Case Report

Robot-assisted minimally invasive bronchial resection with primary anastomosis for schwannoma arising from left main bronchus: a case report

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Background: Tracheobronchial schwannomas are extremely rare, which account for lower than 0.2% in all pulmonary tumors. In large part because of the rarity and insufficient reported clinical details, tracheobronchial schwannoma lacks guidelines or expert consensus for diagnosis and treatment, and the delay in diagnosis can range from months to years. The main treatment option is surgery. Endoscopic intervention can also be selected. An increasing number of thoracic surgery cases were performed on the robotic platforms in recent years. With their assistance, surgeons can accomplish the high technique required surgical procedures with ease.

Case Description: In this case, a 48-year-old female had a history of shortness of breath for more than 1 year. The chest computed tomography (CT) and bronchoscopy examination revealed a new growth of nodule in the left main bronchus. The nodule was considered a schwannoma by transbronchial biopsy, which was removed by robot-assisted bronchial resection with primary anastomosis. The application of Da Vinci Si robotic surgical system benefited the process of this surgery. Pathology and immunohistochemistry results confirmed the diagnosis of schwannomas. The patient tolerated the treatment without any complications. No sign of recurrence was discovered at present, 6 months after the intervention.

Conclusions: We reported the first sleeve resection for bronchial schwannoma using Da Vinci robotic surgical system. The clinical details of tracheobronchial schwannoma should be revealed more specifically to achieve more systematic diagnosis and treatment.

Keywords: Schwannomas; primary tracheobronchial tumor; robot-assisted surgery; case report

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Introduction

Schwannomas are among the most common benign encapsulated nerve sheath tumors, arising from Schwann cells (1), while tracheobronchial schwannomas are sporadic and account for lower than 0.2% in all pulmonary tumors (2). In large part because of the rarity and insufficient reported clinical details, tracheobronchial tumors are hard to diagnose. The delay in diagnosis of these tumors can range from months to years. Complete resection of the tumor combined with reconstruction of the trachea or bronchus is the main treatment for tracheobronchial schwannoma, preventing the recurrence (2,3).

An increasing number of thoracic surgery cases were performed on the robotic platform in recent years. This new technique offers precise and flexible manipulation of multiple instruments, a three-dimensional visual field, and seated ergonomics (4), improving the surgeons' overall control of the operations to complete high technique required surgical procedures.

In this report, we described a left main bronchial schwannoma case in an adult female, which was treated by robot-assisted minimally invasive bronchial resection and primary anastomosis. All procedures were performed using the Da Vinci Si robotic surgical system. We present this case in accordance with the CARE reporting checklist (available at https://tlcr.amegroups.com/article/view/10.21037/tlcr-23-819/rc).

Case presentation

A 48-year-old female felt shortness of breath for more than 1 year. There was no relevant medical, family, or psychosocial history for the patient. She denied all the relevant past interventions. Chest computed tomography (CT) and bronchoscopy examination revealed a new growth of sessile nodule in the left main bronchus, which was 1.5 cm in longest diameter (*Figure 1*). The distance from the nodule to the tracheal carina and the left secondary carina were about 2.0 cm each. The other bronchi were all unobstructed. It was considered a neurogenic tumor, schwannoma, by transbronchial biopsy, using single-use pulmonary biopsy forceps.

The shape and size of the nodule led to high risk of hemorrhage and bronchial perforation brought by endoscopic intervention. The patient's physical condition could tolerate the surgery under general anesthesia. Given these considerations, we believed in the necessity and feasibility of surgery. After adequate communication with the patient, we performed robot-assisted minimally invasive bronchial resection with primary anastomosis of the left main bronchus for her (*Video 1*). Equipment and personnel were positioned in a manner similar to that of other robot-assisted thoracic surgery (RATS) procedures. The patient was placed in the right-lateral decubitus position with single-lung ventilation. Five trocars were placed. Three 8.0 mm trocars were placed in the fifth intercostal space between the anterior axillary line and midclavicular line for arm one, eighth intercostal space in the posterior axillary line for arm two, eighth intercostal space in the scapular line for arm three. One 12.0 mm trocar for observation was placed in the eighth intercostal space in the midaxillary line. One 12.0 mm trocar as assistant port was placed in the seventh intercostal space in the anterior axillary line. Our trocar placement (*Figure 2*) allows flexible movement of robot arms and reduces damage to the intercostal nerve of patients.

