Schwannomas are benign tumors that arise from peripheral, spinal, or cranial nerves, excluding the optic and olfactory nerves. They may occur nearly anywhere in the body, but the most common sites for schwannomas are the head, neck, and flexor surfaces of the upper and lower extremities. The histologic diagnosis of a schwannoma is not particularly difficult. However, schwannomas rarely present as endobronchial lesions. These tumors generally present late, and most patients are asymptomatic. Since this disease is rare and few typical signs are associated with it, preoperative diagnosis is difficult.

Surgical treatment has been the first choice for benign endobronchial tumors, but in recent years, bronchoscopic tumor removal for benign endobronchial tree tumors has been reported to be effective. However, there is limited information about bronchoscopic tumor removal of endobronchial schwannomas.

In this study, we retrospectively review seven cases of surgically or bronchoscopically resected bronchial schwannomas and discuss the clinicopathological characteristics, diagnostic considerations, and treatment options for these tumors.

**MATERIALS AND METHODS**

**Patients**

During a 19-year period (1995-2013), a total of seven patients with endobronchial schwannomas were bronchoscopically or surgically treated at Samsung Medical Center in Seoul, Korea. Each patient’s clinical information, including age at the time of diagnosis, sex, clinical presentation, notable past history, and radiologic and bronchoscopic findings, were obtained from our electronic medical record database. This study was approved by the Institutional Review Board of Samsung Medical Center (SMC 2013-04-095).
Tumor classification according to its location

We classified tumors into central or peripheral type according to tumor location. Our definition differed from the classification of Kasahara et al., which classified tumors located in the trachea or in the proximal bronchus and that are visible by bronchoscopy as the central type. In the current study, we simply considered the tumor location regardless of bronchoscopic accessibility. The tumor was classified as being centrally located when the tumor was located in the trachea or main bronchus. When the tumor was located in the lobar bronchus or segmental bronchus, we considered the tumor to be peripherally located.

RESULTS

A summary of the clinical, radiologic, bronchoscopic features, and treatment details is presented in Table 1.

Clinical features

There were five female and two male patients, showing female predominance (57.1%), and the patients’ ages ranged from 16 to 81 with a mean age of 44.9 years. Each patient’s history and clinical presentation is described below. Three cases (42.8%) involved the main bronchi, one case (14.3%) involved both the carina and main bronchus, one case (14.3%) involved the carina, one case (14.3%) involved the lobar bronchus, and one case (14.3%) involved the segmental bronchus. Clinical presentations included cough, dyspnea, hemoptysis, pleuritic chest pain, and postobstructive pneumonia. One patient was asymptomatic, and the tumor was detected during a routine chest radiographic examination. Among five cases with centrally located schwannomas (carina and main bronchus), four patients (80%) experienced respiratory symptoms such as dyspnea. The patient with carinal involvement also had hemoptysis. However, none of the patients with peripherally located tumors (lobar and segmental bronchus) experienced this symptom. The patient with lobar bronchus involvement had pleuritic chest pain. The patient with segmental bronchus involvement of the tumor was asymptomatic. The duration of symptoms between onset and presentation ranged from one month to 19 months (average, 7 months), with the exception of the asymptomatic patient.

Radiologic features

The tumor size varied from 1.5 to 4 cm (mean size, 2.7 cm). A variety of radiologic impressions were encountered in these cases. These included malignant tumors, such as squamous cell carcinoma, carcinoid tumor, adenoid cystic carcinoma, muco-
epidermoid carcinoma, and metastatic breast cancer, as well as benign tumors such as leiomyoma, cylindroma, inflammatory pseudotumor, and schwannoma. Two patients (cases nos. 3 and 5) had pneumonia (Fig. 1A, B). In case no. 2, the tumor showed lobulation with extraluminal extension (Fig. 1C), and the radiologist had a suspicion of malignant tumor. In case no. 4, the

Fig. 1. (A) Pneumonia observed on chest X-ray. (B) Corresponding computed tomography scan showing a polypoid bronchial mass and postobstructive pneumonia. (C) A tumor located in the carina with lobulated contour and extraluminal extension. (D) An endobronchial nodule. (E) A lobulated mass completely obstructing the bronchial lumen. (F) A well-circumscribed, raised lesion. (G) A whitish, round mass almost completely obstructing the bronchial lumen. (H) Bronchoscopy showing a whitish, smooth surfaced tumor at the carina. (I) A bronchoscopically resected tumor showing a smooth, lobulated contour. (J) Patient no. 6 shows segmental bronchial involvement and undergo a left lower lobectomy. (K) Surgical resection of a recurred tumor is performed in case no. 2. (L) Bronchial cartilage and a well-circumscribed tumor at low magnification. (M) Tumor showing a palisading arrangement of nuclei (Verocay bodies). (N) Eosinophilic infiltration and collagen deposition is noted in some cases. (O) Tumor with ancient change showing degenerative cells with pleomorphic, hyperchromatic nuclei. (P) Positive immunohistochemical staining for S100 protein can help make a correct diagnosis.
noma is a benign peripheral nerve sheath neoplasm that is com-

While schwannoma involving various parts of the body is a relatively frequently encountered histologic diagnosis for pathologists, it rarely presents as an endobronchial lesion. Therefore, a clinician may not suspect a schwannoma in a patient with an endobronchial lesion. Benign endobronchial tumors themselves are uncommon, and of these, endobronchial schwannoma is a rare entity, constituting approximately 2% of benign tracheobronchial tumors.9 Although rare, schwannomas can occur in any area of the tracheobronchial tree, with intraluminal or extraluminal extensions.7,10,11

The clinical presentation of endobronchial schwannoma varies and depends on the tumor location, size, and degree of bronchial obstruction. Symptoms include dry or productive cough, fever, hemoptysis, dyspnea, and postobstructive pneumonia, and any one of these can be the first sign of bronchial schwannoma.12

As described above, the clinical symptoms of our patients included cough, fever, hemoptysis, dyspnea, and pleuritic chest pain. Four out of five patients (80%) with more central tumor locations (carina and main bronchus) experienced dyspnea, while neither of the two patients with peripheral locations (lobar and segmental bronchus) had this symptom. Notably, the patient with the most peripherally located tumor (anterior segmental bronchus of the left lower lobe anterobasal segment) had this symptom. Notably, the patient was only discovered on a routine chest radiograph. The duration of symptoms ranged from one to 19 months, with an average of seven months, excluding the asymptomatic patient.

