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Occlusion with Endobronchial Watanabe Spigot for the management of critical patients with massive hemoptysis

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Abstract
Objective: Mortality rates for massive hemoptysis range from 7.1% to 18.2%. With the endobronchial Watanabe Spigot (EWS) in the control of massive hemoptysis, lober occlusion may be preferred in the first stage of emergency treatment. In this study, we evaluated the efficacy and complications of massive hemoptysis control by discussing the results of EWS using 22 consecutive massive hemoptysis case.
Methods: This study included patients admitted to the intensive care unit due to massive hemoptysis and underwent EWS with rigid bronchoscopy under general anesthesia. Complications during and after the procedure were recorded, and the efficacy of the method was evaluated.
Results: Mean age was 56.5±11.7 years. A patient who suffered massive bleeding due to failed intervention went to lobectomy. Mean duration of hospitalization was 11.7 days. In three cases with hemoptysis control, migration of EWS was observed on postoperative 4-11. days. One patient was exposed the spigot on day 50 and the other patient on day 8. Lobectomy was performed in a patient with a right upper apical segment. Age, gender distribution, length of stay, spigot number, survival time, smoking status, diagnosis and treatment success did not differ significantly in patients with and without complications ($p > 0.05$).
Conclusion: Lobular occlusion with EWS in massive hemoptysis control may be preferred in the first stage of emergency treatment, particularly in patients with tuberculosis or surgically inoperable massive hemorrhage. It is accepted as a safe and effective practice in order to avoid the risks of major surgery.

Keywords: watanabe, hemoptysis, complication, interventional pulmonology

Introduction

Massive hemoptysis is a potentially lethal emergency and requires prompt action. The prognosis of patients is primarily determined by the grade of hemorrhage and the need for surgery. The mortality rate increases up to 40% in emergency surgery patients. As the diagnostic and treatment modalities evolve, the reported mortality has decreased in the range of 6.5-38% [1]. Surgical treatment is often unsuitable for these patients due to respiratory failure and underlying pulmonary pathologies [2].

Endobronchial Watanabe Spigot (EWS) is a special silicone material used with a variety of indications. EWS was specifically developed for endobronchial occlusion and was first introduced by Watanabe *et al*.(3) in 1991. The use of EWS was first reported in the treatment of intractable pulmonary fistulae [4]. The first successful treatment of massive hemoptysis with bronchial occlusion with EWS was reported by Dutau *et al*. [5] It can be placed safely in patients with general disorder [6, 7]. The bronchial lumen is designed to lie flat and has protrusions on its surface to prevent migration. Endobronchial embolization with EWS has been shown to be effective in patients with persistent pneumothorax with low respiratory reserve, such as bronchopleural fistula and empyema developed after esophagectomy [8, 9]. Afterwards successful EWS applications were reported in several case presentations [10, 11]. The aim of this study is to evaluate the efficacy and possible complications of massive hemoptysis control by discussing the results of using consecutive 22 cases undergoing EWS application.

Methods

Following the Ethics Committee approval, 22 patients with acute massive haemoptysis were included in this retrospective cross-sectional cohort study. EWSs were placed with rigid bronchoscopy under general anesthesia to achieve haemoptysis control in intensive care unit. Patients undergoing EWS application between November 2008 and January 2017 were included. Complications during and after the procedure were recorded and the efficacy of the method was evaluated. The demographic data of the patients, the diagnosis of pulmonary disease, the length of stay in the hospital, the number of spigots

used and their time period, smoking history, complications developed by the procedure and success rate were recorded. The relationship between the development of complications and the diagnosis of pulmonary disease with occult segments, procedural success and smoking status was compared.

Preoperative oxygenation was performed until the patients' end-tidal oxygen level exceeds 90%. Following monitorisation with non-invasive blood pressure, pulse oximeter, heart rate, ECG and end tidal CO_2, anesthesia induction was performed by propofol 2-3 mg/kg, fentanyl 2 mcg/kg and rocuronium 0.6 mg/kg. Afterwards rigid bronchoscopy was performed and hemoptysis was assessed at the same time with a flexible bronchoscope. The EWS was placed through the rigid bronchoscope. Manual ventilation with Ventrain was performed during this period. In the perioperative period, propofol and remifentanil were applied as total IV anesthesia using target controlled infusion (TCI) method. Patients who were reversed with sugammadex after the procedure were extubated and followed up in the recovery unit.