The tumor was completely removed by sleeve bronchial resection (*Figure 3*) followed by end-to-end anastomosis with running suture, using 3/0 V-Loc suture (*Figure 4*). The anastomoses were reinforced by a pericardium patch and reserved subcarinal tissue (*Figure 5*). Fiberoptic bronchoscopy check was performed intra-operatively and a day after the operation, which proofed the well anastomosis, and confirmed no active bleeding.

The resected tumor measured 1.5 cm × 1.5 cm × 1.0 cm (*Figure 6A*). Histologically, the tumor was well-circumscribed, but without fibrous capsule. It contained areas composed of fascicles of Schwann cells that have a spindle cell morphology (Antoni A pattern) and areas with more loosely textured and microcystic areas (Antoni B pattern). The Schwann cells presented with faintly eosinophilic cytoplasm, ovoid or spindle nuclei, and no sign of mitotic figures (*Figure 6B*). The immunohistochemistry and special staining showed positive staining for S-100 (*Figure 6C*) and SOX-10 (*Figure 6D*). Negative staining for CD117, DOG-1, CD34, smooth muscle actin (SMA), desmin, AE1/AE3, STAT-6, and p16. The protein expression of H3K27Me3 was detected. There was a 2%

Highlight box

Key findings

- The first sleeve resection for bronchial schwannoma using Da Vinci surgical robotic system.

What is known and what is new?

- Tracheobronchial schwannomas are extremely rare. The main treatment option is surgery. Endoscopic intervention can also be selected.
- Surgical resection is the first choice for tracheobronchial schwannoma, which may offer a better prognosis than endoscopic intervention.
- The application of Da Vinci surgical robotic system benefited the process of the bronchial resection and primary anastomosis of this surgery.

What is the implication, and what should change now?

- There should be more case reports and clinical trials to reveal clinical details of tracheobronchial schwannoma in the future, helping with the guidelines production to achieve more systematic diagnosis and treatment.

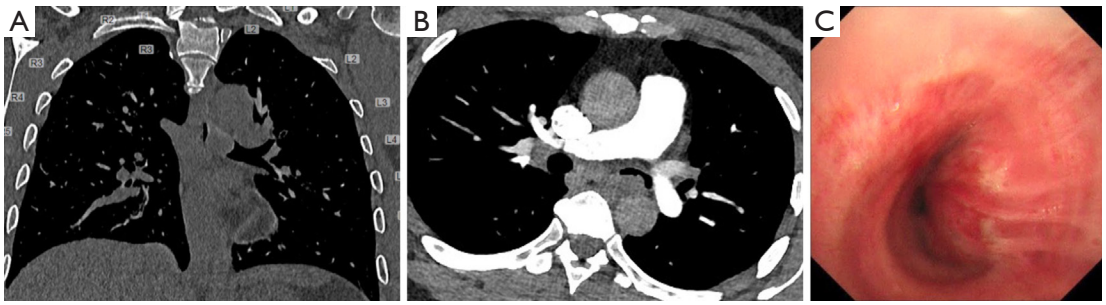
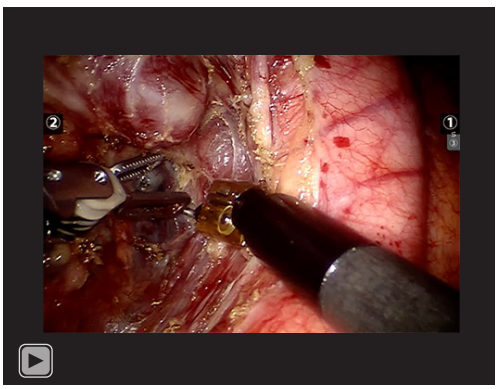


Figure 1 Imaging findings of the nodule. (A) Chest CT showing a broad base nodule in the left main bronchus (coronal). (B) Chest CT showed a broad base nodule in the left main bronchus (axial). (C) Bronchoscopy examination revealed a new growth of nodule in the left main bronchus. CT, computed tomography.



Video 1 The overview of the performed robot-assisted minimally invasive bronchial resection with primary anastomosis for schwannoma arising from left main bronchus.

positive staining for MIB-1 (Ki67). These results came to a definitive diagnosis of schwannoma. Surgical margins were reported clear on final histopathology.