Since symptoms are nonspecific, a diagnosis of schwannoma cannot be made on the basis of clinical presentation. Pre-operatively, several other differential diagnoses for the endobronchial lesion may be considered, including malignant lesions. In our cases, the clinical and radiologic impressions included malignant lesions such as squamous cell carcinoma, adenoid cystic carcinoma, and small cell carcinoma, as well as benign lesions including inflammatory pseudotumor, leiomyoma, and neurogenic tumor. In addition, in three of our cases, radiologists included the possibility of malignant tumor on CT scan. As clinical and radiologic impressions vary, and CT imaging cannot be

Histological features

Histologically, the tumors were visualized as relatively well-circumscribed masses with or without adjacent bronchial cartilage (Fig. 1I). All cases showed similar microscopic characteristics of schwannoma: cellular areas (Antoni type A), more loosely structured areas (Antoni type B), and formation of Verocay bodies (Fig. 1J). Cytologically, tumor cells were bland-looking spindle cells with indistinct cell borders and club-shaped nuclei. Hemorrhage, collagen deposition, and eosinophilic infiltration (Fig. 1M) were also noted in some cases. Two cases (cases nos. 4 and 5) exhibited ancient change (Fig. 1O). On light microscopy, differential diagnosis included leiomyoma and inflammatory myofibroblastic tumor. Every case demonstrated positivity for S100 protein immunohistochemical staining (Fig. 1P), which helped confirm the diagnosis of endobronchial schwannoma.
used to differentiate the nature of the tumor, biopsy is required in most cases.

After a biopsy specimen is obtained, the differential diagnoses can be narrowed into fewer entities by pathology. However, assigning a definite diagnosis on the basis of light microscopy alone is difficult. Initially, tumors that consist of spindled cells, such as leiomyoma, inflammatory myofibroblastic tumor, and menigioma, might be in the differential diagnoses list. One of our patients had a previous biopsy diagnosis of inflammatory pseudotumor at an outside hospital. Although rare, a variety of spindle cell tumors can occur in the tracheobronchial tree, and all of those can be in the differential diagnosis list.

Leiomyoma constitutes around 2% of benign lung tumors, and 45% of pulmonary leiomyomas are endobronchial. Patients with endobronchial leiomyoma usually experience respiratory symptoms due to partial or complete airway obstruction. On microscopy, leiomyoma are composed of bundles and whorls of spindle cells with abundant elongated eosinophilic cytoplasm. The tumors show positivity for desmin and smooth muscle actin, but not for S100 protein.

Inflammatory myofibroblastic tumor is a rare tumor that is usually located in the lung, but can sometimes involve the upper respiratory tract. Histologically, the tumor consists of uniform, bland, fibroblast-like spindle cells arranged in fascicles or in a storiform pattern. Characteristically, the tumor is accompanied by an inflammatory infiltrate of plasma cells.

Meningioma rarely occurs in the pulmonary region, with approximately thirty reports of primary pulmonary meningiomas in the literature. These tumors can contain fascicularly arranged tumor cells resembling fibroblasts. Positivity for epithelial membrane antigen is not pathognomonic, but it is expressed in meningiomas and can be helpful in differential diagnosis.

In the diagnostic process, the identification of the characteristics of schwannoma, including typical Antoni A formation and Verocay bodies in hematoxylin and eosin stains and S100 positivity aids in confirming the correct diagnosis of schwannoma. Although schwannomas are histologically benign, the clinical course depends on the tumor location, size, and degree of bronchial obstruction. Kasahara et al. reported a case of schwannoma leading to patient death with a complication of pneumonia. Considering that schwannoma can lead to other complications, proper management based on each patient’s condition is required.

Until recently, the standard treatment for endobronchial schwannoma has been surgical resection. However, bronchoscopic treatment has been recently utilized for benign tracheobronchial tumors, and has been shown to be a safe and effective tool. However, to date, there is only limited information in the literature on bronchoscopic removal of endobronchial schwannoma.

In our cases, aside from one patient with a segmental bronchial tumor, six patients had bronchoscopic tumor removal as the initial treatment. Five of six patients (83.3%) had successful removal of the tumor without recurrence, revealing a high efficacy of bronchoscopic removal of endobronchial schwannoma. Unfortunately, this procedure cannot always achieve complete resection. In case no. 2, the patient underwent rigid bronchoscopic tumor removal at an outside hospital, but residual tumor was observed a month after the intervention, and she required surgery for complete resection of the tumor. Our study revealed that rigid bronchoscopy is a very effective tool for the management of schwannoma, but also showed that it cannot promise complete resection. Therefore, before performing a bronchoscopic intervention, clinicians and surgeons need a thorough evaluation of resectability considering tumor size and location. In asymptomatic patients, watchful waiting can also be an option.

In conclusion, although endobronchial schwannoma is rare, awareness of the possibility of schwannoma involving the bronchus might be helpful in making a correct diagnosis. After diagnosing the tumor, proper management based on each patient’s clinical setting is required. In addition, our study revealed successful results following bronchoscopic removal of endobronchial schwannomas.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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