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Anesthetic Management in Tracheal Dilatation for Severe Tracheal Stenosis

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We report the anesthetic management of a 65-year-old woman with recurrent, severe tracheal stenosis who underwent tracheal dilatation. She had visited the Department of Respiratory Medicine at our hospital for respiratory distress approximately 20 years ago, and had undergone laser ablation under local anesthesia. Because of recurrence and aggravation of respiratory distress, she now presented at the Department of Thoracic Surgery, and was scheduled for surgery. Percutaneous cardiopulmonary support was prepared, and she was sedated with midazolam and dexmedetomidine. Under bronchoscopic guidance, a 5-mm intubation tube was placed directly above the stenosis site. Laser ablation (by argon plasma coagulation) and balloon dilatation were performed, and the tube was replaced with one with a larger diameter, which was subsequently replaced with another with an even larger diameter. Ultimately, a 7-mm tube was placed beyond the stenosis site, and the operation was completed. After restoration of spontaneous respiration and consciousness, the patient was extubated in the operating room and returned to the intensive care unit. In anesthetic management of patients with tracheal stenosis, treatment of hypoxia is important. In this case, we collaborated with the attending physician, clinical engineers, and operating room nurses throughout, and consequently, were able to perform the operation safely.

Key words: idiopathic tracheal stenosis, tracheal dilatation, general anesthesia

INTRODUCTION

Idiopathic tracheal stenosis is a rare disorder of unknown cause, with only a few reported cases in Japan so far. Herein, we report the anesthetic management of a patient with recurrent, severe tracheal stenosis who underwent tracheal dilatation.

CASE REPORT

A 65-year-old woman (height, 150 cm; weight, 54 kg) had visited the Department of Respiratory Medicine at our hospital with a chief complaint of wheezing approximately 20 years ago. Since the pulmonary function test performed at the outpatient clinic showed a fixed upper airway stenosis pattern on flow-volume curve, she was urgently hospitalized. Diagnostic bronchoscopy was performed, and pathological examination revealed nonspecific chronic inflammation, leading to a diagnosis of idiopathic tracheal stenosis [1]. At that time, tracheostomy had been performed under local anesthesia, followed by laser ablation. During subsequent follow-up, respiratory distress had persisted. Now, after a period of 20 years, she presented at the Department of Thoracic Surgery because of worsening of her respiratory distress, and surgical treatment was indicated. Her condition was classified as Hugh-Jones grade III, and she was able to rest in the supine position.

Preoperative tests

No abnormal blood test results were observed. The pulmonary function test revealed a forced expiratory volume in 1 second (FEV_1) of 1.18 L and a percentage of FEV_1 (FEV_1%) of 49.6%, which indicated the presence of occlusive disorder. The peak flow had markedly decreased to 1.35 L/s. Both the expiratory and inspiratory flow-volume curves showed a fixed upper airway stenosis pattern, which appears as a flat plateau. Figs. 1 and 2 show her sagittal computed tomography (CT) and diagnostic bronchoscopic images. The narrowest part of the stenotic site appeared as a membrane 4 cm from the glottis, and its diameter was approximately 3 mm. The lumen at the tip of the stenotic site was preserved. Because the narrowest part of the stenotic site was located higher than the level of the sternal notch, emergency tracheostomy was considered feasible. Before performing the surgery, we consulted with the respiratory surgeons, physicians, medical technologists, and operating room nurses. We simulated the procedure before anesthetic induction in the largest operating room. The time from emergency tracheostomy to the establishment of percutaneous cardiopulmonary support (PCPS) was measured. Given the risk of bleeding, PCPS was prepared only for standby purposes.

Anesthesia and the course of surgery

After the patient was brought to the operating room, she was attached to routine monitors. Under local anesthesia, an arterial line was placed in the right radial artery. Administration of dexmedetomidine was started at a dose of 6 μg/kg/h, and midazolam