The patient tolerated the operation without any complications. She was discharged at 5 days postoperatively, after removing the chest tube. At present, 6 months after the intervention, the patient continues to be asymptomatic, with a normal functional status, and without any sign of local recurrence. *Figure* 7 gives the specific dates and times of important components of the case.

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this manuscript, the accompanying image, and the video. A copy of the written consent is available for review by the editorial office of this journal.

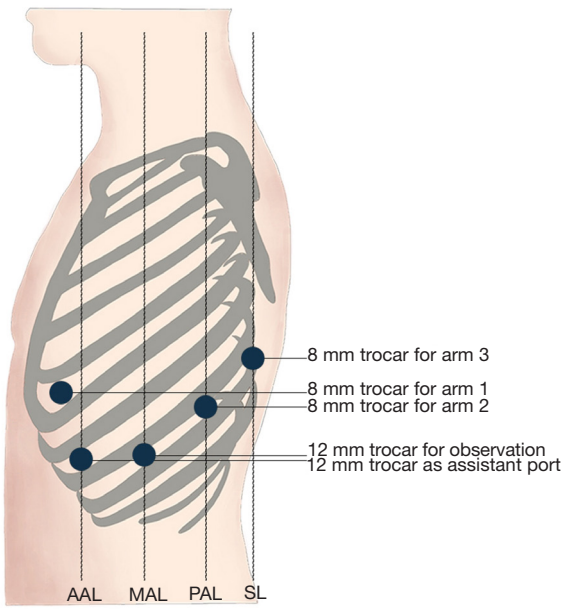


Figure 2 The trocar placement: 8.0 mm trocars placed in the fifth intercostal space between the anterior axillary line and midclavicular line for arm one, 8.0 mm trocars placed in eighth intercostal space in the posterior axillary line for arm two, 8.0 mm trocars placed in eighth intercostal space in the scapular line for arm three, 12.0 mm trocar placed in the eighth intercostal space in the midaxillary line for observation, and 12.0 mm trocar placed in the seventh intercostal space in the anterior axillary line as assistant port. AAL, anterior axillary line; MAL, midaxillary line; PAL, posterior axillary line; SL, scapular line.

Patient perspective

Over the past year, I often felt shortness of breath, especially in the morning. This symptom affected my daily life a lot, so I went to the hospital. I was finally referred to

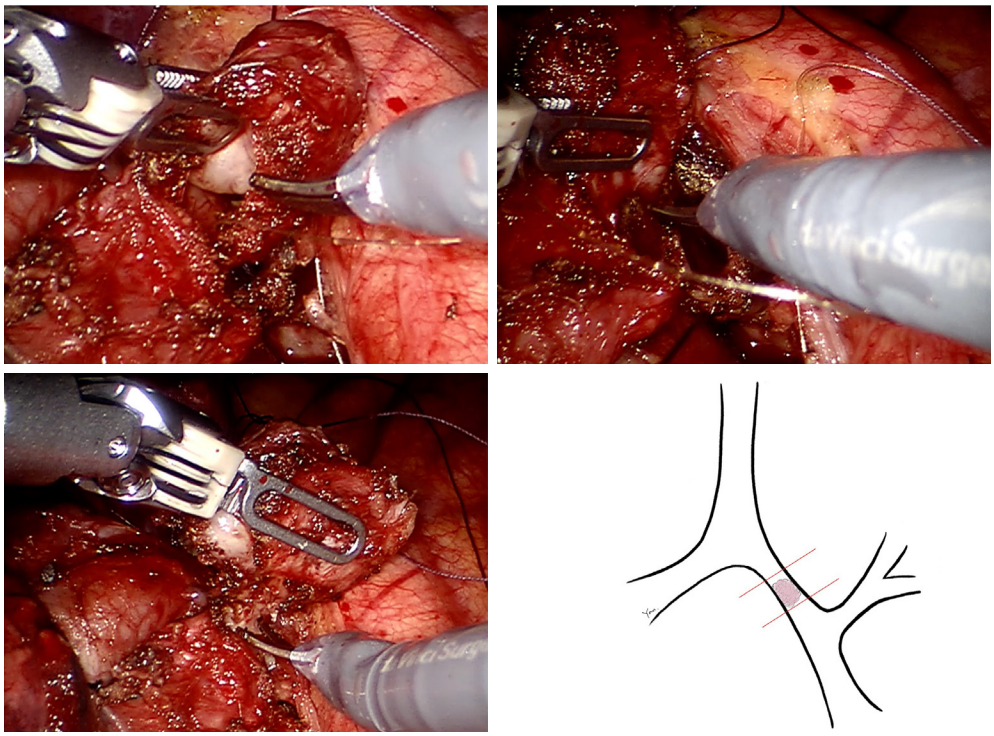


Figure 3 The tumor was completely removed by sleeve bronchial resection.

