ELSEVIER Case Report

Surgical Treatment of Patients With Stenosis of the Central Airway due to Tracheal Tumours

Manabu Yasuda, Takeshi Hanagiri, Yoshinobu Ichiki, Hidetaka Uramoto, Mitsuhiro Takenoyama and Kosei Yasumoto, Second Department of Surgery, School of Medicine, University of Occupational and Environmental Health, Japan, Kitakyushu, Japan.

This study retrospectively evaluated bronchoscopic and surgical treatments for patients with central airway stenosis due to tracheal tumours. Seven patients treated by resection and reconstruction of the trachea for tracheal tumours between 1994 and 2008 were retrospectively reviewed. The most common histological finding was thyroid carcinoma ($n = 3$), followed by adenoid cystic carcinoma ($n = 2$), a metastatic thyroid tumour ($n = 1$), and a benign granular cell tumour ($n = 1$). Three of the patients required preoperative laser treatment (Nd:YAG) for recanalization. Five patients underwent end-to-end anastomosis for reconstruction. There was no postoperative mortality or morbidity such as anastomotic insufficiency of the reconstructed trachea. Three patients with a microscopic residual tumour required postoperative external radiotherapy. Surgical resection of malignant tracheal tumours is recommended not only for curative purposes, but also for reduction of the risk of smothering. [*Asian J Surg* 2010;33(4):212–7]

Key Words: laser ablation, Nd:YAG laser, tracheal resection, tracheal stenosis, tracheal tumour

Introduction

Obstruction of the central airway due to tracheal tumours is caused by intraluminal tumour growth, extraluminal tumour compression, or a combination of both. Primary tracheal tumours are relatively rare neoplasms. Grillo and Mathisen[1] reported that tracheal tumours account for only 2% of lung tumours. Therefore, their clinical characteristics and surgical results have not been thoroughly discussed.[2,3] A variety of histological features of tracheal tumours have been reported, including benign, low-grade, and high-grade malignancies.[4–6] Tracheal tumours are sometimes misdiagnosed; airway obstruction is prone to be treated as asthma and eventually becomes a life-threatening emergency.[5,6] Tracheal involvement of secondary tumours, such as cancers of the larynx, thyroid, oesophagus, and lungs, is more common than that of primary tumours.[7,8] Even mediastinal lymph node enlargement caused by metastasis or tuberculosis may lead to considerable tracheal compression and life-threatening suffocation.[9] Lung cancer invading the distal trachea as T4 tumours is the most common cause for resection of the distal trachea, which is among the most challenging types of surgery.[10]

The present study retrospectively reviewed seven cases of tracheal tumours and describes the clinical features of this rare disease. Furthermore, the therapeutic modalities of the disease are discussed.

Address correspondence and reprint requests to Dr Manabu Yasuda, Second Department of Surgery, University of Occupational and Environmental Health, Japan, School of Medicine, 1-1 Iseigaoka, Yahatanishi-ku, Kitakyushu 807-8555, Japan.
E-mail: m-yasuda@med.uoeh-u.ac.jp • Date of acceptance: 15 December 2010

Case reports

Seven patients with tracheal tumours were treated at this institution between 1994 and 2008. The preoperative evaluation included chest radiography, chest computed tomography (CT), pulmonary function testing, and electrocardiography. CT scanning or echosonography of the abdomen, CT or magnetic resonance imaging of the brain, and bone scintigraphy were routinely performed to exclude distant metastasis. Bronchoscopy was always performed preoperatively to assess any abnormalities and evaluate the resection margin of the trachea.

The tracheal resections were performed via a right posterolateral thoracotomy and were combined with a cervical approach for tumours in the upper part of the tracheal section. The tracheal anastomoses were performed using interrupted 3-0 braided absorbable sutures. An intraoperative frozen section of the resection margin was routinely obtained to confirm oncologic completeness. Postoperative bronchoscopy was routinely performed to ensure the success of the anastomosis at the end of the procedure. Epidural anaesthesia was routinely used to reduce postoperative pain and to enable the patients to clear respiratory secretions through improved coughing and deeper inspiration.

Follow-up information was obtained from all patients through office visits or telephone interviews with the patient, with a relative, or with their primary physicians. The patients were evaluated every month by chest radiography, and bronchoscopy; systemic CT and bone scintigraphy were performed every 6 months for 2 years after surgery and annually thereafter. The mean follow-up period was 68.4 months.

