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Case report

Bronchoscopic balloon dilatation combined with laser cauterization of high and long segmental tracheal stenosis secondary to endobronchial tuberculosis: A case report

Jun Hanaoka[a,*], Masatugu Ohuchi[b], Ryosuke Kaku[a], Keigo Okamoto[a], Yasuhiko Ohshio[a]

[a] Division of General Thoracic Surgery, Department of Surgery, Shiga University of Medical Science, Shiga, Japan
[b] Department of Thoracic Surgery, National Hospital Organization Shiga Hospital, Shiga, Japan

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ABSTRACT

Background: Airway stenosis after bronchial tuberculosis may reduce the patient's activities of daily living owing to various respiratory symptoms. Thus, it is necessary to treat the condition. Various treatment modalities, such as balloon dilatation, are attempted in cases where radical surgical resection is difficult to perform; however, the best treatment method remains unknown. Although balloon dilatation is relatively easy to perform and effective, there are not many cases reporting successful treatment of tracheal stenosis as compared to that of bronchial stenosis.

Case presentation: We report a case involving a 63-year-old man who presented with dyspnea on effort and stridor for 6 months. He was diagnosed with bronchotracheal stenosis due to endobronchial tuberculosis. A chest computed tomography scan showed thickening of the tracheal lumen and deformation of the tracheal cartilage from the annular cartilage to the middle trachea, and severe stenosis in the left main bronchus. Good patency of the trachea and the left main bronchus was obtained after two rounds of balloon dilatation with laser cauterization, which resulted in improvement of symptoms over a relatively long period.

Conclusions: Our study shows that balloon dilatation combined with laser cauterization can be easily repeated and may be effective for treatment of patients with bronchotracheal stenosis, wherein radical treatment cannot be performed.

1. Introduction

Endobronchial tuberculosis (EBTB) has been reported in 10%–36.8% of patients with pulmonary tuberculosis [1]. Airway stenosis secondary to EBTB can cause dyspnea on effort, cough, stridor, or recurrent infections. There are various treatment modalities for symptomatic improvement of airway stenosis, such as surgical procedures, neodymium-doped yttrium aluminum garnet (Nd:YAG) laser treatment, electrocautery, stent placement, and balloon dilatation. Surgical resection with airway reconstruction is a radical and suitable method [2]. However, selecting surgical resection as the treatment modality may be difficult owing to the patient's physical condition, anatomic limitations, and/or technical difficulties. In contrast, balloon dilatation is a much less invasive technique. Although many studies have reported the success of balloon dilatation combined with laser cauterization in the bronchus, only few such cases have been reported regarding its effectiveness in the trachea [3,4]. Herein, we report a case with stenosis in the upper trachea after EBTB, which showed improvement of symptoms over 36 months after balloon dilatation combined with laser cauterization.

2. Case presentation

A 63-year-old man presented with dyspnea and stridor on effort that gradually progressed over 6 months. The patient had a drug history of anti-tuberculosis medication, including isoniazid, rifampicin, and ethambutol for pulmonary tuberculosis that he developed 32 years ago. However, he never felt restricted in his everyday life, until he recently became aware of stridor during deep breathing. Subsequently, he developed stridor at rest and severe dyspnea on effort. Thus, he visited a local hospital. Although bronchoscopy revealed tracheal scar stenosis, the sputum smear for acid-fast bacilli was negative. He was admitted to

* Corresponding author. Tsukinowacho, Seta, Otsu, Shiga, 520-2192, Japan.
E-mail addresses: hanaoka@belle.shiga-med.ac.jp (J. Hanaoka), ohuchi-masatsugu@shiga-hosp.jp (M. Ohuchi), kakutin@belle.shiga-med.ac.jp (R. Kaku), okeigo@belle.shiga-med.ac.jp (K. Okamoto), yasuhiko@belle.shiga-med.ac.jp (Y. Ohshio).

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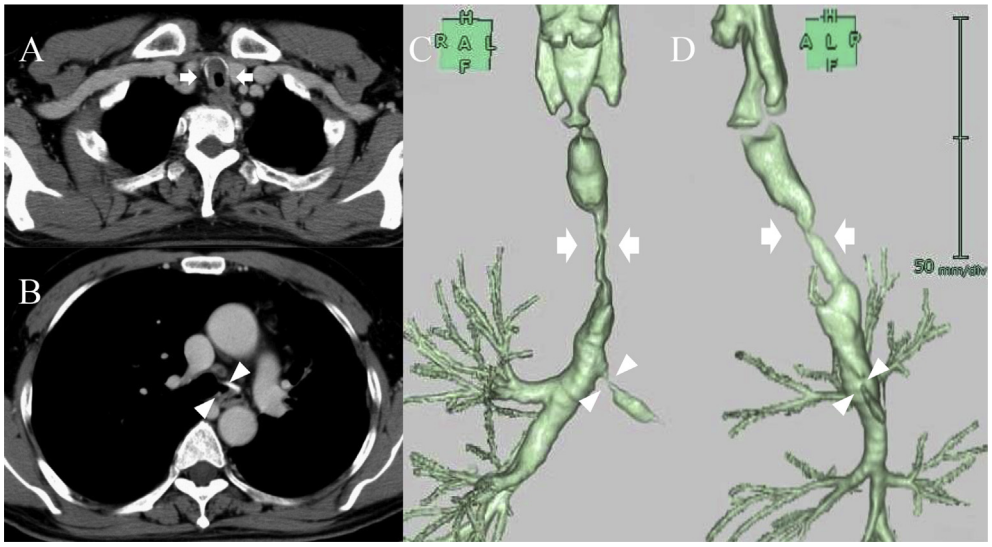

