

Original Article

Comparing Bronchoscopic Sealing with Absolute Alcohol, Silver Nitrate and Methylene Blue to Traditional Surgical Approaches in the Management of Persistent Bronchopleural Fistula

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Background : Persistent Bronchopleural Fistula (BPF) is a challenging complication of various pulmonary diseases and surgery. Traditional surgical approaches have been the mainstay of treatment, but bronchoscopic interventions have gained popularity as less invasive alternatives. This study aims to evaluate the efficacy of bronchoscopic sealing of persistent BPF using absolute alcohol or silver nitrate in a cohort of 120 cases over a 13-year period.

Aims and Objectives : The primary objective of this study was to assess the success rate of bronchoscopic sealing in closing persistent BPFs using absolute alcohol or silver nitrate. Secondary objectives included evaluating the safety and feasibility of the procedure and identifying factors associated with treatment success.

Materials and Methods : A retrospective analysis was conducted on 120 consecutive cases of persistent BPF treated bronchoscopically using absolute alcohol and silver nitrate. Patient demographics, underlying pulmonary conditions, fistula characteristics, procedural details and outcomes were reviewed. The bronchoscopic sealing technique involved direct instillation of absolute alcohol or silver nitrate application to the fistula site.

Results : Out of the 120 cases, successful bronchoscopic sealing of persistent BPF was achieved in 114 cases, resulting in a remarkable success rate of 95%. The mean age of the patients was 45 years, with a male predominance. Underlying pulmonary conditions included postoperative BPF (n=4), necrotizing pneumonia (n=25), empyema (n=20), and traumatic injury (n=15), secondary pneumothorax (n=50). Complications were minimal, including mild bronchospasm in two cases and transient fever in three cases.

Conclusion : Bronchoscopic sealing with absolute alcohol or silver nitrate is a highly effective and safe technique for treating persistent BPF. This study demonstrates a remarkable success rate of 95% in closing BPFs using this approach. Bronchoscopic intervention should be considered as a first-line treatment option in selected cases, providing a less invasive alternative to surgery. Further prospective studies are warranted to validate these findings and refine the bronchoscopic sealing technique for optimal outcomes.

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Key words : Bronchopleural Fistula, Bronchoscopy, Absolute Alcohol, Silver Nitrate.

BPFs are communications between the pleural space and the bronchial tree. Persistent Bronchopleural Fistula (BPF) is a complex and challenging complication that can arise from various pulmonary conditions, including postoperative

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Editor's Comment :

- Bronchoscopic sealing of BPF with absolute alcohol and silver nitrate offers a minimally invasive, safe and highly effective approach for managing Persistent Bronchopleural Fistulas, with a lower complication rate compared to traditional surgical methods, particularly for small and less complex fistulas.
- This technique should be considered the first-line treatment, not restricted to patients who are poor surgical candidates. However, it does require a learning curve, and surgery remains the gold standard for larger or more complex fistulas.

complications, Necrotizing Pneumonia, Empyema, secondary to various lung diseases most notably Tuberculosis and Traumatic Injuries. It is characterized by an abnormal communication between the bronchial tree and the pleural space, leading to the continuous leakage of air or fluid. The failure to heal BPF may be from improper initial closure or inadequate blood supply. Impaired respiratory mechanics and contralateral lung contamination further contribute to its poor outcome. BPF poses significant clinical problems, such as

prolonged hospital stays, increased morbidity and mortality and impaired Quality of Life for affected individuals¹. Traditionally, surgical interventions, including thoracotomy and muscle flap reconstruction, have been the standard approach for treating persistent BPF. However, these procedures are associated with considerable invasiveness, morbidity and prolonged recovery periods. Patients have failure rates as high as 35-40% and overall mortality of up to 20%²⁻⁴. In recent years, bronchoscopic techniques have emerged as less invasive alternatives for managing persistent BPF. These interventions aim to seal the fistula from within the airways, offering the potential for faster recovery, reduced complications and improved patient outcomes. One such bronchoscopic approach involves the use of absolute alcohol or silver nitrate for sealing persistent BPFs. Absolute alcohol is a sclerosing agent. The mechanism of action of silver nitrate on bronchial mucosa to treat large BPF was studied on dogs and it was seen that immediate application led to bronchial mucosa swelling and ulceration with microscopic examination showing necrosis of the bronchial epithelium with some degenerative changes in the musculature that causes tissue inflammation and Fibrosis⁵. This therapy has shown promise in closing persistent BPFs through bronchoscopic intervention.

The present study aimed to evaluate the success rate, safety and feasibility of sealing persistent BPFs bronchoscopically with absolute Alcohol or Silver Nitrate. The study reviewed a total of 120 cases treated, mostly referred patients with intercostal drain in situ with free air leak positive over a 13-year period. The outcomes of interest included the closure rate of BPFs, procedural complications and factors associated with treatment success.