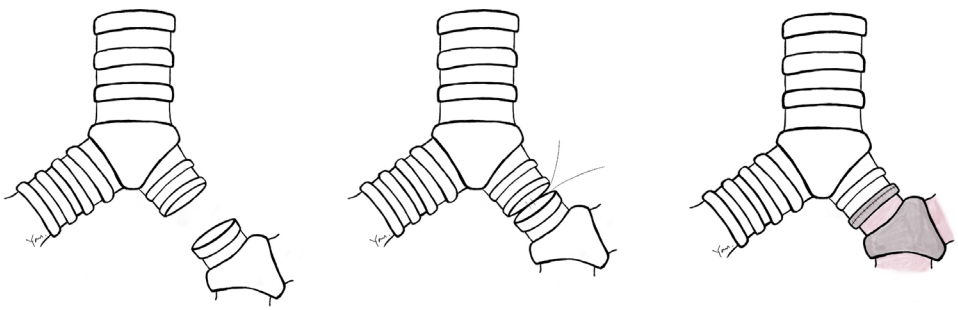


Figure 4 The anastomosis of the two ends of the bronchus was performed.

the Department of Thoracic Surgery for further diagnosis and treatment. I received a chest CT examination first, and new growth of nodule was found in my left main bronchus. Then the bronchoscopy examination revealed that the nodule was a sessile tumor, which was considered a schwannoma, by transbronchial biopsy.

From the diagnosis, everything went very quickly. My doctors told me that the tumor was difficult to be removed completely by endoscopic intervention without risk of hemorrhage and bronchial perforation because of its size and shape, so the surgery was necessary. This surgery was a high technique required one, and the Da Vinci Si robotic surgical system could help the surgeons to complete it with ease. I went through comprehensive preoperative evaluation, making sure that I could tolerate the surgery under general anesthesia. Then the surgery took place. Thanks to the successful operation, I recovered quickly without severe pain. The chest tube was removed 5 days after the surgery, then I was discharged.

It was 6 months after the surgery, when my doctors contacted me for written consent. The result of the chest

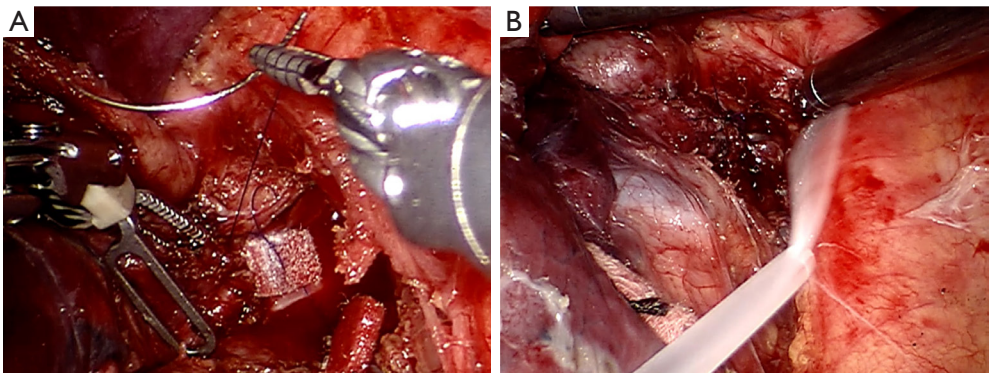


Figure 5 The process of reinforcing the anastomosis. (A) Reinforcing the anastomosis with a pericardium patch. (B) Reinforcing the anastomosis by reserved subcarinal tissue.

