion, and unresolved loculated pneumothorax. Exclusion criteria were a history of moderate to severe allergic reactions to anesthetics and the inability to provide written informed consent.

The study was approved by the Local Clinical Ethics Committee of Shiraz University of Medical Sciences (IR.SUMS.REC: 1400.431). After obtaining the written informed consent, an expert interventional radiologist evaluated the practical and clinical outcomes of patients' imaging, radiology reports, and medical records.

All interventions were performed by interventional radiologists who were certified in CT-guided interventions. After sterile draping, 20 mL of ripovacaine hydrochloride (Ripovacaina[®], Molteni) was applied for local anesthesia. Patients were in the supine or prone position, and a spinal needle 22 gauge was inserted into the designated orifice of BPF in a 30-degree attitude and fixed. In our first attempt, we injected the 1:1 solution of 2 mL cyanoacrylate glue (Histacryl[®], B.Braun, Germany) with Lipiodol[®] (Guerbet, France) into the opening to seal the orifice (figure 1). Since the solution had low viscosity, it diffused into the pleural space and partially closed the BPF. After two weeks,

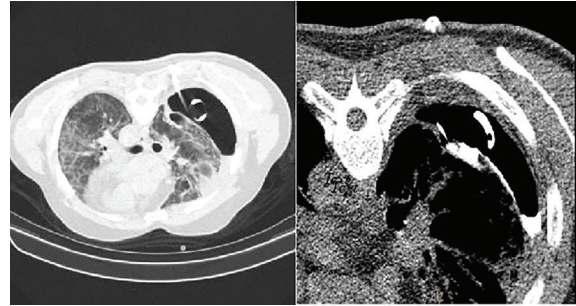


Figure 1: CT-guided percutaneous injection of cyanoacrylate glue and lipiodol into the BPF orifice in the first patient was performed. Since the solution had low viscosity, it leaked into the pleural space.

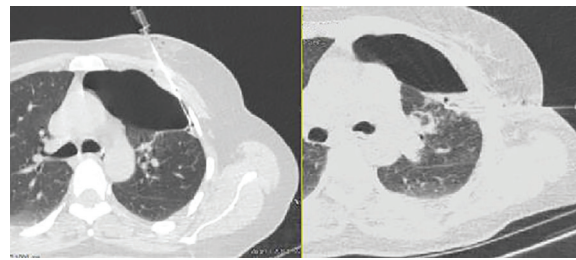


Figure 2: Under the guidance of a CT scan, a percutaneous injection of 1 cc pure cyanoacrylate glue into the BPF orifice was performed.

the severity of pneumothorax was decreased, however, the BPF was still patent. In the next step, pure cyanoacrylate glue was injected into the BPF orifice. The pneumothorax was completely resolved at the second follow-up appointment after two weeks. Following the successful experience with the first patient as a pilot, we injected pure cyanoacrylate (1 mL) through the needle into the orifice of BPF twice, with two weeks interval, to observe the complete closure of BPF (figure 2). Clinical success was defined as the resorption of loculated pneumothorax and the absence of further leakage in the control CT scan.

The patient's general characteristics are presented in table 1. All patients were managed with pneumocatheter (10 F) insertion, which was connected to a bottle. After two weeks, a follow-up HRCT revealed a continuous air leakage. Therefore, percutaneous injection of glue was conducted under the guidance of a CT scan. Injection of cyanoacrylate glue solution with lipiodol was only performed in the first episode for the first case, and regarding the leakage of the latter solution, pure cyanoacrylate (1 mL) was injected in the BPF orifice in the next session and for the other three cases. The first two cases required secondary injections of glue. However, after gaining experience with these patients, only one session of glue injection was required, and the entire closure of BPF was observed in all four cases. In the last follow-up after a month, all patients had complete responses to this method with no complication or recurrence.

Table 1: Patient's demographic information and treatment data

Patients	Sex	Age (year)	Size of BPF (millimeter/mm)	Complete Closure	Underlying disease
1	Male	51	4	Yes	None
2	Female	40	3.7	Yes	None
3	Male	32	3.6	Yes	None
4	Male	45	4	Yes	None

BPF: bronchopleural fistula

Discussion

Herein, using a CT scan as a guide, we managed to successfully close the BPF of all four COVID-19 patients using glue treatment, with no complication.

Necrotizing pneumonia, which can develop into BPF, is a common complication among COVID-19 patients. Since Iran is regarded as a high-risk region, reports of respiratory complications are significantly higher.⁷

It is not a novel technique to seal the BPF using cyanoacrylate glue. However, given the fragile pulmonary texture of COVID-19 patients, as a result of cytokine storm and the short amount of available time, the path of injecting the glue was the source of our concern.⁴ Endoscopy and bronchoscopy are frequently used to find the BPF orifice and inject the glue. This method, however, is not without its relative risks. The main concerns for reaching the orifice of BPF are lung rupture, bronchial damage, anesthesia, hospital admission, and the difficulty of reaching the distal fistula. These risks are more prominent in COVID-19 patients with a more fragile pulmonary system due to the pathology of the disease. Considering the aforementioned risks, which endangered not only the patients but also the clinicians, an alternative, less invasive method was explored.⁸

Since pulmonary involvement of COVID-19 is mainly in the peripheral zone, BPF was seen in the distal chest wall in all four referred patients. As a result, not only was it simpler to locate the BPF orifice with a needle, but also there was less chance that the glue would leak into the main bronchus. Last but not least, the small size of the BPF orifice, which was less than 5 mm in all four cases, would confirm a higher rate of success in BPF closure.⁹

To the best of our knowledge, this was the first case of complete BPF closure in a SARS-CoV-2 patient. 100% resolution of pneumothorax and complete sealing of BPF were observed after a one-month follow-up. Therefore, CT-guided percutaneous cyanoacrylate glue injection for BPF in post-COVID-19 patients is strongly recommended. This procedure will decrease hospital admissions and subsequent

contamination for both healthcare professionals and the general public, which is essential during this pandemic. We also recommend the presented technique for sealing BPFs with other etiologies rather than COVID-19.

Despite the above-mentioned strengths, this study had a limitation. The patients were selected based on their clinical conditions. Therefore, no randomizing of the patients for any consumed drug or omitting any potential confounding factor was considered. This issue highlights the necessity of conducting a multi-center randomized clinical trial to assess and compare the long-term safety and efficacy of this method.

Conclusion

In conclusion, in COVID-19 patients with small and distal BPF, percutaneous glue injection is recommended for BPF closure.

Authors' Contribution

A.R: as the main surgeon who performed this method for the first time, he managed to design the study, gathered the data, and visited the patients post-operational to assess the results. He also reviewed the article and provided the very first revision, H.B: provided the role of the main author who provided the primary script and participated in data gathering, data analysis, and reviewing the drafts of other authors, M.M: participated in the main subject of discussion while assessing the data and their accuracy, he also provided the final touch with his critical review, P.M: participated in the primary conduction of the method and review the results while assessing the patients clinically. He, then, provided the first draft of the method and revised the script academically, M.A.A: as he proposed such a method to perform among patients with COVID-19, he chose this subject as his thesis, and as one of the major radiologists he performed this method on patients and arranged their follow-up. He then provided the basic script and assessed the data. As the corresponding author, he took the responsibility of making inline the data which was received from other authors. All authors have read and approved the

final manuscript and agree to be 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.

Conflict of Interest: None declared.

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