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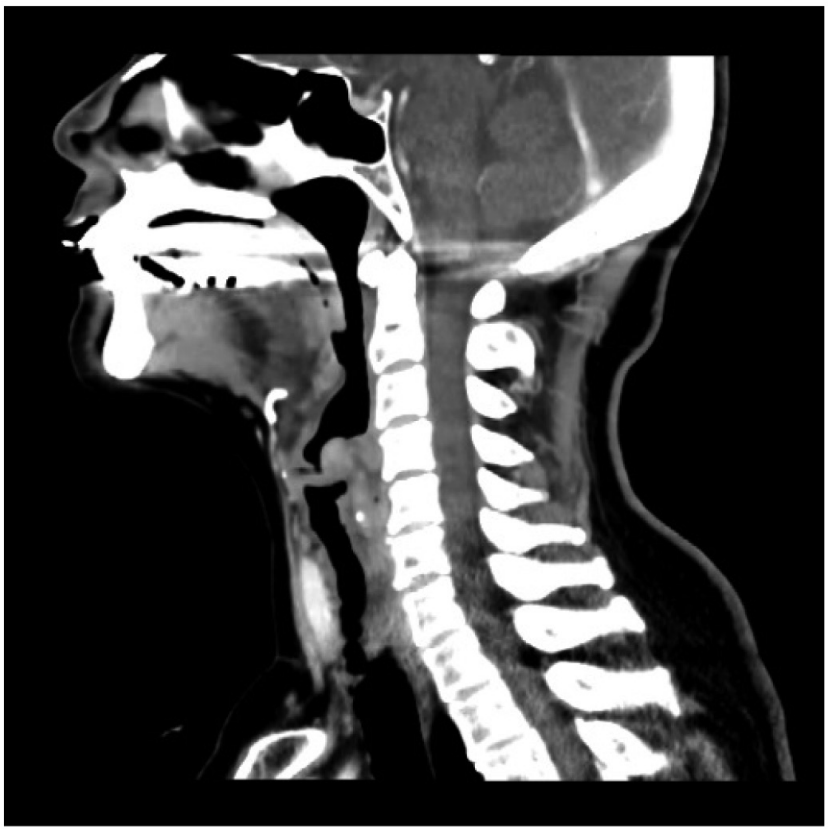

Fig. 1 Sagittal chest computed tomography image
The narrowest part of the stenotic site was located approximately 4 cm below the glottis. Because it was located cranial to the sternal notch, tracheostomy appeared feasible.

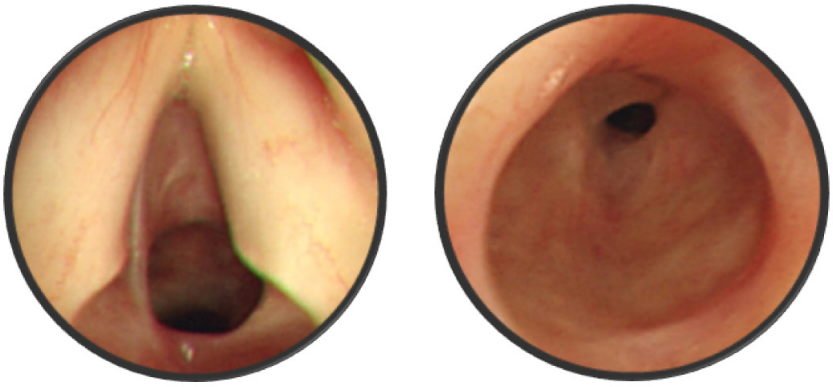

Fig. 2 Bronchoscopic findings
The narrowest part of the stenotic site measured approximately 3 mm in diameter and did not allow the passage of a 5-mm caliber bronchoscope. Computed tomography suggested that the lumen was preserved in the segment beyond the stenotic site.

2 mg was administered 5 minutes later. Because she was sedated to Ramsay Score 3, a tube with a 5-mm caliber was inserted under bronchoscopic guidance but did not pass through the narrowest part of the stenotic site. The tip of the tube was placed directly above this site, The controlled radial expansion (CRE) balloon dilation catheter with a balloon length of 5.5 cm and an inflated outer diameter of. 8−10 mm (Boston Scientific Corporation, MA) was inserted via the tube, and the balloon was dilated at 5 atm for 30 seconds.

Because the 5-mm tube had passed through this part, we confirmed that ventilation could be performed, and local anesthesia was replaced by general anesthesia. A target control infusion (TCI) of propofol was started at a dose of 2.0 μg/mL, and rocuronium 40 mg and fentanyl 50 μg were administered. Subsequently, anesthesia was maintained with propofol. After spontaneous respiration stopped, the tube was pulled out to the part superior to the stenotic site, and ablation was performed using argon plasma coagulation (APC). After ablation, the tube was replaced

