Emergency Medicine and Health Care
ISSN 2052-6229 | Volume 4 | Article 1

HOAJ
Herbert Open Access Journals

Original Research Open Access

Endobronchial embolization using a watanabe spigot for persistent air leakage

Terunaga Inage, Takahiro Nakajima*, Hironobu Wada, Taiki Fujiwara, Hidemi Suzuki, Takekazu Iwata, Shigetoshi Yoshida and Ichiro Yoshino

*Correspondence: takahiro_nakajima@med.miyazaki-u.ac.jp

Department of General Thoracic Surgery, Chiba University Graduate School of Medicine, Chiba, Japan.

Abstract

Background: Endobronchial embolization is an alternative strategy for the management of pneumothorax or empyema with persistent air leakage. The previous reports analyzed heterogeneous populations of patients, including patients with good performance status (PS, 0 or 1). However, the usefulness of Endobronchial embolization for managing persistent air leakage in patients with poor PS (3 or 4) is not well described.

Methods: The aim of this study was to evaluate the feasibility of occlusion using an Endobronchial Watanabe Spigot (EWS) to treat persistent air leakage in patients with poor performance status. Charts of 10 consecutive patients who underwent endobronchial embolization using the EWS between March 2013 and April 2014 were retrospectively reviewed.

Results: All patients had chronic pulmonary disease; 8 patients had parapneumonic empyema. The Eastern Cooperative Oncology Group performance status (PS) was 3 in 6 patients and 4 in 4 patients. EWS placement at the corresponding bronchus successfully reduced air leakage for all patients, and PS improved in 8 patients. The chest tube could be removed from 4 patients, and successful thoracoplasty was achieved in 3. The other 3 patients died while being managed for pyothorax by fenestration. There were no serious complications associated with EWS insertion.

Conclusion: Endobronchial embolization using an EWS for persistent air leakage appeared to be safe and effective, even for compromised patients.

Keywords: Endobronchial plugs, pneumothorax, empyema, endobronchial watanabe spigot, EWS

Introduction

The standard strategy for the management of pneumothorax is chest drainage and lung expansion. For patients who have pneumothorax with persistent air leakage, additional treatments such as pleurodesis or surgery are considered. Surgical treatment for pneumothorax is known to be effective, and video-assisted surgery is a widely accepted minimally invasive approach. However, the management of pneumothorax with persistent air leakage in patients with several respiratory comorbidities, including empyema, and pneumonia and respiratory failure requiring mechanical ventilation, is often challenging.

Endobronchial embolization has been used to treatpatients with persistent air leakage, with the employment of various types of material, including Bismuth Tribromophenate (Xeroform), fibrin glue, gelatin sponge, and cyanoacrylate [1,2]. However, these agents have limitations, because they cannot maintain their shape and are easily dislocated. The Endobronchial Watanabe Spigot (EWS), asilicone plug that was designed for endobronchial embolization, was introduced by Watanabe et al., in 1991 [6] to treatbronchopleural fistula. Several case series have reported the utility of EWS for cases of persistent airleakage. However, the previous reports analyzed heterogeneous populations of patients, including patients with good performance status (PS, 0/1). In this study, we retrospectively evaluated the EWS for managing persistent air leakage in patients with poor PS (3 or 4) and fatal condition, regarding its usefulness.

Methods

Patients

A retrospective review was performed of the chartsof patients

doi: 10.7243/2052-6229-4-1

with persistent air leakage who underwent endobronchial embolization with a EWSat Chiba University Hospital between March 2013 and April 2014. All cases were evaluated by the staff surgeons during a surgical conference. This study was approved by the ethical committee of the Graduate School of Medicine, Chiba University (No. 2161), and written consent was waived because of the retrospective nature of this study.

Balloon occlusion test

Prior to the procedure, the patients underwent chest computed tomography (CT) for the evaluation of the lungs as well as identifying airleak-related bronchus. The patients were transferred to the bronchoscopy suite to undergo bronchoscopy. They were anesthetized with 5mL of nebulized 1% lidocaine and 5mL of 4% lidocaine that were applied to the pharynx. The bronchoscope was inserted orally during midazolam-induced conscious sedation. A balloon occlusion test was performed to identify the airleak-related bronchus, using a 6Fr Fogarty Arterial or Venous Thrombectomy Catheter (Edwards Lifesciences Corporation, NY, USA). To identify the specific bronchus responsible for air leakage, the airway was systematically occluded by the balloon, starting with the lobar, followed by the segmental, and subsegmental bronchus. The target bronchus was identified by observation of decreasedair leakage following its occlusion.