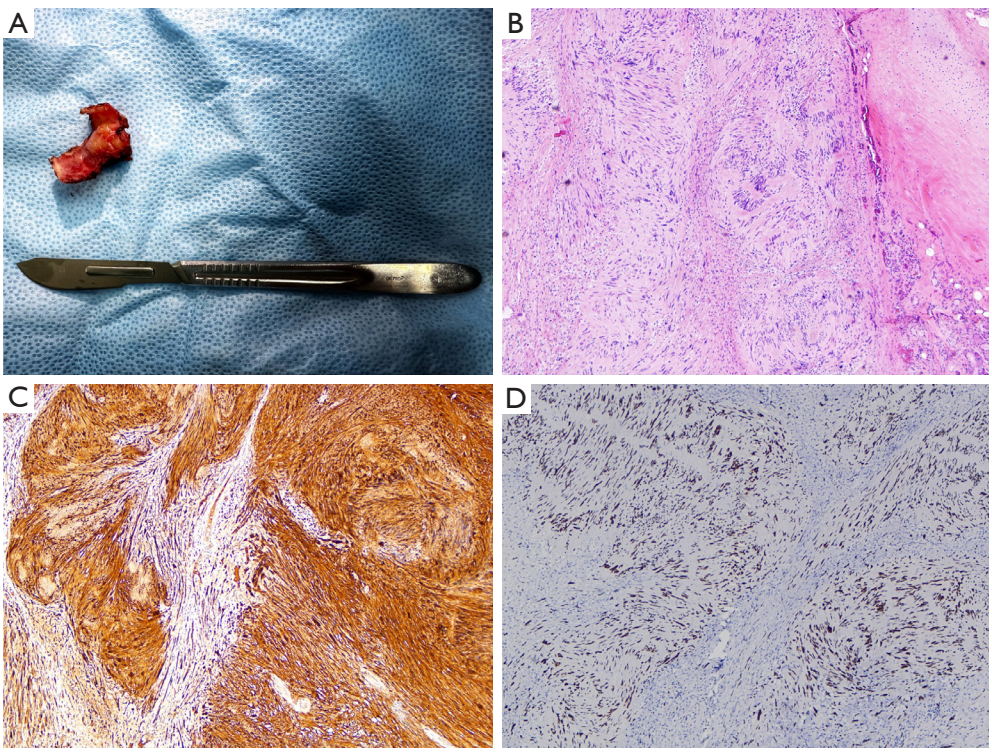


Figure 6 Pathology report of the tumor. (A) The resected tumor. (B) HE staining showed the tumor consisted of spindle cells, histologically (original magnification ×50). (C) Immunohistochemistry and special staining showed positive staining for S-100 (original magnification ×50). (D) Immunohistochemistry and special staining showed positive staining for SOX-10 (original magnification ×50). HE, hematoxylin-eosin.

CT examination found no sign of local recurrence. I am now living a normal life. I am very satisfied for the accurate and timely diagnosis, the comprehensive preoperative evaluation, and the appropriate and skilled surgical techniques to end a year of breath shortness.

Discussion

Tracheobronchial tumors are extremely infrequent, accounting for about 0.4% of all tumors (5). The benign tracheobronchial tumors only account for 0.5% of tracheobronchial tumors (6). Tracheobronchial schwannoma

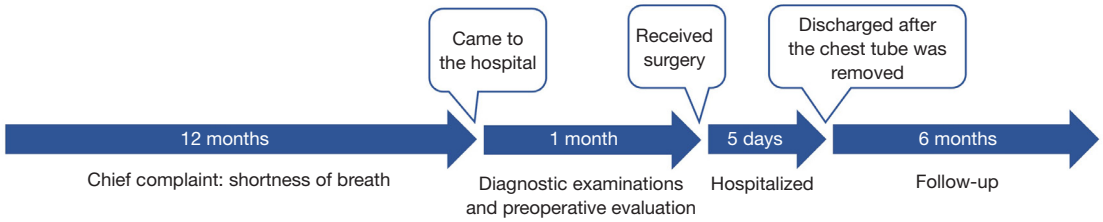


Figure 7 The timeline showing how the key events of this case unfolded.

is even uncommon. Its share of benign tracheobronchial tumors is only 2.2% (6).

