Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.elsevier.com/locate/mjafi

Original Article

Closure of bronchopleural fistula by interventional bronchoscopy using sealants and endobronchial devices

Col C.D.S. Katoch^{a,*}, Col V.M. Chandran^b, Col D. Bhattacharyya^a,
Brig M.S. Barthwal^c

^a Senior Advisor (Medicine & Pulmonary Medicine), Military Hospital (Cardio Thoracic Center), Pune-411040, India

^b Associate Professor, Department of Radiology, Armed Forces Medical College, Pune-411040, India

^c Commandant, Military Hospital Mhow, C/o 56 APO, India

ARTICLE INFO

Article history:

Received 2 November 2012

Accepted 22 April 2013

Available online 6 August 2013

Keywords:

Bronchopleural fistula

Interventional bronchoscopy

Glues and coils

ABSTRACT

Background: Bronchopleural fistula (BPF) is a communication in the form of a sinus tract between the pleural space and the bronchial tree. Chronic bronchopleural fistula (BPF) is a rare but a serious complication of several pulmonary and postoperative conditions. BPF carries a high morbidity and mortality and is associated with prolonged hospital stay and thus high resource consumption. Till date surgical intervention has been the main stay of management of chronic BPF. Our study was carried out to study the efficacy of sealants like Bioglue, Tissel glue and endobronchial devices like coils to close the BPFs through bronchoscopic interventions in those cases which failed to close with the conventional treatment regimen and progressed to chronicity.

Method: This study was carried out in a tertiary care hospital. A total 25 patients of chronic BPF/air leaks were selected and subjected to bronchoscopic localization and subsequent intervention using sealants and coils.

Results: Total 25 patients with chronic BPF were treated with bronchoscopic interventions using glues, and coils. 23 patients were males and 2 were females and 14 were postoperative while 11 patients were non operative. Only smaller fistulas were amenable to glues and coils while there was recurrence in patients with larger air leaks requiring surgical intervention.

Conclusion: From this study it is concluded that non-operative bronchoscopic interventions to seal the air leaks are effective only in smaller air leaks i.e. alveolopleural fistula (APF). The larger air leaks like leaking stump and larger bronchopleural fistula have not got long lasting and encouraging results with sealants and endobronchial devices.

© 2013, Armed Forces Medical Services (AFMS). All rights reserved.

* Corresponding author.

E-mail address: cdskatoch@gmail.com (C.D.S. Katoch).

0377-1237/\$ – see front matter © 2013, Armed Forces Medical Services (AFMS). All rights reserved.

<http://dx.doi.org/10.1016/j.mjafi.2013.04.009>

Introduction

Bronchopleural fistula is a communication in the form of a sinus tract between the pleural space and the bronchial tree or a communication between the lung parenchyma and the pleural space. This air leak can be due to either alveolopleural fistula (APF) or bronchopleural fistula (BPF). An APF is a communication between the pulmonary parenchyma distal to a segmental bronchus and the pleural space, while a BPF is a communication between a main stem, lobar, or segmental bronchus and the pleural space. The air leaks caused postoperatively are invariably BPF and as a consequence of lung parenchymal diseases are APF.¹ We used the term BPF for any air leak which failed to heal conservatively and progressed to chronicity. Presently, the air leaks are classified into four types. The largest and most uncommon is a continuous air leak, which is present throughout the respiratory cycle. This is seen in the patients who are receiving mechanical ventilation or have large bronchopleural fistula. The second type is an inspiratory air leak seen almost exclusively in the patient receiving mechanical ventilation or with a larger size APF or a small BPF. The third type of leak is called an expiratory air leak, which is present only during expiration. This type of leak is commonly seen after pulmonary surgery and is usually due to APF. Finally, if a leak is present only with coughing, it is referred to as forced expiratory leak.² The BPF may be due to postoperative or non operative reasons. Usually smaller air leaks heal of its own with adequate chest drainage but those of larger size (BPF) or managed by inadequate chest drainage and associated with poorly controlled chest infection progress to chronicity and require intervention, surgical or bronchoscopic. BPF carries a high morbidity and mortality and is associated with prolonged hospital stay and thus high resource consumption. There are various etiologies of BPF. A BPF is suspected in a susceptible case when there is increased sputum production, air in the pleural space and changing air fluid levels. The treatment of BPF includes control of infection, pleural space drainage, surgical interventions and bronchoscopic interventions. Till date surgical intervention has been the main stay of management of chronic BPF. Our study was carried out to study the efficacy of sealants like Bioglue, Tissel glue and endobronchial devices like coils to close the chronic BPF of various etiologies.³