Bronchial embolization using the EWS

After the targeted bronchus was identified, a EWS was prepared forits occlusion. The patient underwent endotracheal intubation under local anesthesia with moderately conscious sedation provided by midazolam, if the patient was not already intubated. The EWS is available with a diameter of 5mm, 6mm, or 7mm. A 5- or 6-mm EWS was selected for occlusion of a subsegmental bronchus, and a 7-mm EWS was used for occlusion of a segmental bronchus. The EWS has protuberances that act to anchor the device and prevent dislocation once it is inserted. It also has a small handlethat can be grasped using a biopsy forceps (FB-19C-1; Olympus, Tokyo, Japan). The EWS is grasped by the forceps andinserted using a flexible bronchoscope through an endotracheal or tracheostomy tubeas same procedure in previous reports [**11**]. The required time for a series of EWS embolization procedures was 15 to 30 minutes.

Results

Patients

Ten patients were included in this study. The characteristics of the patients are summarized in **Table 1**. They comprised 7 men and 3 women, with a mean age of 64years (46- 71). All patients underwent chest tube drainage, and air leakage was manifested. Four patients had chronic obstructive pulmonary disease, and 2 of these patients had undergone esophageal surgery. Four patients had been receiving immunosuppressant medication for rheumatoid arthritis (RA) and RA-related interstitial lung disease, and 2 of these had aspergillosis infection. One patient had idiopathic pulmonary fibrosis, and another had severe depression and pneumonia. Eight patients had concomitant parapneumonic empyema.

Table 1. Clinical characteristics.

Patient No	Age	Sex	Localiszation	PS	Etiology	Pre-treatment respiratory condition				Previous treatment	*Size of pneumothorax before EWS
						Pneumoniae	ARDS	Ventilator	Empyema		
1	54	F	RLL	3	RA-ILD	Yes	No	No	Yes	Pleurodesis, Fenestration	Small
2	71	M	LUL	3	IPF	No	No	No	No	Fibrogammin P	Small
3	65	M	LUL	3	RA-ILD	Yes	No	No	Yes	Fibrogammin P	Small
4	46	F	RUL	4	Empyema	Yes	Yes	Yes	Yes	Pleurodesis, Fibrogammin P	Moderate
5	70	M	RUL	4	COPD▪Esophagial surgery	Yes	Yes	Yes	Yes	No	Moderate
6	71	F	RUL	3	RA-ILD▪ Aspergillosis	Yes	No	No	Yes	No	Moderate
7	67	M	RUL	3	COPD▪Esophagial surgery	Yes	No	No	Yes	No	Moderate
8	65	M	LUL+S6	4	RA-ILD▪ Aspergillosis	Yes	No	No	Yes	Intrapleural administration of fibrin glue	Complete
9	69	M	RMLL	3	COPD	Yes	No	No	Yes	No	Moderate
10	67	M	RUL	4	COPD	Yes	No	No	No	No	Small

LLL=Left lower lobe; LUL=left upper lobe; RUL=right upper lobe; RMLL=right middle and lower lobe.
RA-ILD=rheumatoid arthritis related interstitial lung disease. COPD=chronic obstructive pulmonary disease.
ARDS=acute respiratory distress syndrome
*Size of pneumothoraxwere classified into three groups in the BTS guidelines1993.

doi: 10.7243/2052-6229-4-1

Every patient required supplemental oxygen, 2 of whom were mechanically ventilated for acute respiratory distress syndrome. The Eastern Cooperative Oncology Group (ECOG) PS of 6 patients was 3 and of 4 patients were 4. Prior to EWS insertion, 2 patients underwent picibanil (OK-432) pleurodesis; 3 patients were administered coagulation factor XIII concentrate (Fibrogammin P; CSL Behring UK Limited); and 1 patient underwent intrapleural administration of fibrin glue. However, these procedures had been ineffective for decreasing the air leakage from the thoracostomy tube. The median time between pneumothorax and insertion of the EWS was 17 days (range, 2 days to 153 days).