Results

There were four males and three females whose ages ranged from 30 to 65 years (mean, 52.6 years). One had a benign tumour and six had malignant tumours. All patients were symptomatic. Their symptoms included dyspnoea ($n = 3$), haemoptysis ($n = 2$), coughing ($n = 1$), and a cervical tumour ($n = 1$) (Table 1). Tracheal stenosis was observed in each case by preoperative bronchoscopy. The severity of the tracheal stenosis ranged from 20% to 90%. The tumours were located in the upper part of the tracheal section in three patients (Cases 4, 5, and 7), and in the middle part of the tracheal section in four patients (Cases 1–3 and 6). The longitudinal spread of the tumour was a median of 2.3 cm (range: 1.0–3.0 cm).

Preoperative endoscopic intervention was necessary in three patients (Cases 1, 2, and 7) due to severe stenosis (> 80%), and laser ablation (Nd:YAG) was performed to maintain airway patency (Figure 1). Case 2 also underwent bronchial arterial infusion (BAI) therapy with cis-diamminedichloroplatinum (CDDP).[10–12]

The surgical procedures are summarized in Table 2. A right posterolateral thoracotomy was performed with mobilization of the mediastinum and pericardial circumcision

Table 1. Seven patients with tracheal tumour[10–12]

Case	Age	Gender	Symptom	Length of tumour (cm)	Severity of stenosis (%)	Treatment before surgery	Diagnosis
1	64	F	Dyspnea	2.5	80	Nd-YAG laser	Adenoid cystic carcinoma
2	41	M	Dyspnea	3.0	80	Nd-YAG laser, BAI	Adenoid cystic carcinoma
3	30	F	Haemosputum	1.0	20	None	Granular cell tumour
4	52	M	Cough	3.0	50	None	Thyroid cancer
5	55	F	Haemosputum	3.0	50	None	Thyroid cancer
6	61	M	Cervical tumour	1.5	20	None	Thyroid cancer (Lymph node metastasis)
7	65	M	Dyspnea	2.0	90	Nd-YAG laser	Metastatic thyroid tumour

BAI = bronchial arterial infusion therapy.[10–12]

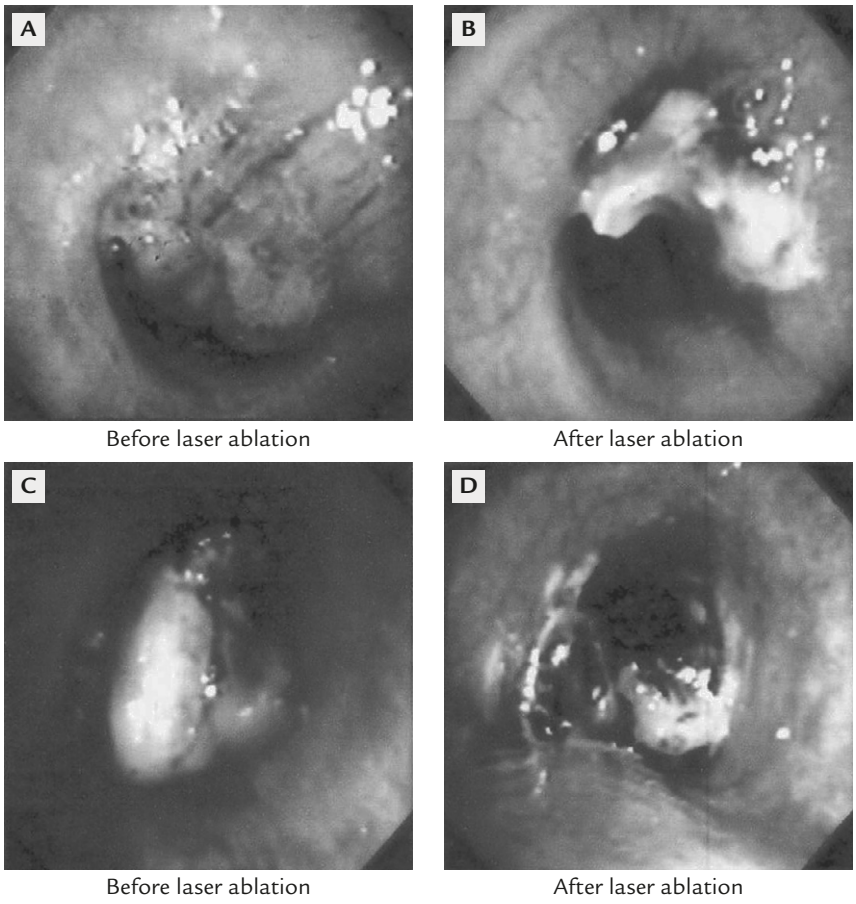

Figure 1. Effect of laser ablation for a tracheal tumour. (A, B) Adenoid cystic carcinoma (Case 1). (C, D) Metastatic thyroid tumour (Case 7).