Material and methods

This study was carried out in a tertiary care hospital. Total 25 patients of chronic BPF were selected and subjected to bronchoscopic intervention using sealants and coils.

All the patients with persistent air leaks in spite of adequate pleural cavity drainage and optimal antibiotic or antitubercular therapy irrespective of the size of air leak with postoperative or non operative etiologies were included in this study.

Total 25 patients ($n = 25$) were enrolled in the study over a period of two years. All these patients were admitted to the hospital and informed consent was taken from all the patients.

All the patients included in the study were evaluated further. The classical clinical picture was a patient with

pneumothorax on chest tube drainage, varying bubbling during respiratory cycle and failure of lung to expand despite adequate pleural cavity drainage and antibiotic therapy. The following steps were followed:

- 1 All the relevant investigations including HRCT chest were carried out in all the enrolled patients.
- 2 Preparation of the patient for bronchoscopy a day prior to intervention as per standard protocol.
- 3 Bronchoscopic localization of the BPF was done.
- 4 Insertion of sealants or coils depending on the case was done.
- 5 Follow up of the case was done periodically.

The material used as sealant was Bioglue which is a 2-component adhesive composed of purified bovine serum albumin and glutaraldehyde. The solutions are dispensed by a controlled delivery system. Once dispensed, the adhesive solutions are mixed in vitro through the tortuous path of the applicator tip, where cross-linking starts. Bioglue begins to set up within 20–30 s and reaches its bonding strength within 2 min. Other sealant used was Cyanoacrylate glue. This initially seals by acting as a plug, and later by inducing an inflammatory response that leads to fibrosis and mucosal proliferation, thus permanently sealing the defect. The coils used were, vascular embolization spring occluding coils.

Out of 25 patients, localization of the lesion was done as follows: In 17 patients 2 ml of non ionic dye was instilled in all the segments sequentially starting from the upper segment, under fluoroscopic guidance and its leak was noted in the pleural cavity.

In five patients methylene blue was instilled in the same manner and after 4–5 min it was observed in the intercostal drainage chamber. If the dye appeared in the drainage chamber after instilling in a particular segment then it was interpreted as the site of BPF.

In two patients the tamponade balloon tip was used to block a suspected segment and then confirmed that segment was completely occluded. Stoppage of bubbling in drainage chamber confirmed the site of BPF in these patients. In one patient the BPF site was localized by just seeing the bubbling in a segment which was in continuation with the stump of left lower lobe after lobectomy. All the procedures were carried out in the bronchoscopy suite under local anesthesia by flexible fiberoptic bronchoscope. Only few patients required sedation. There was no untoward incident during the procedures. The fiber-optic bronchoscope was inserted via the mouth or nasal route under local anesthesia. The catheter for guiding the embolization coil was introduced through the treatment channel of the bronchoscope. The first metallic coil was then anchored at the fistula. After anchoring all the coils at the fistula, glue was sprayed through the catheter in order to obliterate the small gaps between the coils. All the patients were closely followed thereafter.

Results

There was immediate stoppage of air leak after the intervention in all the patients. Twenty-three patients were males and 2 were females. One patient had Type 1 diabetes mellitus, one

hypertension and one had hypertension and coronary artery disease as comorbidities.

