Acute Exacerbation of Tracheal Obstruction and Severe Respiratory Failure after a Single Dose of 2-Gy Irradiation for Squamous Cell Lung Carcinoma: A Case Report

Keita Kawakado\textsuperscript{a}  Takamasa Hotta\textsuperscript{a}  Jin Sakamoto\textsuperscript{b}  
Mika Horie\textsuperscript{a}  Misato Kobayashi\textsuperscript{a}  Takae Okuno\textsuperscript{a}  
Yoshihiro Amano\textsuperscript{a}  Megumi Hamaguchi\textsuperscript{a}  Yukari Tsubata\textsuperscript{a}  
Noriaki Kurimoto\textsuperscript{a}  Takeshi Isobe\textsuperscript{a}  

\textsuperscript{a}Department of Internal Medicine, Division of Medical Oncology and Respiratory Medicine, Shimane University Faculty of Medicine, Izumo, Japan; \textsuperscript{b}Department of Respiratory Surgery, Shimane Prefectural Central Hospital, Izumo, Japan

Keywords
Radiotherapy · Tracheal stent · Extracorporeal membrane oxygenation · Lung cancer

Abstract
The patient, a 62-year-old woman, complained chiefly of cough. We planned chemoradiotherapy for squamous nonsmall cell lung cancer. A single dose of 2-Gy irradiation and no antitumor agent administration exacerbated the airway stenosis with severe respiratory failure. Urgent tracheal intubation was performed, and a tracheal stent was implanted under extracorporeal membrane oxygenation (ECMO). Because her performance status (PS) worsened from 1 to 2, we administered radiotherapy. The tumor size decreased. There was no recurrence for the next 3 months, and her PS improved to 1. Emergency tracheal intubation and tracheal stent placement under ECMO can be effective for exacerbated airway obstruction after radiotherapy.
**Introduction**

Acute airway obstruction, such as endobronchial invasive malignancies, can cause critical respiratory failure. Radiation therapy for airway obstruction is less invasive and palliatively effective [1]. Tracheal stent implantation is a common and immediately effective intervention for airway obstruction, but in cases of severe respiratory failure, stent implantation is difficult. Extracorporeal membrane oxygenation (ECMO) is useful for salvaging cases of severe respiratory failure; a case series analysis of its effectiveness for airway obstruction with severe respiratory failure is available in the literature [2]. We experienced a case in which we assumed that radiotherapy could treat airway obstruction, but the patient suffered from respiratory failure due to post-radiotherapy tracheal edema and required stent placement under ECMO. Airway obstruction was considered to have occurred due to tracheal edema caused by radiotherapy, but currently, there are no reports of edema at the initial stage of radiotherapy.

**Case Report/Case Presentation**

The patient was a 62-year-old woman with an Eastern Cooperative Oncology Group performance status (ECOG PS) of 1. Her smoking history was 42 pack-years, and she had a history of chronic obstructive pulmonary disease. She presented to our hospital with the chief complaint of cough. Computed tomography showed tumors of approximately 66 mm in the right lung upper lobe, enlarged mediastinum lymph nodes, and tracheal stenosis due to tumor invasion. Computed tomography-guided biopsy revealed squamous cell nonsmall lung cancer (cT4N3M0 cStage IIIIC), and chemoradiotherapy was planned. As there was no change in the tracheal stenosis, ECOG PS, and respiratory statuses between those at diagnosis and those before treatment, we started radiotherapy. Three hours after a single dose of 2-Gy irradiation, acute respiratory failure occurred with a sound characteristic of airway obstruction. We performed emergency tracheal intubation, which only required airway management and very little auxiliary ventilation. Thereafter, we performed bronchoscopy and found almost no airway secretion or sputum. She was then transferred to a facility where tracheal stent placement was possible, and a Dumon Y-stent (Novatech, La Ciotat, France) implantation into the trachea was performed through rigid bronchoscopy under ECMO (shown in Fig. 1). The duration of ECMO was 99 min, and ECMO was worn off. Her respiratory condition fully improved, but ECOG PS worsened from 1 to 2; as a result, we changed the treatment from chemoradiotherapy to radiotherapy alone (60-Gy). After the administration of 60-Gy of radiation, the tumor size decreased (shown in Fig. 2). No recurrence occurred within the next 3 months, and her ECOG PS improved to 1.

**Discussion/Conclusion**

We report a case of emergency tracheal intubation and tracheal stent placement under ECMO because of exacerbation of airway obstruction a few hours after a single dose of 2-Gy irradiation. In Japan, the number of facilities where tracheal stent implantation can be performed is limited. Therefore, in this case, we proceeded with radiation therapy instead of implanting a tracheal stent. However, we found that the radiation therapy likely caused edema, since bronchoscopy revealed that there was almost no airway secretion or sputum, and airway narrowing had clearly progressed shortly after 2-Gy irradiation. Sanguineti et al. [3] reported that there was a risk of exacerbation of airway edema in a dose-dependent manner.
with irradiation of 30-Gy or more. However, to our knowledge, there has been no report of airway stenosis in the early stages of irradiation. Although we were unable to confirm inflammatory edema associated with radiation, it most likely caused the symptoms of our patient.

