Bilateral mediastinal vagus neurogenic tumors are very rare. We herein report the case of Neurofibromatosis type 1 (NF-1) patient with bilateral neurofibromas originating from the mediastinal vagus just distal site of the recurrent nerve, who underwent two-staged extirpations that successfully preserved both recurrent nerves. A 31-year-old female with a history of NF-1 was admitted to our hospital under a diagnosis of multiple tumors in the upper mediastinum. First, the tumor at the right paratracheal to precarinal site was completely resected through a median sternotomy, preserving the right recurrent nerve. After confirming no right recurrent nerve paralysis, thoracoscopic resection of the tumor at the aorto-pulmonary window was then performed preserving the left recurrent nerve. The histopathological diagnosis was neurofibroma originating from the bilateral mediastinal vagus nerves. A two–staged operation can be an option in cases with bilateral mediastinal vagus nerve tumors to avoid the risk of bilateral recurrent nerve paralysis.

**Keywords:** neurofibromatosis type 1, neurofibroma, vagus nerve, surgery

### Introduction

Mediastinal neurogenic tumors usually arise from an intercostal nerve or a sympathetic chain, and they comprise the majority of the posterior mediastinal tumors. On the other hand, neurogenic tumors that arise from vagus nerve are rare.1,3 In particular, bilateral mediastinal vagus neurogenic tumors are even rarer. To the best of our knowledge, there have so far been only 3 reports of resected cases for patients with bilateral mediastinal vagal neurogenic tumors in the English literature.2,4 We herein report our experience with a two-staged operation for neurofibromas originating from bilateral mediastinal vagus nerves in a patient with Neurofibromatosis type 1 (NF1).

### Case Report

A 31-year-old female was admitted to our hospital because of two masses in the upper mediastinum. In 1995, when she was 16 years of age, she was diagnosed with von Recklinghausen’s disease (which is now called NF-1). In 1999, she underwent a resection of a neurofibroma in the right upper arm. In 2011, she consulted her primary physician for general fatigue, and the mediastinal masses were incidentally found on chest X-ray. When retrospectively reviewed, the masses were not found on the chest X-ray taken in 1999. A physical examination revealed café au lait spots and multiple soft subcutaneous small tumors. No hoarseness was observed. Her family history was negative for similar skin findings. No serum tumor markers were elevated.

A computed tomographic (CT) scan demonstrated two round masses with sharp borders, one on the right side of the trachea (4.0 cm in diameter) and...
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Fig. 1 (A) The round mass with sharp borders on the right side of the trachea (4.0 cm in diameter) is shown. (B) A more caudal slice of CT than that shown in (A). The mass in the right side of the trachea extended in front of the trachea caudally to the bifurcation of the trachea (arrow). A round mass with sharp borders on the left side of the aorto-pulmonary window (2.5 cm in diameter) is shown.

the other on the left side of the aorto-pulmonary window (2.5 cm in diameter) (Fig. 1A and 1B). The mass on the right side of the trachea extended in front of the trachea caudally to the bifurcation (Fig. 1B). A whole-body fluorine-18-2-fluoro-D-glucose positron emission tomography/CT (FDG-PET/CT) examination revealed focal FDG uptake [standard uptake value (SUV) max. 2.5] in the right mass, and weak FDG uptake (SUVmax. 1.8) in the left mass. No other abnormal FDG uptake was observed. Magnetic resonance imaging (MRI) revealed that these masses showed low signal intensity in T1-weighted images and high signal intensity in T2-weighted image. Based on these findings, the masses were diagnosed to be neurogenic tumors originating from the bilateral mediastinal vagus nerves.

A two-staged resection for these tumors was planned to avoid the risk of bilateral recurrent nerve paralysis. First, the tumor on the right side was resected through a median sternotomy, because the tumor extended to the precarinal portion. During surgery, the tumor was found to be soft and whitish, originating from the right mediastinal vagus nerve at the caudal level of the bifurcation of the recurrent nerve. The right mediastinal vagus nerve was cut just distal to the recurrent nerve using scissors, and then the tumor was completely resected with negative surgical margins, while preserving the right recurrent nerve. The postoperative course of the first operation was uneventful, and no hoarseness was noted. Microscopically, the tumor was composed of spindle-shaped cells with narrow nuclei without atypia. Edematous interstitial tissue was seen in the background. (Fig. 2) The histopathological diagnosis was neurofibroma originating from the right mediastinal vagus nerve.

The second operation was performed 3 months after the first operation. A thoracoscopic approach with 3 ports was indicated to resect the tumor on the left side at the aorto-pulmonary window. During the operation, the tumor was found to be connected to the left mediastinal vagus nerve. The nerve itself has a bead-like shape at the cranial level of the bifurcation of the left recurrent nerve (Fig. 3). It was deemed impossible to completely excise the tumor margin while preserving the nerve. Therefore, a subtotal resection of the tumor, preserving the recurrent nerve, was performed. The histopathological diagnosis was neurofibroma originating from the left mediastinal vagus nerve. The postoperative course after the second operation was also uneventful, and the patient was discharged with no complications. No recurrent nerve paralysis was observed postoperatively. To date, 10 months after the operation, the patient has no recurrence of the tumor.