Fourteen patients had primary pleuropulmonary disease and 11 patients had postoperative BPF (Table 1).

In 4 patients, having larger air leaks, coils were inserted followed by Bioglue or cyanoacrylate. These patients remained free of air leak for 48 h–72 h, but expectorated the glue thereafter and developed forced expiratory air leak and pneumothorax. Two of them were twice reinstalled glue but expectorated the same after few days and were symptomatic again. They were taken up for surgery subsequently for stump reclosure.

Rest two patients with coils remained symptom free for one year. They developed air leak thereafter and were all reinstalled glue and were asymptomatic thereafter i.e. one year after reinstallation of glue (Table 2).

Twenty-one patients who had complete cessation of air leak after Bioglue/cyanoacrylate instillation remained symptoms free for 30–40 days only. In these patients sealants had to be reinstalled repeatedly of which 5 patients are symptoms free at present after two years of reinstallation of sealants and others have been subjected to surgical closure of BPF.

Discussion

Persistent chronic bronchopleural fistula is associated with prolonged morbidity and mortality.

The incidence of BPF after pneumonectomy reported in various studies range from 1.5 to 28%. In some studies the incidence of BPF varies from 4.5% to 20% after pneumonectomy and 0.5% after lobectomy. Bronchopleural fistula typically manifests seven to fifteen days following a lung resection. Among the several proposed classifications, of air leaks Varoli et al classified it according to the time of onset after the operation: early [1–7 days] intermediate [8–30 days] and late fistulas [more than 30 days]. Bronchopleural fistulas developing as a complication of pleuropulmonary infections may develop at any point of time during the course of illness.⁴

Radiological features that are suggestive of the presence or the development of a BPF include: (1) steady increase in intrapleural air space (2) appearance of a new air fluid level (3) changes in an already present air fluid level (4) development of tension pneumothorax and (5) a drop in the air fluid level more than 2 cm if patient has no functional chest tube in situ.⁵

Table 2 – Patient wise bronchoscopic intervention.

Number of patients	Intervention
14	Tissel glue
7	Bioglue
4	Endobronchial coils and glue

The main stay of BPF treatment has been either spontaneous or surgical closure. In most of the studies pulmonary resection has been the commonest cause of chronic BPF. In general, the endoscopic procedure is preferred in high-risk surgical candidates to avoid the risk of anesthesia and surgery.

In 1977, Hartmann, Rausch and Ratliff et al reported the first successful endobronchial management of BPF using tissue glue and a lead shot, respectively.^{6,7} Coils have been used alone or in conjunction with other sealants to treat BPF. Angiographic occlusion coils placed endobronchially is another procedure used by some investigators.

The cause of chronic BPF in majority of patients in our study was pleuropulmonary tuberculosis while literature reveals postoperative air leaks as the commonest etiology. The commonest mechanisms involved in the genesis of BPF secondary to pleuropulmonary tuberculosis are, rupture of a peripheral tubercular cavity in the pleural space, erosion of bronchial wall by caseating tubercular lymph node and tuberculosis associated vasculitis. The endobronchial coils were successful in two patients only. These two patients were postoperative cases and the leak was from bronchial stump. The sealants were also used along with coils. The other two patients were later subjected to surgical closure of BPF after repeated attempts with sealants failed to permanently seal the BPF.

In our study 21 patients who had complete cessation of air leak after Bioglue/cyanoacrylate instillation, remained symptoms free for few weeks only. In all these patients sealant had to be repeatedly instilled and only 5 patients are symptoms free at present after two years of reinstallation of sealants and others have been subjected to surgical closure of BPF.

The coils were chosen for the patients having larger air leaks like leaking bronchial stumps in postoperative cases. The patients who responded to single instillation were having small air leaks (Alveolopleural fistula) as was evident clinically (Bubbling during forced expiration only). It has been observed that BPFs of size 8 mm or more are not suitable for endoscopic management, while those 1 mm or less in size have the highest success rate.⁸

The success rate of surgical closure of BPF has been reported between 80% and 95% but is associated with the risk of

Table 1 – Causes of BPF, comorbidities and diagnosis.