in all seven patients. Tracheal resection was performed via the cervical approach in the cases with lesions in the upper part (Cases 4, 5 and 7). The extent of the tracheal resection was a median of 2.8 cm (2.0–4.0 cm). Five patients underwent an end-to-end anastomosis for reconstruction. A terminal tracheostomy was performed in Case 6 because he had undergone a laryngectomy for laryngeal cancer. A partial tracheal resection was performed in Case 7 because of a metastatic renal tumour in the thyroid, and it was covered with pericardium and thymic tissue. Two cases (Cases 4 and 5) with thyroid cancer required suprahyoid release of the larynx and thyroidectomy. High-frequency jet ventilation was used during the anastomoses in all patients.

All surgical margins were examined by frozen sections during surgery to confirm the absence of tumour cells. The pathological diagnoses included a malignant tumour in six cases (three thyroid carcinomas, two adenoid cystic carcinomas, and one metastatic renal carcinoma) and a benign tumour in one (granular cell tumour). Microscopic tumour invasion at the resection margin was revealed in a paraffin-embedded section in the cases with adenoid cystic carcinoma (Cases 1 and 2), and in the case of a metastatic renal tumour (Case 7).

There was no postoperative morbidity. No patients experienced anastomotic leakage or stenosis. Four patients experienced complications, which are listed in Table 2. Two patients had pneumonia and one had mediastinitis. One patient (Case 5) experienced dysphagia and required tracheostomy and temporary gastrostomy. Postoperative external radiotherapy was performed in three patients (Table 2) because of microscopic residual tumour tissue (Cases 1, 2 and 7). One patient (Case 4) with thyroid cancer underwent iodine-131 therapy.

The long-term results are summarized in Table 2. The median survival was 55 months for the six patients who had a malignancy. Four patients died without local recurrence. Three patients were still alive with no sign of recurrence (one adenoid cystic carcinoma, one thyroid carcinoma, and one benign tumour). The patients with adenoid cystic carcinoma ($n = 2$) survived for 17–119 months after surgery. Case 1 had a local recurrence and

Table 2. Operation and mortality after surgery in seven patients

Case	Operative procedure	Length of resected trachea (cm)	Reconstruction of trachea	Complication after surgery	Treatment after surgery	Recurrence site	Prognosis
1	Segmental resection	2.8	End-to-end	None	Irradiation	Local distant (liver, lung)	Death from distant metastasis (119 mo)
2	Segmental resection	3.0	End-to-end	Pneumonia	Irradiation	None	Recurrence-free survival (24 mo)
3	Segmental resection	2.3	End-to-end	None	None	None	Recurrence-free survival (172 mo)
4	Segmental resection Total thyroidectomy	4.0	End-to-end	Pneumonia	131-I	Distant (liver, lung) Lymph nodes (mediastum)	Death from distant metastasis (28 mo)
5	Segmental resection Total thyroidectomy	3.2	End-to-end	Recurrent nerve pulsy	None	None	Recurrence-free survival (60 mo)
6	Segmental resection	2.5	Terminal tracheostomy	None	None	None	Death from other disease (58 mo)
7	Partial resection Hemithyroidectomy	2.0	Pericardial patch Lapping of thymus	Mediastinitis Athelectasis	Irradiation	Distant (lung, bone, chest wall)	Death from distant metastasis (46 mo)

was repeatedly treated with laser ablation. She died after 119 months because of distant metastasis to the liver. Another patient (Case 2) underwent postoperative radiotherapy because of a microscopic residual tumour and maintained good health without local recurrence for 2 years.