Discussion

Neurogenic tumors arising from the vagus nerve are rare. They are often reported to be associated with NF 1. Dabir et al. reported that 8 of 29 cases of vagus...
nerve tumors in their series were associated with NF 1, and these 8 cases were all neurofibromas. NF 1, formerly called as von Recklinghausen’s disease, is one of the most prevalent genetic disorders, and is characterized by multiple neurofibromas and dermal café au lait spots. Because neurogenic tumors in NF1 carry a risk of approximately 10% for malignant degeneration, surgical resection is often indicated.

The major problem at surgery for these masses is preservation of the nerve. It is often impossible to completely resect the neurofibroma while preserving the original nerve, because neurofibromas are non-encapsulated tumors containing all nerve elements, i.e., axons, sheath cells, and connective tissues. While the indications for surgery for neurofibromas in NF1 located in head and neck have been discussed in surgical series, those for tumors located in the mediastinum remain unclear. In the textbook by Masaoka et al., it is stated that the “indications for surgery for multiple neurogenic tumors in NF 1 is limited to the cases which are symptomatic, enlarging, or undergo malignant degeneration.” In the present case, because the tumors were not found in the chest X-ray taken in 1999, they are considered to have newly developed or enlarged during the period between 1999 and 2011. In addition to this, it was speculated that symptoms due to tracheal compression might have occurred if the right tumor had enlarged. Therefore, surgery was indicated.

Recently, it was reported that radiologic examinations by MRI and PET are useful in distinguishing benign and malignant peripheral nerve sheath tumors in NF 1. However, limitations of these modalities have also been pointed, and a definitive diagnosis can only be made by a histological examination of the tumor. On the other hand, the data on the use of radiologic examinations for mediastinal neurogenic tumors in NF 1 remains insufficient. In the present case, the two benign tumors had FDG uptake and the SUVmax values were 2.5 and 1.3, respectively. Future data collection is needed to differentiate between benign and malignant mediastinal neurogenic tumors in NF 1.

Of the previously reported 3 cases of patients with bilateral mediastinal vagal neurogenic tumors, 2 cases were neurofibromas with NF 1 and 1 case had schwannomas with schwannomatosis. Both of the neurofibroma cases with NF 1 underwent a resection for the left tumor with sacrifice of the left recurrent nerve, and the right tumor was not resected to avoid bilateral recurrent nerve palsy. The schwanna case with schwannomatosis underwent a single stage right-sided thoracoscopic surgery, resulting in complete resection of bilateral tumors. His right vagus nerve was cut at the caudal level, followed by bifurcation of the right recurrent nerve with the tumor, as in our case. His left tumor, which was connected to the left vagus nerve, was then resected. He suffered from transient hoarseness postoperatively, probably due to right recurrent nerve palsy. In the present case, because both tumors were located near the bifurcations of the recurrent nerves as indicated by preoperative CT, a two-staged operation was planned to avoid bilateral recurrent nerve palsy.

In the present case, the right vagus nerve was resected at the caudal level of the bifurcation of the recurrent nerve while the left vagus nerve was preserved. Anatomically, after the right vagus nerve gives rise to the right recurrent nerve, it runs posterior to the superior vena cava and descends posterior to the right main bronchus and contributes to cardiac, pulmonary, and esophageal plexuses. Then it constitute the posterior vagal trunk at the lower esophagus and runs through the diaphragm via the esophageal hiatus. The vagus nerves supplies motor parasympathetic fibers to the organs described above and then are responsible for heart rate, gastrointestinal peristalsis. Theoretically, vagus nerve impairment results in a increase in heart rate, gastroesophageal reflux, achalasia. However, these symptoms were not observed in the present case. It
is speculated that hemilateral vagus nerve denervation is well tolerated without symptoms by preserving contralateral vagus nerve.

In the first operation for the right tumor, a median sternotomy was adopted because of the location of the tumor in the precardinal site and the certainty for preservation of the right recurrent nerve. In the second operation for the left tumor, it was deemed impossible to completely excise the tumor while preserving the left recurrent nerve at surgery. We intraoperatively judged that the preservation of the nerve was more important than complete resection due to the suspected benign histology of the mass. Although the resected tumor was histologically benign, careful follow-up observation is mandatory in the present case due to the presence of residual tumor.

In conclusion, the surgical procedure used for such masses should be carefully considered, with tumor curability and preservation of the recurrent nerve both being important factors. However, resection of multiple neurogenic tumors in NF1 may be indicated in certain cases, and was successful in our present case.

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