The first reported case of tracheobronchial schwannoma was in 1951 with recurrent pneumonia as chief complaint. The left-main-bronchus-located tumor was established by multi-stage tracheoscopic resection (7). Following reports revealed that tracheobronchial schwannomas can be located in any area of the airway without characteristic symptoms, or even asymptomatically (3), resulting in delayed diagnosis (5). Consequently, it is important to conduct further evaluation with chest CT and bronchoscopy examination, if a tracheobronchial tumor is suspected (8). The positron emission tomography (PET)-CT is an optional choice to rule out malignant lesions, when necessary (8). In this case, the patient received a chest CT and bronchoscopy examination. The malignant lesions were excluded by transbronchial biopsy, therefore PET-CT was not adopted.

Definite diagnosis can only be made by pathological study and immunohistochemistry staining. Schwannomas are well-circumscribed encapsulated nerve sheath tumors, arising from Schwann cells (1). It features positive staining for S-100 (1). As described, SOX-10 is superior to S-100 in the diagnosis of schwannoma (9,10). The Ki-67, a tumor cell proliferation marker, has been reported in determining malignant potential for peripheral nerve sheath tumors (11), which often exhibits under 5% nuclear staining for benign tumors (12). Positive staining for S-100 and SOX-10, 2% positive staining for Ki-67, helped with the definite diagnosis.

As an extremely uncommon tumor, tracheobronchial schwannoma lacks guidelines for diagnosis and treatment. The main treatment option is surgery. Endoscopic intervention can also be selected. With a low malignant potential, the goal of the treatment is complete resection of the tumor to relieve obstructive symptoms. To summarize the treatment options for tracheobronchial schwannoma, we searched the cases with the combination of terms via PubMed, and identified 56 cases in the full-text available reports written in English (*Table 1*). Among those surgery-applied cases, 13 trachea-located schwannomas were treated with tracheotomy (14,18,21-23,36-38,43,47,53,54,59), 14 bronchus-located schwannomas received surgeries including pneumonectomy, lobectomy, segmentectomy, or bronchial resection (3,16,19,24-27,35,39,40,42,45,46,52). Others received endoscopic interventions as primary treatments or follow-up (7,13,15,17,20,28-34,41,44,48-51,55-58). Notably, recurrence was observed in six endoscopic intervention cases, but not reported in the surgery group. The difference in mortality between the two treatments was not found. In addition, the shape of the tumor might be an essential factor for the choice of the treatment, for the sessile schwannoma might increase the risk of endoscopic intervention-related complications. Thus, we believe surgical resection is the first choice for tracheobronchial schwannoma, which offers a favorable prognosis. The surgical procedure depends on the size and location of the tumor (5). In this case, the performed surgery ensured complete resection of the tumor, and the two ends of the bronchus provided enough length for reconstruction. Moreover, patients' physical status must be assessed carefully for the tolerance of surgery. The risk of all kinds of surgical-related complications should also be considered.

The bronchial anastomosis and reconstruction of this surgery required high technique for surgeon. The high-definition three-dimensional video of Da Vinci robotic system provided the surgeons with a clear picture of anatomic structures, helping to reduce the visual fatigue of surgeons during the operation (60). Furthermore, with tremor suppression and better maneuverability of instruments (61), it contributed to the precise sutures and knotting in a narrow anatomical space during the process of the primary anastomosis of this surgery, indisputably. However, like other surgical technology, the Da Vinci robotic system also has limitations. First of all, robotic surgery is still a new technology and lacks enough long-

Table 1 The details of the 56 tracheobronchial schwannoma cases[†]