Discussion

There are a variety of primary tracheal tumours, including benign, low-grade, and high-grade malignancies. Adenoid cystic carcinomas, which most commonly develop in the salivary glands, are also a common type of neoplasm in the trachea. These tumours are generally regarded to have low-grade malignant potential;[13] however, they have a tendency for local recurrence and late development of distant metastasis, as observed in Case 1. Surgical resection is thought to be the first choice of treatment for localized lesions. However, because tumours with a malignant potential tend to infiltrate along the airways, they are often treated with an incomplete resection and thus are prone to recur locally (Cases 1 and 2). The complete resection rates in reported cases range from 42% to 57%. Pearson et al[14] reported that nine of 26 adenoid cystic carcinoma surgeries resulted in an incomplete resection, and seven of these nine patients died of local failure. Gaissert et al[15] also reported that 59% of patients with resected adenoid cystic carcinoma had positive airway margins. They noted that the adenoid cystic carcinomas were longer and frequently extended into the peritracheal soft tissues or to adjacent organs. Despite the administration of preoperative induction chemotherapy (BAI with CDDP) in the current series, Case 2 had microscopic residual tumours at the surgical margin. However, this patient did well without local recurrence after the completion of postoperative radiotherapy. Local recurrence after surgery in Case 1 was also controllable with radiotherapy and repeated laser ablation. Tracheal involvement due to thyroid carcinoma was the most common neoplasm among the secondary tumours in the current study (Cases 4–7). The frequency of laryngotracheal invasion by thyroid cancer is approximately 7–10%.[7,8] The management of locally invasive thyroid carcinoma has been controversial. The postoperative survival rate is much worse in patients undergoing an incomplete resection than in those undergoing a complete resection of thyroid carcinoma.[16,17] Therefore, a complete resection must always be attempted

whenever possible in thyroid carcinoma that secondarily involves the trachea.

Induction therapies for tracheal tumours are not well established because of their rarity. Induction radiotherapy increases the risk for complications, such as failure of anastomosis after surgery; thus, most of the current patients were treated with radiotherapy after the surgical resection (Cases 1, 2, and 7). There have been a few reports about the safety of bronchoplasty procedures after preoperative chemotherapy.[18–20] BAI is applied as an induction therapy for locally advanced nonsmall cell lung cancer (NSCLC)[10,11] and as a radical therapy for hilar early NSCLC.[12] One of the advantages of BAI is that a high dose of antitumour agents can be used for locally advanced lesions without serious systemic toxicities. Eighteen patients with locally advanced NSCLC underwent BAI with CDDP at 50–100 mg/m^2 as preoperative induction chemotherapy.[11] There were no serious BAI therapy-related perioperative complications or postoperative deaths. Survival was better when a complete resection was achieved after the induction BAI, especially in patients with stage IIIB (T4) disease. In addition, three patients underwent a carinal resection after induction BAI for locally advanced NSCLC and demonstrated a favourable prognosis.[10] Induction BAI may contribute to complete resection in tracheal malignancies.

Preoperative endoscopic treatments such as Nd:YAG laser treatment, argon plasma coagulation, intraluminal brachytherapy, and stenting, also play an important role in the management of tracheal malignancies.[5,21,22] These bronchoscopic interventions before a tracheal resection can improve the surgical results and increase the overall success of these patients by providing both functional improvement and precise staging.[5,21,22] It is thought that stenosis of the central airway of less than 60–80% due to tracheal tumours does not prevent adequate ventilation, clearance of secretions, correct evaluation of the site of origin, or accurate extension of the distal margin of the tumour.[21] The primary indication for preoperative endoscopic treatment is more than 80% stenosis of the central airway (Table 1, Figure 1). These patients also experienced severe dyspnoea (Table 1). Several therapeutic options are available when tracheal stenosis is relieved, depending on the patient's condition. Preoperative Nd:YAG laser ablation improved the performance status in Case 2; sequential induction chemotherapy (BAI) could then be performed, resulting in remarkable tumour reduction without increasing postoperative complications. Further studies of induction therapies for tracheal malignancies may allow for the design of new therapeutic approaches to control these diseases.

Rapid evaluations of the tumour (severity of stenosis, location, length, and invasion status) and the possibility for surgical resection is the most important strategy for treating patients with stenosis of the central airway due to tracheal tumours. Therefore, a complete resection, if possible, provides the best potential benefit as well as symptomatic relief for patients with tracheal tumours. Furthermore, various options, including induction therapies such as laser ablation and BAI, should be applied according to the severity of tracheal stenosis and the patient's condition before surgical intervention.