Dyspnea caused by malignant tumor invasion or compression of the tracheobronchial tree is an oncologic emergency [4]. Endobronchial intervention is useful for the treatment of airway obstruction caused by various tumors [5]. In cases of severe respiratory failure and major bleeding, it is difficult to perform interventions using conventional respiratory management due to risk [6]. ECMO is useful not only for salvaging acute respiratory failure, but also for managing patients with hypoxia and critical airway obstruction during various procedures, such as stent placement and removal, rigid bronchoscopy, or pediatric surgery [7, 8]. However, because the prognosis for advanced (lung) cancers tends to be poor, the application of ECMO should be considered specifically for each patient with respect to the risks and benefits [9]. Park et al. [2] reported a summary of 17 cases (16 out of the 17 cases were cancer cases) of implantation of a tracheal stent under ECMO. The survival period was 122 days (range, 10–496 days) after stent placement. Of the 17 patients, 4 (23.5%) died within 30 days (mean, 19 days; range, 10–25 days) of stent placement because of a respiratory problem associated with the underlying disease, despite successful ECMO weaning [2]. Nishine et al. [10] reported that tracheal obstruction of more than 50% causes a pressure difference between stenotic and nonstenotic areas, which causes negative pressure buildup.
in the trachea and increases the risk of tracheal obstruction [10]. A previous study reported that the prophylactic administration of corticosteroids was effective for the prevention of post-extubation stridor and reintubation in adults [11]. However, prevention of radiotherapy-associated lower airway stenosis has not been reported. Although steroids were useful in preventing airway edema, the evidence was limited, and only empirical administration was performed in previous studies.

In our case, we measured the cross-sectional area of the trachea in the most obstructed area and the cross-sectional area of the nonobstructed area on the cranial side. The most obstructed cross-sectional area was 98 mm², and the nonobstructed cross-sectional area was 133 mm². Therefore, the tracheal obstruction rate was less than 50% (shown in Fig. 3). As the airway stenosis did not progress compared with the level observed 1 month ago, radiation therapy resulted in severe tracheal stenosis. Early tracheal stenting may be considered when planning radiation therapy for patients with airway obstruction.

**Conclusion**

Herein, we reported that a single dose of 2-Gy irradiation for the treatment of squamous cell lung carcinoma resulted in an acute exacerbation of tracheal obstruction and severe respiratory failure. The degree of edema relative to the extent of radiation varies from patient to patient; as such, caution is required regardless of the degree of airway obstruction.

**Acknowledgment**

We would like to thank Editage (www.editage.com) for the English language editing services they provided.
Statement of Ethics

The patient provided written informed consent for publication of the medical case and any accompanying images. This study is exempt from ethical approval by the Ethics Committee of Shimane University Faculty of Medicine.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Funding Sources

No funding was acquired for this study.

Author Contributions

Keita Kawakado wrote this case report. Keita Kawakado, Takamasa Hotta, Mika Horie, Misato Kobayashi, Takae Okuno, Yoshihiro Amano, Megumi Hamaguchi, Yukari Tsubata, Noriaki Kurimoto, and Takeshi Isobe performed radiotherapy. Jin Sakamoto performed stent implantation. All authors discussed the results of the case report, made comments on the manuscript, and gave final approval of the version to be published.

Data Availability Statement

All data in this study are included in this article. Further inquiries can be directed to the corresponding author.

References

1. Choi HS, Jeong BK, Jeong H, Ha IB, Kang KM. Role of radiotherapy in the management of malignant airway obstruction. Thorac Cancer. 2020;11(8):2163–9.
2. Park JH, Shin JH, Kim KY, Lim JY, Kim PH, Tsuao J, et al. Respiratory support with venovenous extracorporeal membrane oxygenation during stent placement for the palliation of critical airway obstruction: case series analysis. J Thorac Dis. 2017;9(8):2599–607.
3. Saji H, Furukawa K, Tsutsumi H, Tsuboi M, Ichinose S, Usuda J, et al. Outcomes of airway stenting for advanced lung cancer with central airway obstruction. Interact Cardiovasc Thorac Surg. 2010;11(4):425–8.
4. Sanguineti G, Adapala P, Endres EJ, Brack C, Fiorino C, Sormani MP, et al. Dosimetric predictors of laryngeal edema. Int J Radiat Oncol Biol Phys. 2007;68(3):741–9.
5. Sherani K, Vakil A, Dodhia C, Fein A. Malignant tracheal tumors: a review of current diagnostic and management strategies. Curr Opin Pulm Med. 2015;21(4):322–6.
6. Bolliger CT, Sutedja TG, Strausz J, Freitag L. Therapeutic bronchoscopy with immediate effect: laser, electrocauterity, argon plasma coagulation and stents. Eur Respir J. 2006;27(6):1258–71.
7. Wang L, Xu XP, Zhan H, Zhang SM. Application of ECMO to the treatment of benign double tracheoesophageal fistula: report of a case. Ann Thorac Cardiovasc Surg. 2014;20 Suppl:423–6.
8. Gourdin M, Dransart C, Delaunois L, Louagie YA, Gruslin A, Dubois P. Use of venovenous extracorporeal membrane oxygenation under regional anesthesia for a high-risk rigid bronchoscopy. J Cardiothorac Vasc Anesth. 2012;26(3):465–7.
9. Hong Y, Jo KW, Lyu J, Huh JW, Hong SB, Jung SH, et al. Use of venovenous extracorporeal membrane oxygenation in central airway obstruction to facilitate interventions leading to definitive airway security. J Crit Care. 2013;28(5):669–74.
10  Nishine H, Hiramoto T, Kida H, Matsuoka S, Mineshita M, Kurimoto N, et al. Assessing the site of maximal obstruction in the trachea using lateral pressure measurement during bronchoscopy. *Am J Respir Crit Care Med.* 2012;185(1):24–33.

11  Kuriyama A, Umakoshi N, Sun R. Prophylactic corticosteroids for prevention of postextubation stridor and reintubation in adults: A systematic review and meta-analysis. *Chest.* 2017;151(5):1002–10.