Outcome of bronchial occlusion

Nine of 10 patients showed marked decrease of air leakage during the balloon occlusion test, and the bronchicor responding to the air leakage were identified. The appropriate bronchus was identified in the remaining patient by findings on both the balloon occlusion test and CT. EWS was placed in the bronchus of the right upper lobe (n=5), right middle and lower lobe (n=1), right lower lobe (n=1), left upper lobe (n=2), and left upper lobe and segment 6 (n=1). After placement of the devices, all 10 patients showed obvious signs of decreasedair leakage. The average number of EWS devices required for occlusion of the target bronchus was 6.1 (**Table 2**).

After insertion of EWS devices, the chest tube was successfully removed in 1 patient, and lung expansion was achieved in 3 patients with removal of the chest tube following picibanil pleurodesis. The amount of air leakage decreased after EWS insertion into 5 patients, whose PS improved so that they could undergo radical surgery for empyema. In patient No1, she could improved respiratory condition and PS after EWS embolization, and underwent Thoracoplasty (**Figure 1**). One postesophagectomy patient died of acute respiratory distress, and 2patients with interstitial lung disease due to rheumatoid arthritis died of chronic respiratory failure after fenestration for empyema. Eventually, 7 of 10 patients were discharged from the hospital without needing supplemental oxygen (**Table 2**).

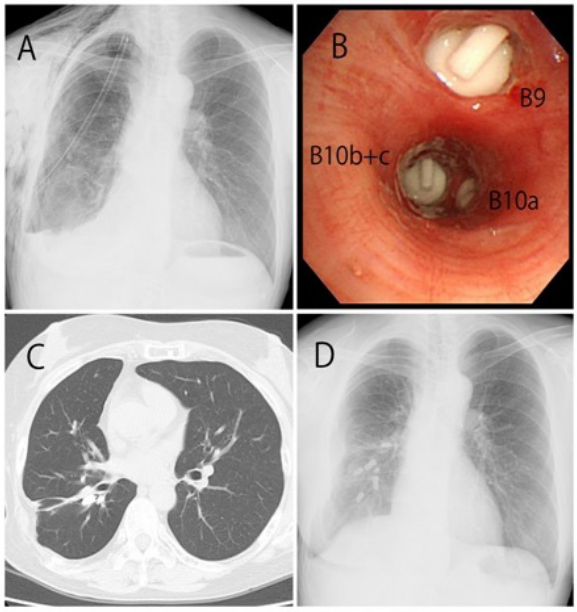

Figure 1. A54-year-old patient with pneumothorax and empyema after surgery for metastatic lung tumor (S8 segmentectomy for metastasis from colon cancer). The patient also had interstitial lung disease due to rheumatoid arthritis. The patient had a performance status of 3 at the time of insertions of the Endobronchial Watanabe Spigots (EWS).
(**A**) Persistent air leakage was observed even after the patient had undergonepicibanilpleurodesis 5 times.
(**B**) AnEWS was inserted into the right B9, B10a, and B10b+c; a total of 7 spigots were used.
(**C**) EWS successfully occluded each targeted bronchus.
(**D**)Continued expansion of lung parenchymawas seen after the EWS insertions.

Interestingly, the lung parenchyma of the targeted pulmonary area remained expanded, although the regional airways were occluded. There were no complications associated with EWS placement, including obstructive pneumonia. Migration of the EWS devices has not occurred in this case series.

Table 2. Treatmentsand outcomes.

Patient No	Days prior to EWS insertion	Number of spigot	Pre-treatment PS	Post-treatment PS	Chest tube removed after embolization	Additional treatment	Surgical treatment	Outcome
1	153	7	3	2	No	--	Thoracoplasty	Discharge
2	14	3	3	2	Yes	Pleurodesis	--	Discharge
3	32	10	3	2	No	--	Fenestration	Death
4	55	10	4	3	Yes	Pleurodesis	--	Discharge
5	29	5	4	4	No	--	--	Death
6	8	7	3	2	No	--	Fenestration	Discharge
7	12	2	3	2	Yes	Fibrogammin P	--	Discharge
8	22	3	4	3	No	--	Fenestration	Death
9	12	9	3	3	No	--	Fenestration	Discharge
10	20	5	4	3	Yes	Pleurodesis	--	Discharge

 doi: 10.7243/2052-6229-4-1

Table 3. Summary of previous reports of EWS embolization.