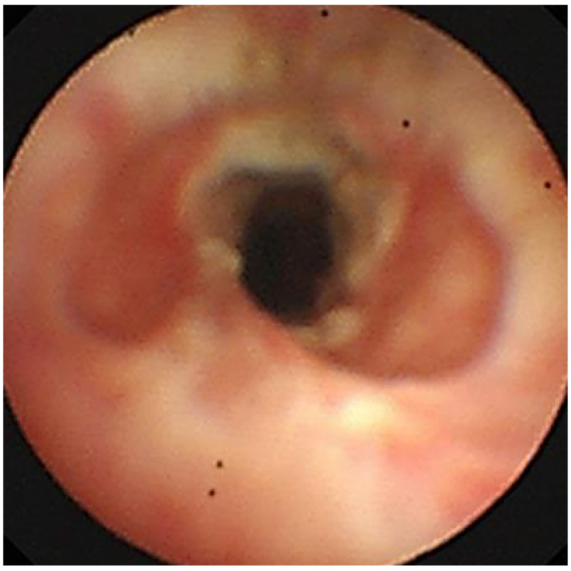

Fig. 3 Postoperative bronchoscopic findings
Dilatation of the stenotic site can be observed.

by a 6-mm caliber tube, which was placed beyond the stenotic site. This process was performed twice, and the operation was completed by ultimately placing a tube with a 7-mm caliber. The postoperative bronchoscopic findings are shown in Fig. 3. When spontaneous respiration was restored after the operation, a cuff-leak test was performed. The absence of edema in the tracheal lumen was confirmed, and the patient was extubated. Subsequently, a laryngeal mask allowing intubation (AirQ) was inserted. After the absence of edema or bleeding in the trachea was confirmed by bronchoscopy, sugammadex was administered to reverse muscle relaxation. Administration of propofol was discontinued, and eye opening was observed with a bispectral index of 78. Once it was confirmed that the patient could follow instructions, the laryngeal mask was removed. She did not complain of any respiratory distress. Finally, she was returned to the intensive care unit. The operative time was 1 hour 45 minutes, and the length of stay in the operating room was 2 hours 50 minutes. She was transferred to the general ward on the day after the surgery and discharged with independent ambulation on the fourth day after surgery. The pulmonary function test performed on the third day after surgery revealed marked improvement in both FEV_1 and $FEV_1\%$.

The preoperative and postoperative flow-volume curves are shown in Figs. 4 and 5.

DISCUSSION

Idiopathic tracheal stenosis was first reported by Bhalla et al in 1993 [1]. Although the disorder is considered prevalent among white women, its cause remains unknown. In the case reported here, the pathological examination performed on initial admission revealed findings of chronic fibrous inflammation, suggesting that the patient had this disorder. In this disorder, maintenance of oxygenation after anesthesia induction is always challenging. Some reports indicate that, depending on the site of tracheal stenosis, tracheostomy, which necessitates assisted circulation, may not be feasible [2–3]. Previously reported procedures for anesthetic management in these patients include placement of an intubation tube beyond the stenotic site [4], management using a supraglottic device [5], and management using high-frequency ventilation [6]. In order to select the appropriate management procedure, it is important to determine the surgical and anesthetic strategies through the assessment of preoperative images, examination of the patient, and careful consultation with all concerned departments. In our case, because the sagittal chest CT scan revealed that the narrowest part of the stenotic site was located 4 cm below the glottis, i.e. higher than the level of the sternal notch, emergency tracheostomy was considered feasible. Thus, PCPS and veno-venous extracorporeal membrane oxygenation (V-V ECMO) were prepared. As for balloon dilatation of the trachea, it is reported that prolonged dilatation may be necessary, depending on the condition of the tissue and connective tissue in the stenotic site [3]. Although we had first planned to dilate a balloon at 5 atm for 30 seconds, we also considered the possibility that it might be necessary to leave the patient without ventilation for approximately 10 minutes if dilatation turned out to be difficult. In such a case, the femoral region is disinfected beforehand to establish PCPS through the femoral artery and vein. Although it is controversial which procedure — PCPS or V-V ECMO — is superior, PCPS was selected in our case because of its efficiency with respect to oxygenation. During establishment of PCPS, because the cervical and coronary circulations might become hypoxemic via spontaneous circulation, the oxygenation status was assessed by right radial arterial blood gas analysis and percutaneous oxygen saturation on a right finger in this case. Because the use of heparin is inevitable regardless of whether PCPS or V-V-ECMO is performed, we decided to have PCPS only on standby, considering the risk of possible bleeding. Moreover, high-frequency ventilation was not performed because of the concomitant application of ablation to the respiratory mucosa and concern regarding elevation of