Understanding the effectiveness of bronchoscopic sealing with absolute Alcohol and Silver Nitrate in treating persistent BPFs could have significant clinical implications. If proven to be a reliable and successful technique at various centres, it could offer a less invasive option for patients, potentially reducing the need for surgical interventions and their associated complications. Author have experienced and used various other sealants of which anecdotal reports of success have been published earlier and found comparatively these two agents highly successful with minimal failure rate and immediate results in bpf closure compared to most other agents. Therefore, this study aims to contribute valuable insights into the management of persistent BPFs, potentially guiding

clinical decision-making and improving patient care.

MATERIALS AND METHODS

Study Design :

This study is a retrospective analysis of 120 consecutive cases of persistent Bronchopleural Fistula (BPF) treated bronchoscopically with absolute Alcohol and Silver Nitrate. The study was conducted at a Tertiary Care Center over a 13-year period.

Data Collection :

Patient records, medical charts and radiological reports were reviewed to collect relevant data. The following information was extracted for each case: patient demographics (age, gender), underlying pulmonary conditions leading to BPF (postoperative BPF, Necrotizing Pneumonia, Empyema, Traumatic injury, Secondary Spontaneous Pneumothorax (SAP), fistula characteristics (location, size), procedural details and treatment outcomes.

Bronchoscopic Sealing Technique :

The bronchoscopic sealing technique involved the following steps: in cases of Pneumothorax in which already intercostal drainage has been done without expansion of lung and a persistent Bronchopleural Fistula suggested by free air leak in icd bag; after lignocaine spray (no other anaesthesia given because patients intact cough reflex is paramount to success of the procedure), a flexible bronchoscope was inserted through the airway to identify the site of the persistent BPF. The Fistula characteristics, such as size and location, were assessed. The slowest step of the procedure was to identify the Fistula or sub segment leading to Fistula. This step is never hurried as unlike Postsurgical cases the site is not known in spontaneous pneumothorax and hard to be found. Diluted methylene blue dye was injected through the intercostal drainage tube after clamping and a total of 50-100 ml was needed in various cases. The dye can be identified bronchoscopically (Fig 1) and the site can be localised. Wedging of various segment and subsegment using ballon was another technique applied. In rare cases Fistula was directly visible. Absolute alcohol was directly instilled into the Fistula (Fig 2) using a catheter or injection needle after withdrawing the scope a little using 1ml aliquots 3-4 in number. After a short period, Silver Nitrate was applied to the Fistula site using a dedicated applicator or spray catheter using 0.3% 1ml aliquots 2 in number. There was immediate blanching of the mucosa followed by inflammation and swelling (Fig 3) and the free air leak checked by patient coughing stopped or decreased drastically on the table itself. By the next day the free air leak stopped in nearly all cases and

on inspecting the patient bronchoscopically visible swelling of mucosa was seen. Check procedure performed after two weeks showed significant fibrosis obliterating the lumen with resolution of inflammation (Fig 4) There was no Postprocedural collapse of lung in any case.

Outcome Measures :

The primary outcome measure was the success rate of bronchoscopic sealing in closing persistent BPFs. Success was defined as the absence of air or fluid leakage through the Fistula, confirmed by bronchoscopy and/or Chest imaging. The secondary outcome measures included procedural complications such as bronchospasm, bleeding, or infection.

RESULTS

A total of 120 cases of persistent Bronchopleural Fistula (BPF) treated bronchoscopically with absolute Alcohol and Silver Nitrate were included in this retrospective analysis. The mean age of the patients was 45 years, with a predominance of males. Out of the 120 cases, successful bronchoscopic sealing of persistent BPF was achieved in 114 cases, resulting in a remarkable success rate of 95%. Underlying pulmonary conditions included postoperative BPF (n=4), Necrotizing Pneumonia (n=25), Empyema (n=20), and Traumatic injury (n=15), Secondary Pneumothorax (n=50). Closure of the Fistula was achieved through the instillation of absolute alcohol directly into the Fistula, followed by the application of Silver Nitrate to the Fistula site.

Overall, procedural complications were minimal. Two cases experienced mild bronchospasm following the bronchoscopic sealing procedure, which resolved with appropriate management. Additionally, three cases had transient fever following the procedure, but without any signs of infection or systemic complications.

The findings of this study highlight the high success rate of bronchoscopic sealing with absolute alcohol and silver nitrate in closing persistent BPFs. This less invasive technique offers a promising alternative to

traditional surgical approaches, providing faster recovery, reduced morbidity and improved patient outcomes. These results support the consideration of bronchoscopic intervention as a first-line treatment option in selected cases of persistent BPF.

It is important to note that this study is limited by its retrospective design. Further prospective studies are needed to validate these findings and refine the bronchoscopic sealing technique.