References

1. Grillo HC, Mathisen DJ. Primary tracheal tumours: treatment and results. *Ann Thorac Surg* 1990;49:69–77.
2. Pearson FG, Todd TRJ, Cooper JD. Experience with primary neoplasms of the trachea and carina. *J Thorac Cardiovasc Surg* 1984; 115:70–3.
3. Xu LT, Sun ZF, Li ZJ, et al. Tracheobronchial tumours: an eighteen-year series from capital hospital, Peking, China. *Ann Thorac Surg* 1983;35:590–6.
4. Aberle DR, Brown K, Young DA, et al. Imaging techniques in the evaluation of tracheobronchial neoplasms. *Chest* 1991;99:211–5.
5. Schneider P, Schirren J, Muley T, et al. Primary tracheal tumours: experience with 14 resected patients. *Eur J Cardiothorac Surg* 2001;20:12–8.
6. Refaely Y, Weissberg D. Surgical management of tracheal tumours. *Ann Thorac Surg* 1997;64:1429–32.
7. McCarty TM, Kuhn JA, Williams WL Jr, et al. Surgical management of thyroid cancer invading the airway. *Ann Surg Oncol* 1997;4: 403–8.
8. Cansiz H, Yener M, Bozkurt AK, et al. Surgical treatment of laryngeal tumours with subglottic extension and tracheal tumours with composite nasal septal cartilage graft: technique and outcome. *Auris Nasus Larynx* 2008;35:363–8.
9. Freixinet J, Varela A, Lopez Rivero L, et al. Surgical treatment of childhood mediastinal tuberculous lymphadenitis. *Ann Thorac Surg* 1995;59:644–6.
10. So T, Osaki T, Nakata S, et al. Carinal resection after induction bronchial arterial infusion for locally advanced non-small cell lung cancer. *Jpn J Thorac Cardiovasc Surg* 2004;52:143–7.
11. Osaki T, Oyama T, Takenoyama M, et al. Feasibility of induction chemotherapy using bronchial arterial infusion for locally advanced non-small cell lung cancer: a pilot study. *Surg Today* 2002;32:772–8.
12. Osaki T, Hanagiri T, Nakanishi R, et al. Bronchial arterial infusion is an effective therapeutic modality for centrally located

early-stage lung cancer: results of a pilot study. *Chest* 1999;115: 1424–8.
13. Albers E, Lawrie T, Harrell JH, et al. Tracheobronchial adenoid cystic carcinoma: a clinicopathologic study of 14 cases. *Chest* 2004;125:1160–5.
14. Pearson FG, Todd TRJ, Cooper JD. Experience with primary neoplasms of the trachea and carina. *J Thorac Cardiovasc Surg* 1984; 88:511–8.
15. Gaissert HA, Grillo HC, Shadmehr MB, et al. Long-term survival after resection of primary adenoid cystic and squamous cell carcinoma of the trachea and carina. *Ann Thorac Surg* 2004;78:1889–96.
16. Mattavelli F, Bombardieri E, Collini P, et al. Role of surgery in treatment of advanced differentiated thyroid carcinomas. *Acta Otorhinolaryngol Ital* 2007;27:62–7.
17. Wada N, Nakayama H, Masudo Y, et al. Clinical outcome of different modes of resection in papillary thyroid carcinomas with laryngotracheal invasion. *Langenbecks Arch Surg* 2006;391:545–9.
18. Burfeind WR Jr, D'Amico TA, Toloza EM, et al. Low morbidity and mortality for bronchoplastic procedures with and without induction therapy. *Ann Thorac Surg* 2005;80:418–21.
19. Ohta M, Sawabata N, Maeda H, et al. Efficacy and safety of tracheobronchoplasty after induction therapy for locally advanced lung cancer. *J Thorac Cardiovasc Surg* 2003;125:96–100.
20. Veronesi G, Solli PG, Leo F, et al. Low morbidity of bronchoplastic procedures after chemotherapy for lung cancer. *Lung Cancer* 2002;36:91–7.
21. Venuta F, Rendina EA, De Giacomo T, et al. Endoscopic treatment of lung cancer invading the airway before induction chemotherapy and surgical resection. *Eur J Cardiothorac Surg* 2001;20:464–7.
22. Venuta F, Rendina EA, De Giacomo T, et al. Nd:YAG laser resection of lung cancer invading the airway as a bridge to surgery and palliative treatment. *Ann Thorac Surg* 2002;74: 995–8.