No of patients & sex (25)	Diagnosis	Surgery	Comorbidity
14 Males	Pleuropulmonary tuberculosis	–	Nil
1 Female	Aspergilloma in post tubercular cavity	RUL lobectomy	Type 1 DM
4 Male	Hydatid cyst	Post LLL lobectomy	Nil
1 Male	Intra pulmonary hamartoma	RLL lobectomy	Nil
2 Males	Squamous cell CA lung	RLL lobectomy	Hypertension
2 Males	Mesothelioma	Post thoracoscopic pleural biopsy	Nil
1 Female	Localized bronchiectasis (Post tubercular)	RLL lobectomy	Hypertension coronary artery disease

RLL – right lower lobe, LLL – left lower lobe, RUL – right upper lobe.

open thoracotomy. Surgical options include chronic open drainage, direct stump closure with intercostal muscle reinforcement, omental flap, transsternal bronchial closure, and thoracoplasty with or without extrathoracic chest wall muscle transposition.⁹

In order to successfully manage a BPF with bronchoscopic techniques, the fistula must be directly visualized or must have significant reduction or stoppage of air leak on occlusion with endobronchial catheter tip. The potential success of bronchoscopic approach is based on the fact that most of the leaks are peripheral or alveolar, rather than in the large airways.^{10–12}

Conclusion

From this study it is concluded that non-operative bronchoscopic measures to seal the air leaks is effective only in smaller air leaks i.e. alveolopleural fistula (APF) in those cases where standard conservative therapy fails. The larger air leaks like leaking stump and bronchopleural fistula are not amenable to sealants, endobronchial devices or their combination. Most of such cases in this study with larger air leak have to undergo surgical intervention after repeated failure of sealants.

Conflicts of interest

This study has been funded by research grant from O/o DGAFMS.

REFERENCES

1. Cerfolio RJ. Advances in thoracostomy tube management. *Surg Clin North Am.* 2002;82:833–848.
2. Cerfolio Robert James. Recent advances in the treatment of air leaks. *Curr Opin Pulm Med.* 2005;11:319–323.
3. Williams NS, Lewis CT. Bronchopleural fistula: a review of 86 cases. *Br J Surg.* 1976;63:520–522.
4. Lois Manuel, Noppen Marc. An overview of the problem with special focus on endoscopic management. *Chest.* 2005;128:3955–3965.
5. Sarkar P, Chandak T, Shah R, Talwar A. Diagnosis and management of bronchopleural fistula. *Indian J Chest Dis Allied Sci.* 2010;52:97–102.
6. Hartmann W, Rausch V. A new therapeutic application of the fiberoptic scope [letter]. *Chest.* 1977;71:237.
7. Ratliff JL, Hill J, Tucker H, et al. Endobronchial control of bronchopleural fistula. *Chest.* 1977;71:98–99.
8. McManigle JE, Fletcher GL, Tenholder MF. Bronchoscopy in the management of bronchopleural fistula. *Chest.* 1990;97:1235–1238.
9. Sabanathan S, Richardson J. Management of postpneumonectomy bronchopleural fistula. *J Cardiovasc Surg.* 1994;35:449–457.
10. Lan R, Lee C, Tsai Y, et al. Fiberoptic bronchial blockade in a small bronchopleural fistula. *Chest.* 1987;92:944–946.
11. Iwata T, Iida S, Hanada S, Inoue H, Morikawa Y, Inoue K. Transbronchial occlusion of a malignant bronchopleural fistula with cyanoacrylate glue. *J Bronchol Intervent Pulmonol.* 2011;18:176–178.
12. Kinoshita T, Miyoshi S, Katoh M, et al. Intrapleural administration of a large amount of diluted fibrin glue for intractable pneumothorax. *Chest.* 2000;117:790–795.