Statistical analysis

Mean, standard deviation, median lowest, highest, frequency and ratio values were used in the descriptive statistics of the data. The distribution of the variables was measured by the Kolmogorov simirnov test. Mann-Whitney U test was used in the analysis of quantitative independent data. Chi-square test was used to analyze qualitative independent data, and fischer test was used when chi-square test conditions were not met. SPSS 22.0 program was used in the analyzes.

Results

A total of 22 patients' data were analyzed. The mean age was 56.5 ± 11.7 (18-71) years (Table 1). There were nine tuberculosis, 7 cancer, 5 infection. A patient who suffered massive bleeding due to failed intervention went to lobectomy. Three patients were diagnosed with sepsis after the procedure and couldn't survive. The mean duration of hospitalization was 11.7 days (2-90 days). In three cases with hemoptysis control, migration of EWS was observed on postoperative 4-11 days. One patient did not tolerate the Spigot on day 50 and the other patient on day 8. Lobectomy was performed in a patient with a right upper apical segment. The age, gender distribution, length of hospital stay, the used spigot number, the period of therapy, smoking status, diagnosis and treatment success rate did not differ significantly in patients with and without complications (Table 2, $p > 0.05$). The distribution of segments occluded by EWS is shown in Table 3. No statistically significant difference was found in the distribution of occlusion when comparing according to complication development ($p > 0.05$).

Discussion

In accordance with our results, massive hemoptysis patients were successfully treated with EWS in 95.2% of cases and complications were found in 14%. These complications included migration, sepsis, lobectomy, and exitus.

EWS may be preferred in cases such as air leakage due to bronchopleural fistula, persisting pneumothorax, empyema, postoperative bronchopleural fistula, massive / recurrent hemoptic bronchial artery embolization or to control until surgery and endoscopic volume reduction. The most common indication is pneumothorax due to persistant air leaks following postoperative bronchopleural fistula. In our study, approximately 43% of patients developed massive hemoptysis due to tuberculosis and EWS was performed successfully [12-15]. It should be noted that access to the upper lobes of the EWS may be difficult due to bronchial tree anatomy. However, this situation is closely related to the practitioner's experience and the occlusion of the upper and lower lobes has been successfully performed in our study.

According to Inage *et al.* [7] experience, the longest use of EWS lasted longer than 3 years and no tissue response or damage was reported. The longest stay was 90 days in our patients. In these patients, tissue response did not occur, either.

Endobronchial Watanabe Spigot is usually placed through the endotracheal tube under local anesthesia with moderate sedation under preserved spontaneous respiration.(8) There are different techniques in different clinics and experience determines the surgical and anesthetic methods. In some centers only a flexible bronchoscope is used during the procedure. However, in our center EWS was inserted through the rigid bronchoscope, therefore rocuronium was administered. The patient was discharged from the operating room by being reversed by sugammadex in order to prevent the residual blockade. The method using Cytologic Curette, which is shown to be easier and safer to place EWS in less experienced bronchoscopists, may be preferred in persistant bronchopleural fistulas in clinical practice.(12)

Several studies have shown that endobronchial Watanabe Spigot is a useful therapeutic tool for massive hemoptysis.(10,13) However, there are many different occlusion materials besides EWS. These include oxycel-cotton, bismuth tribromophenate (xeroform), fibrin glue, gelatin sponge and cyanoacrylate. Each has advantages and disadvantages. On the other side, EWS can be placed reversibly and that is more reliable in the risk of infection. Long-term use is mostly more convenient than the others. Most of the non-EWS materials are absorptive and not primarily designed for endobronchial occlusion. They can easily migrate. Another advantage of EWS is that allows selective bronchial occlusion, unlike the balloon catheter, which is especially valuable in patients with respiratory insufficiency. This feature of EWS is based on placement using a flexible bronchoscope.(7,10) In this study, we preferred the use of EWS for endobronchial occlusion considering all these advantages.

EWS in the control of hemoptysis is a preferred method for patients who have experienced repeated arterial embolization but have not achieved sufficient success.(13) In this study, we evaluated the efficacy of EWS in cases of massive hemoptysis but that was effective in patients with some other diagnosis, too. For example, EWS can be a palliative intervention that can be used at the onset of pneumothorax after drug therapy, which can lead to delayed wound healing. EWS, which is applied in a patient with recurrent pneumothorax, enhances the quality of life by ensuring that the patient can be discharged to the hospital until the surgery, although it does not prevent the eventual lobectomy intervention. Combined treatment of EWS with internal occlusion and pleurodesis with external talc powder in inoperative, persistent secondary pneumothorax cases has been shown to be more successful than monotherapy. The termination of air leaks was approximately 40-50% due to collateral

ventilation in observed patients.