Citations	Gender	Age (years)	Tumor location (originated)	Number	Max-D of tumor (mm)	Shape	Primary treatment	Surgical approach	Follow-up	Recurrence
Straus GD, 1951 (7)	M	28	Left main bronchus	Single	12	–	Endoscopic intervention	–	6 weeks	N
Feldhaus RJ, 1989 (13)	M	74	Right main bronchus	Single	20	–	Endoscopic intervention	–	1 year	N
Stack PS, 1990 (14)	M	35	Trachea	Single	30	–	Tracheotomy	Cervical incision	3 weeks	N
Rusch VW, 1994 (15)	M	45	Trachea	Single	20	Pedunculated	Endoscopic intervention	–	5.5 years	N
Nesbitt JC, 1996 (16)	F	64	Right main bronchus	Single	30	–	Pneumonectomy	–	3 years	N
Weiner DJ, 1998 (17)	M	16	Trachea	Single	20	–	Endoscopic intervention	–	–	N
Dorfman J, 2000 (18)	M	33	Trachea	Single	22	Pedunculated	Tracheotomy	Cervical incision	3 months	N
Chen SR, 2003 (19)	M	18	Right lower lobe bronchus	Single	15	Sessile	Lobectomy	–	2 months	N
Kasahara K, 2003 (20)	M	76	Ridge of right middle and lower bronchus	Single	2–3	–	Endoscopic intervention	–	1 year	N
	M	86	Left lingular lobe bronchus	Single	2–3	–	Endoscopic intervention	–	Few weeks	N
Nio M, 2005 (21)	F	9	Trachea	Single	15	Pedunculated	Tracheotomy	–	4 months	N
Righini CA, 2005 (22)	F	51	Trachea	Single	15	–	Tracheotomy	Cervical incision	3 years	N
Dincer SI, 2006 (23)	M	49	Trachea	Single	17.4	–	Tracheotomy	Thoracotomy	7 months	N
Shigematsu H, 2007 (24)	M	41	Left lingular lobe bronchus	Single	–	–	Segmentectomy	–	–	N
Nakamura R, 2009 (25)	F	48	Left main bronchus	Single	37	Sessile	Bronchial resection	Thoracotomy	3 years	N
Stouffer CW, 2010 (26)	F	18	Left upper lobe bronchus	Single	–	–	Lobectomy	Thoracotomy	6 months	N
Tansel T, 2010 (27)	F	8	Left main bronchus	Single	15	–	Pneumonectomy	Thoracotomy	4 years	N
Dumoulin E, 2012 (28)	M	64	Carina right middle lobe bronchus right lower lobe bronchus	Multiple	–	–	Endoscopic intervention	–	3 months	N
Lee BR, 2012 (29)	F	44	Left main bronchus	Single	19	–	Endoscopic intervention	–	4 months	N

Table 1 (*continued*)

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Citations	Gender	Age (years)	Tumor location (originated)	Number	Max-D of tumor (mm)	Shape	Primary treatment	Surgical approach	Follow-up	Recurrence
Melendez J, 2012 (30)	M	63	Trachea	Single	–	Sessile	Endoscopic intervention	–	6 months	N
Thomas R, 2012 (31)	F	37	Trachea	Single	–	Pedunculated	Endoscopic intervention	–	–	Y
Dalar L, 2014 (32)	M	42	Trachea	Single	–	–	Endoscopic intervention	–	–	N
Kushima H, 2014 (33)	F	71	Left lower lobe bronchus	Single	–	Sessile	Follow-up	–	10 years	N
Isaac BT, 2015 (34)	M	24	Trachea	Single	–	–	Endoscopic intervention	–	6 months	N
Oliveira RC, 2016 (35)	F	66	Left upper lobe bronchus	Single	37.5	–	Lobectomy	–	3 weeks	N
Hamouri S, 2017 (36)	M	60	Trachea	Single	<20	Sessile	Tracheotomy	Cervical incision	1 year	N
Han DP, 2017 (37)	F	45	Trachea	Single	15	Sessile	Tracheotomy	Cervical incision	–	N
Ally M, 2018 (38)	M	54	Trachea	Single	–	–	Tracheotomy	Cervical incision	1 year	N
Komatsu M, 2018 (39)	F	58	Left main bronchus	Single	12	–	Surgery	VATS	–	N
Liao H, 2019 (40)	F	42	Left lower lobe bronchus	Single	43	–	Lobectomy	–	1 year	N
Chen H, 2019 (41)	F	23	Trachea	Single	16	Sessile	Endoscopic intervention	–	6 months	Y
Ishibashi H, 2019 (42)	M	64	Right lower lobe bronchus	Single	20	–	Lobectomy	Thoracotomy	7 years	N
Chávez-Fernández DA, 2020 (43)	F	31	Trachea	Single	14	–	Tracheotomy	Cervical incision	14 months	N
Zhang L, 2020 (44)	M	11	Trachea	Single	10	–	Endoscopic intervention	–	4 weeks	N
Zhou D, 2020 (45)	F	56	Right upper lobe bronchus	Single	70	–	Lobectomy	Thoracotomy	–	–
Imen T, 2021 (46)	M	60	Right upper lobe bronchus	Single	60	–	Lobectomy	–	4 weeks	N
Esch M, 2021 (47)	F	65	Trachea	Single	30	–	Tracheotomy	Cervical incision	8 years	N