No	Author	Year	Number of Pts	Co-morbidity	PS	Succesful of drain removal	Comments
1	Uomoto Masashi	2003	10	COPD:4 LK:2 Carcinomatous pleuritis:2	Unkown	6/10 (60%)	--
2	Yoshida Mitsuteru	2009	13	Postoperative Bronchial Fistula:6 IP:5 Empyema:2	PS0:3 PS1:1 PS2:2 unkown:7	8/13 (62%)	--
3	Shinji Sasada	2011	24	COPD:7 RA-ILD:5 Tubeculosis:4 LK:2 Pneomoia: 2	unkown	15/24 (63%)	4 patients required mechanical ventilation
4	Atsuko Ishida	2014	3	COPD:3	Unkown	3/3 (100%)	All 3 cases needed tarcpleurodesis

Disucussion

Patients with chronic lung disease, persistent air leakage with or without empyema, and with poor PS underwent endobronchial embolization byEWS devices. The treatment for persistent air leakage in patients with chronic respiratory disease is often challenging, especially for those with poor PS due to pneumonia or empyema. Surgery is effective and should be considered the first-line treatment; however, surgical intervention is often contraindicated because of the patient's poor physical condition. These patients should be managed until their condition is sufficiently improved so that they can tolerate surgery. Actually in this study, 5 patients improved because of EWS placement and successfully underwent radical surgery for empyema. In previous case series of patients with pneumothorax who were managed by bronchial embolization, some of the patients had good PS (0/1) (**Table 3**). The actual utility of EWS should be analyzed in patients with poor PS (3/4) who cannot immediately undergo surgery. In this study, endobronchial embolization therapy using EWS was safely performed and obtained excellent results regarding the improvement of airleakage as well as PS.

In the most of the cases, we used the both medium size of EWS (6mm) which was designed to occlude the subsegment bronchus plus large size of EWS (7mm) which was designed to occlude the segment bronchus to ensure the complete occlusion of the target airway. In the majority of the cases, to occlude one subsegment bronchus was not enough due to the high collateral ventilation and massive airleakage. Eventually, we used 6.1 EWS per patient on average.

There are several alternative methods for the management of prolonged air leakage, including chemical pleurodesis (talc, picibanil (OK-432), doxycycline, minocycline), blood patch, and fibrin glueinjection [**3**,**4**]. A thoraco graphic fibrin glue sealing method has been introduced as a safe and effective method for refractory pneumothorax [**5**]. Endobronchial occlusion has been attempte dusing various types of material, including Oxycel-cotton [**6**], Bismuth Tribromophenate (Xeroform), fibrin glue, gelatin sponge, and cyanoacrylate [**1**,**2**]. However these materials have several limitations, and long-term placement is difficult because they are unstable. EWS is a spigot constructed of silicone, anonabsorbable, stable material, with protuberances serving as anchorsfor preventing migration and enabling long-term placement. In this study, there was no migration or expectoration of the EWS devices. Endobronchial valves can be used for prolonged airleakage and some reports revealed clinical results [**12**]. Usually, the Endobronchial valvesplacement need a special system generally consists of a delivery catheter, a loadersystem, a guidewire, and the implantable valves.The advantage of EWS is thatare easy to perform endobronchial embolizationwith a simple bronchoscope.

As for the EWS, one case report was published that the use of EWS in the ICU setting for the treatment of empyema [**13**].

The utility of EWSwas previously reported for selected cases [**7**,**8**], including cases of hemoptysis [**9**]. Interestingly, even for EWS occlusion of the responsible bronchus, the involved lobe remained inflated. This might be attributed tothe pores of Kohn and/or canals of Lambert, and the discharge was drained through these structures, avoiding development or progression of pneumonia. In conclusion, endobronchial embolization using EWS is a safe and effective alternative procedure for the management of persistent air leakage in patients with poor PS. It leads to improvement of severe respiratory impairment and enables eventual surgical intervention.

Conclusion

Endobronchial embolization using an EWS for persistent air leakage appeared to be safe and effective, even for compromised patients.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	TI	TN	HW	TF	HS	TI	SY	IY
Research concept and design	✓	✓	--	--	--	--	--	--
Collection and/or assembly of data	✓	✓	✓	✓	✓	✓	✓	✓
Data analysis and interpretation	✓	✓	--	--	--	--	--	--
Writing the article	✓	--	--	--	--	--	--	--
Critical revision of the article	--	✓	--	--	--	--	--	✓
Final approval of article	✓	✓	✓	✓	✓	✓	✓	✓
Statistical analysis	✓	✓	--	--	--	--	--	--

doi: 10.7243/2052-6229-4-1

Acknowledgement
Takahiro Nakajima received an unrestricted grant for medical research from Harada Corporation. The sponsor of the study had no role in the study design, conduct of the study, data collection, data management and interpretation, preparation of the report, review of the report, or approval of the report.