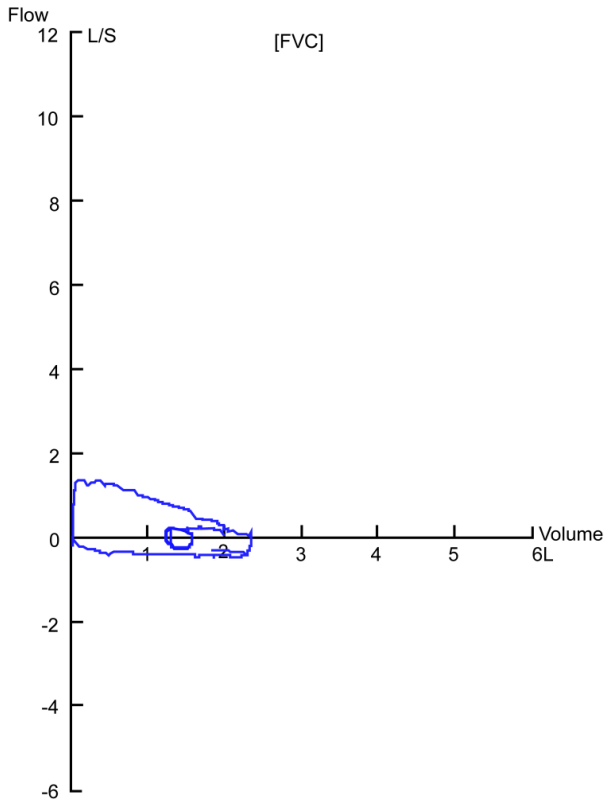

Fig. 4 Pulmonary function test results and flow-volume curve at the time of admission
Peak flow, 1.35 L/s; Percentage of forced expiratory volume in 1 second (FEV_1%), 49.6%; Forced expiratory volume in 1 second (FEV_1), 1.18 L

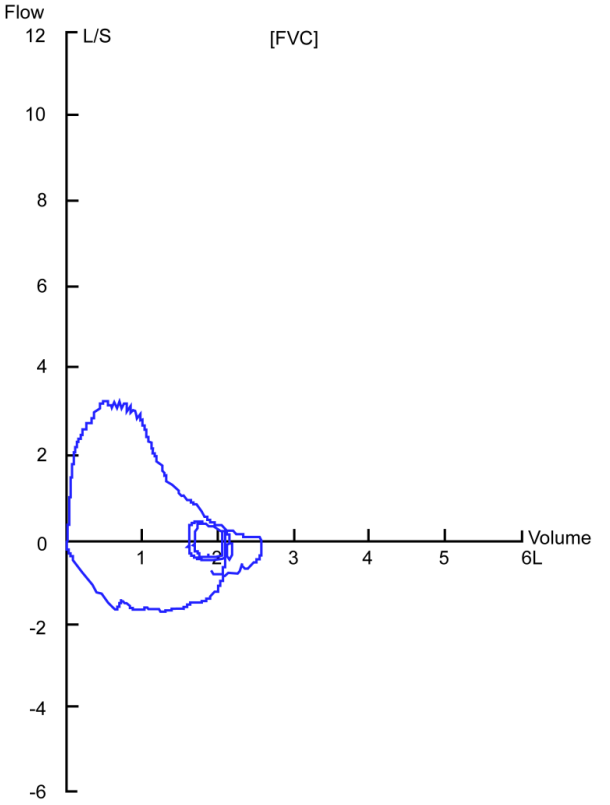

Fig. 5 Pulmonary function test results and flow-volume curve on the day after surgery
Peak flow, 3.25 L/s; Percentage of forced expiratory volume in 1 second (FEV_1%), 71.7%; Forced expiratory volume in 1 second (FEV_1), 1.80 L

intrathoracic pressure due to ventilatory impairment peripheral to the stenotic site.

In our case, although the patient complained of respiratory distress when she presented at the hospital, the reason for the emergency admission was the fixed upper airway stenosis suspected on the flow-volume curve obtained from the pulmonary function test. This pattern was also observed on the pulmonary function test performed at the time of the second admission (Fig. 4). In this pattern, the peak flow markedly decreases, and both FEV_1 and FEV_1% decrease, revealing an occlusive disorder pattern. Both the expiratory and inspiratory flow-volume curves form a small plateau and appear trapezoid. In such cases, severe upper airway stenosis is suspected, and prompt tests and treatment may be necessary. In our case, the pulmonary function and flow-volume curves showed marked improvement after the operation, and we believe that they can be used as valuable tools for determining therapeutic effects.

In conclusion, we report the anesthetic management of a patient with severe tracheal stenosis who underwent tracheal dilatation. Although anesthetic management did not require any special devices, we performed a simulation before surgery to enable us to take prompt action in case of sudden changes in the patient's condition.

ACKNOWLEDGEMENTS

This case report has been presented at the 39th Annual Meeting of the Japanese Association for Operative Medicine (Tokyo, 2017). In addition, written consent for publication of the case has been obtained from the patient.

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