Table 1 (*continued*)

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Citations	Gender	Age (years)	Tumor location (originated)	Number	Max-D of tumor (mm)	Shape	Primary treatment	Surgical approach	Follow-up	Recurrence
Jin B, 2021 (48)	F	59	Trachea	Single	15	Pedunculated	Endoscopic intervention	–	7 years	N
	M	32	Left main bronchus	Single	20	Pedunculated	Endoscopic intervention	–	–	Y
	M	57	Trachea	Single	40	Sessile	Endoscopic intervention	–	12 years	Y
	M	56	Left main bronchus	Single	10	Pedunculated	Endoscopic intervention	–	6 years	N
	M	63	Trachea	Multiple	20	Sessile	Endoscopic intervention	–	3 years	N
	M	37	Left main bronchus	Single	15	Sessile	Endoscopic intervention	–	3 years	Y
	F	26	Right main bronchus	Single	20	Sessile	Endoscopic intervention	–	2 years	N
Aoyama Y, 2022 (3)	M	37	Right middle lobe bronchus	Single	17	–	Bilobectomy	VATS	–	N
Jahromi MG, 2022 (49)	F	7	Right main bronchus	Single	18	–	Endoscopic intervention	–	–	N
Nishi Y, 2022 (50)	F	89	Trachea	Single	–	–	Endoscopic intervention	–	3 years	Y
Shen YS, 2022 (51)	F	61	Trachea	Single	15	–	Endoscopic intervention	–	2 months	N
Shimada T, 2022 (52)	F	79	Right main bronchus	Single	25	Sessile	Surgery	–	3 years	N
Afsin E, 2022 (53)	M	21	Trachea	Single	28	–	Tracheotomy	Cervical incision	–	N
Xia C, 2022 (54)	M	54	Trachea	Single	27	Sessile	Tracheotomy	Thoracotomy	6 months	N
Lina G, 2023 (55)	F	60	Right main bronchus	Single	40	–	Endoscopic intervention	–	10 days	N
Alkhars HF, 2023 (56)	M	37	Trachea	Single	22	–	Endoscopic intervention	–	2 weeks	N
Burton KA, 2023 (57)	F	71	Left lower lobe secondary carina	Single	2	–	Follow-up	–	–	N
Botero JD, 2023 (58)	F	57	Trachea	Single	–	Sessile	Endoscopic intervention	–	3 months	N
Karam C, 2023 (59)	F	19	Trachea	Single	17	–	Tracheotomy	–	–	N

[†], the details in the full-text available reports written in English searched with the combination of terms ("schwannoma"[Title] OR "neurilemmoma"[Title] OR "neurilemoma"[Title] OR "neurinoma") AND ("bronchus"[Title] OR "trachea"[Title] OR "tracheobronchial"[Title] OR "endobronchial"[Title] OR "bronchial"[Title] OR "endotracheal"[Title] OR "tracheal"[Title]) via PubMed. "–" indicates not mentioned. Max-D, maximal diameter; M, male; N, no; F, female; Y, yes; VATS, video-assisted thoracic surgery.

term follow-up studies to well establish its uses and efficacy. And the multiple incisions may increase patients' injury, which will be optimized by single-port robotic surgery with Da Vinci SP robotic surgical system. Other disadvantages are the size and cost of this system. We believe all the disadvantages will be remedied with the development of technology.

Conclusions

In conclusion, primary tracheobronchial schwannomas are extremely rare. Surgical resection is the first choice for these tumors, which may offer a better prognosis than endoscopic intervention. We reported the first sleeve resection for bronchial schwannoma using Da Vinci surgical robotic system. The application of Da Vinci Si robotic surgical system benefited the process of this surgery, undoubtedly. Hopefully, more case reports and clinical trials will shed light on the clinical details of tracheobronchial schwannoma, and help with the guidelines production to achieve more systematic diagnosis and treatment.

Acknowledgments

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at https://tlcr.amegroups.com/article/view/10.21037/tlcr-23-819/rc

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this manuscript, the accompanying image, and the video. A copy of the written consent is available for review by the editorial office of this journal.

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