Publication history
Editor: Luca Ansaloni, Papa Giovanni XXIII Hospital, Italy.
Received: 30-May-2016 Final Revised: 26-Jun-2016
Accepted: 08-Jul-2016 Published: 18-Jul-2016

Citation:
Inage T, Nakajima T, Wada H, Fujiwara T, Suzuki H, Iwata T, Yoshida S and Yoshino I. **Endobronchial embolization using a watanabe spigot for persistent air leakage**. *Emerg Med Health Care*. 2016; **4**:1. http://dx.doi.org/10.7243/2052-6229-4-1

References

1. Ishikawa K, Kato T, Aragaki M, Hase R, Saikai T, Matsui Y and Kaji M. **Endobronchial closure of a bronchopleural fistula using a fibrin glue-coated collagen patch and fibrin glue**. *Ann Thorac Cardiovasc Surg*. 2013; **19**:423-7. | Article | PubMed
2. Fujiwara M, Sassoon CS, Kota C and Mazdisnian F. **Successful closure of bronchopleural fistula with Xeroform dressing**. *J Bronchology Interv Pulmonol*. 2012; **19**:251-4. | Article | PubMed
3. Gyorik S, Erni S, Studler U, Hodek-Wuerz R, Tamm M and Chhajed PN. **Long-term follow-up of thoracoscopic talc pleurodesis for primary spontaneous pneumothorax**. *Eur Respir J*. 2007; **29**:757-60. | Article | PubMed
4. Chen JS, Chan WK, Tsai KT, Hsu HH, Lin CY, Yuan A, Chen WJ, Lai HS and Yang PC. **Simple aspiration and drainage and intrapleural minocycline pleurodesis versus simple aspiration and drainage for the initial treatment of primary spontaneous pneumothorax: an open-label, parallel-group, prospective, randomised, controlled trial**. *Lancet*. 2013; **381**:1277-82. | Article | PubMed
5. Kurihara M, Kataoka H, Ishikawa A and Endo R. **Latest treatments for spontaneous pneumothorax**. *Gen Thorac Cardiovasc Surg*. 2010; **58**:113-9. | Article | PubMed
6. Watanabe Y, Hiraki S and Araki M. **Bronchial embolization using dental impressin material in a case of pyelo-bronchial fistula with candida fungemia**. *The Journal of the Japan Society for Bronchology*. 1991; **13**:607-610.
7. Sasada S, Tamura K, Chang YS, Okamoto N, Matsuura Y, Tamiya M, Suzuki H, Uehara N, Kobayashi M, Hirashima T and Kawase I. **Clinical evaluation of endoscopic bronchial occlusion with silicone spigots for the management of persistent pulmonary air leaks**. *Intern Med*. 2011; **50**:1169-73. | Article | PubMed
8. Watanabe Y, Matsuo K, Tamaoki A, Komoto R and Hiraki S. **Bronchialocclusion with endobronchial Watanabe spigot**. *The Journal of the Japan Society for Bronchology*. 2003; **10**:264-267. | Article
9. Bylicki O, Vandemoortele T, Laroumagne S, Astoul P and Dutau H. **Temporary endobronchial embolization with silicone spigots for moderate hemoptysis: a retrospective study**. *Respiration*. 2012; **84**:225-30. | Article | PubMed
10. Watanabe Y, Matsuo K and Tamaoki K. **Bronchial occlusion with Endobronchial Watanabe Spigot**. *Journal of Bronchology*. 2003; **10**:264-267.
11. Weinreb N, Riker D, Beamis J and Lamb C. **Ease of use of watanabe spigot for alveolopleural fistulas**. *J Bronchology Interv Pulmonol*. 2009; **16**:130-2. | Article | PubMed
12. John M, Jeremiah T and Tomothy W. **Endobronchial Valves in the Treatment of PersistentAir Leaks**. *Ann ThoracSurg*. 2015; **100**:1780-6.
13. Dalar L, Kosar F, Eryuksel E, Karasulu L and Altin S. **Endobronchial Watanabe spigot embolisation in the treatment of bronchopleural fistula due to tuberculous empyema in intensive care unit**. *Ann Thorac Cardiovasc Surg*. 2013; **19**:140-3. | Article | PubMed