As a result of studies, several complications related to the use of EWS have been reported. Atelectasis, obstructive pneumonia, myocardial infarction, paroxysmal supraventricular tachycardia, EWS migration have been reported due to EWS placement. Cardiovascular complications are thought to be related to diagnostic bronchoscopy.[7,12] Migration is the most common complication of EWS.[9] Migration was observed in 3 cases with hemoptysis control in this study. Sepsis has a role in all of the developing deaths.

The major limitation of this study was the low number of patients and the retrospective nature of the study. There is a need for further prospective studies investigating the efficacy of EWS.

Lobar occlusion with EWS in massive hemoptysis control may be preferred in the first stage of emergency treatment, particularly in patients with tuberculosis or surgically inoperable massive hemorrhage. EWS was considered as a safe and effective practice with a high success rate in order to avoid the risks of major surgery.

Table 1: Demographic characteristics, mean duration of hospital stay, spigot duration time, pulmonary disease, success and complication rates of patients

		Min-Max	mean±sd - (%)
Age (years)		18.0-71.0	56.5±11.7
Gender	Female		3 (14.3%)
	Male		18 (85.7%)
Hospital stay (days)		2.0-90.0	12.3±19.3
Number of Spigot		1.0-4.0	1.9±0.9
Spigot duration time (days)		2.0-90.0	16.2±19.6
Smoker	No		6 (28.6%)
	Yes		15 (71.4%)
Diagnosis	Cancer		7 (33.3%)
	Infexion		5 (23.8%)
	Tuberculosis		9 (42.9%)
Success	(-)		1 (4.8%)
	(+)		20 (95.2%)
Complication			
No			17 (81.0%)
Yes			4 (19.0%)
Massive Bleeding			1 (4.8%)
Migration, Sepsis and Exitus			1 (4.8%)
Sepsis and Exitus			2 (9.5%)

Table 2: Comparison of age, gender, duration of hospitalization, number of spigots, smoking, diagnosis, and treatment success in patients with and without complications

		Complication (-)		Complication (+)		p	
		mean±sd - (%)	Median	mean±sd - (%)	Median		
Age (years)		56.7±12.0	59.0	55.5±11.7	53.0	0.501	m
Gender	Female	3 (17.6%)		0 (0.0%)		1.000	X^2
	Male	14 (82.4%)		4 (100.0%)			
Hospital stay (days)		12.3±20.9	6.0	12.5±12.1	8.0	0.419	m
Number of Spigot		1.8±0.8	2.0	2.3±1.5	2.0	0.574	m
Spigot duration time (days)		16.5±21.3	10.0	15.0±9.5	10.0	0.514	m
Smoker	No	6 (35.3%)		0 (0.0%)		0.281	X^2
	Yes	11 (64.7%)		4 (100.0%)			
Diagnosis	Cancer	6 (35.3%)		1 (25.0%)		1.000	X^2
	Infexion	3 (17.6%)		2 (50.0%)		1.000	X^2
	Tuberculosis	8 (47.1%)		1 (25.0%)		1.000	X^2
Success	(-)	0 (0.0%)		1 (25.0%)		0.190	X^2
	(+)	17 (100.0%)		3 (75.0%)			
m Mann-whitney u test / X^2 Chi-square test (Fisher test)							

Table 3: Distribution of occlusion segments with Watanabe Spigot

Segmentation with occlusion	n	%
Lobectomy	1	4.8%
Right inferior anterior	1	4.8%
Right inferior anterobasal	1	4.8%
Right inferior basal	1	4.8%
Right inferior lateral	1	4.8%
Right inferior medio-lateral basal	1	4.8%

Right inferior superior	2	9.5%
Right intermedian	1	4.8%
Right superior anterior	3	14.3%
Right superior apical	1	4.8%
Right superior apical and anterior	1	4.8%
Right superior posterior	1	4.8%
Left inferior basal	1	4.8%
Left inferior lateral	1	4.8%
Left inferior superior	1	4.8%
Left superior lingula	1	4.8%
Left superior anterior	1	4.8%
Left superior posterior	1	4.8%

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