DISCUSSION

Persistent Bronchopleural Fistula (BPF) is a challenging complication that can result from various pulmonary conditions, leading to significant morbidity and mortality. According to the consensus statement of the American College of Chest Physicians, patients should be operated on at the second occurrence or in case of persistent air leaks of >4 days (BPF)⁶. Traditional surgical interventions have been the mainstay of treatment, but bronchoscopic techniques have emerged as less invasive alternatives. Initially it was thought to be proposed for patients with poor general conditions and high operative risk however during the present study, authors are of the opinion that it should be the first line treatment of all persistent BPF. Various materials have been used in sealing bpf like polidocanol-1, Silver Nitrate⁷, Fibrin and Acrylic Glue⁸⁻¹⁰, Methylene Blue¹¹ In this retrospective analysis of 120 cases, we evaluated the efficacy of bronchoscopic sealing with absolute Alcohol and Silver Nitrate in closing persistent BPFs and found a remarkable success rate of 95%.

The high success rate observed in our study underscores the effectiveness of bronchoscopic sealing with absolute Alcohol and Silver Nitrate along with diluted methylene blue through icd tube for localising which incidentally also has been used in a study for sealing BPF through ICD tube in the management of persistent BPFs. The mechanism of action involves the use of absolute Alcohol and Silver Nitrate as a sclerosing agent, causing tissue inflammation and Fibrosis and also provides local

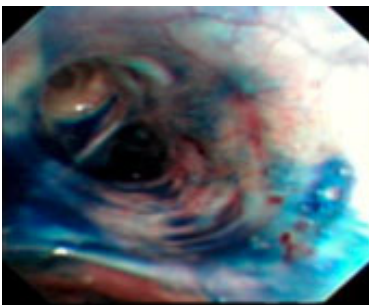


Fig 1 — Diluted methylene blue in the bronchus helping to identify BPF

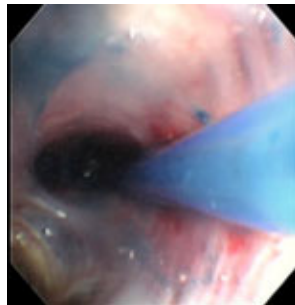


Fig 2 — Absolute alcohol and silver nitrate injected in BPF site with catheter



Fig 3 — Immediate after injecting swelling of the mucosa with inflammation

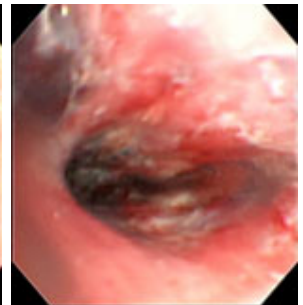


Fig 4 — Postprocedural fibrosis checked on 3rd day causing stenosis of the BPF site

antimicrobial effects. This combination therapy effectively sealed the Fistula, preventing the continuous leakage of air or fluid into the pleural space. The success rate achieved in our study is comparable to or even higher than those reported in previous studies utilizing different bronchoscopic techniques for BPF closure. For instance, studies evaluating the use of fibrin sealants or endobronchial valves have reported success rates ranging from 40% to 85%¹². Our findings suggest that the use of absolute Alcohol and Silver Nitrate may offer a superior sealing capability, potentially making it a preferred and first option for bronchoscopic closure of persistent BPFs.

The benefits of bronchoscopic sealing with absolute Alcohol and Silver Nitrate extend beyond the high success rate. The technique is less invasive than traditional surgical approaches, mini^{13,14} missing patient trauma, reducing hospital stay duration and potentially enabling faster recovery. Furthermore, the low incidence of procedural complications in our study supports the safety and feasibility of this approach. The few cases of mild bronchospasm and transient fever observed were manageable and did not lead to significant adverse outcomes.

The selection of patients suitable for bronchoscopic sealing with absolute Alcohol and Silver Nitrate is an important consideration. In our study, we included cases with persistent BPFs of various etiologies, such as Postoperative BPF, Necrotizing Pneumonia, Empyema, Secondary Spontaneous Pneumothorax Post TB and Traumatic Injury, however, very large BPF are not amenable to closure by the bronchoscopic means.

During the course of study the authors also tried a number of other sealants including but not limited to n-butyl cyanoacrylate, fibrin, amplatz, watnabe etc, but found them to be inferior to absolute Alcohol and Silver Nitrate in terms of results both immediate and follow up combined which later led to complete cessation of using of these products by the authors.. Authors also had the advantage of initially having a number of patients with icd In situ for more than a month who were showing at various institutes nearby which enhanced the confidence in the procedure.

Despite the promising results of this study, several limitations should be acknowledged. Firstly, the retrospective nature of the analysis introduces inherent biases, including selection bias and incomplete documentation of certain variables. Prospective studies with standardized protocols and longer follow-up periods are warranted to confirm our findings. Secondly, multi-center studies involving diverse patient populations would provide a more comprehensive assessment of the technique's efficacy and safety.

CONCLUSION

In conclusion, bronchoscopic sealing with absolute Alcohol and Silver Nitrate demonstrates an impressive success rate of 95% in closing persistent BPFs in our case series. This technique offers a less invasive alternative to traditional surgical approaches with potential benefits including faster recovery, reduced morbidity and improved patient outcomes. These findings support the consideration of bronchoscopic intervention as a first-line treatment option for selected cases of persistent BPF. Further prospective studies are needed to validate these results, assess long-term outcomes, and refine the bronchoscopic sealing technique for optimal patient care.

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