Fig. 1. Chest computed tomography (CT) findings at initial presentation. The image shows tracheal stenosis (arrow) with prominent lumen thickening (a), and the entrance part of the left main bronchus stenosis (b; arrow head). Anteroposterior (c) and lateral (d) views of 3D reconstruction CT showing stenosis of the trachea from beneath the annular cartilage to the middle trachea (52 mm in length) and severe stenosis in the left main bronchus.

our hospital for further treatment. On admission, physical examination revealed a pulse rate of 113 beats/min, blood pressure of 132/74 mm Hg, and oxygen saturation of 97% on room air. The flow-volume curve was consistent with fixed airway obstruction with a functional vital capacity (FVC) of 2.77 L and 1-second forced expiratory volume (FEV1) of 1.18 L (FEV1/FVC: 42.7%). Chest computed tomography (CT) examination including three-dimensional reconstructions revealed thickening of the tracheal lumen and deformation of the tracheal cartilage from the annular cartilage to the middle trachea (length, 52 mm; luminal diameter, 4 mm) and severe stenosis in the orifice of the left main bronchus (Fig. 1a–d). Thus, we diagnosed him with airway stenosis probably resulting from EBTB, based on the case history and imaging findings. We believe that the latent symptoms associated with airway stenosis became apparent owing to a decrease in pulmonary function with age. Since reconstruction of the airway was considered difficult due to the site of the operation and range of the defect, we decided to perform balloon dilatation combined with laser cauterization under bronchoscopy. Moreover, the patient did not wish to undergo invasive procedures. We intended to place a stent under a rigid endoscope, if expansion was obtained. Under general anesthesia, bronchoscopy using a laryngeal mask revealed severe subglottic scar stenosis (Fig. 2) through which the bronchoscope (BF type-260, Olympus Corporation, Tokyo, Japan) with an external diameter of 4.9 mm could not pass. The stenosis was Grade III according to the Myers-Cotton subglottic stenosis grading scale [5]. Under X-ray fluoroscopic imaging, a guide wire was placed transbronchoscopically through the stenotic portion. Subsequently, the bronchoscope was withdrawn leaving behind the guide wire. CRE™ Pulmonary Balloon Dilatation Catheter (Boston Scientific Corporation, Marlborough, MA, USA; Fig. 3a and b) was introduced over the wire and placed in the tracheal stenosis area. The balloon was inflated with a diluted contrast solution for 10 seconds repeatedly, gradually increasing the expansion pressures. Based on CT findings, the balloon diameter that did not exceed the airway diameter at maximum expansion was selected. After the first expansion at a pressure of 3 atm, which was performed thrice (balloon diameter: 12 mm), the bronchoscope could pass through the stenosis. After maximum cauterization of the scar site with the laser (Fig. 3c and d), balloon dilatation was performed at an expansion pressure of 4.5 atm (balloon diameter: 13.5 mm) followed by 8 atm (balloon diameter: 15 mm) thrice each, with simultaneous observation of the lumen with the bronchoscope (Fig. 2). Although the degree of tracheal stenosis improved to Grade II after balloon dilatation, placement of the Dumon stent under a rigid endoscope was impossible due to residual stenosis that did not allow sufficient expansion of the silicon stent. In this course of treatment, only the balloon dilatation was performed in the left main bronchus at an expansion pressure of 3 atm (balloon diameter: 12 mm); however, notable improvement was not observed as the stenosis grading scale remained unchanged. Subsequently, intubation with a 7-mm tracheal tube, management with a mechanical ventilator overnight, and extubation the next day were performed. He was discharged because his symptoms were alleviated; however, the stridor and dyspnea on effort gradually worsened during the follow-up period. A chest CT scan showed restenosis of the trachea (Fig. 4a and b). Consequently, we decided to perform balloon dilatation with laser cauterization after 3 months of the initial treatment. The CRE™ Pulmonary Balloon Dilatation Catheter (Boston Scientific Corporation, Marlborough, MA, USA) with a maximal expanded diameter of 18 mm at an expansion pressure of 7 atm was selected for this round of treatment. The balloon dilatation was performed with excision and incision of the fibrocicatrization by laser cauterization in a more aggressive manner than that during the initial treatment. Tracheal stenosis improved from Grade III to I. We also performed balloon dilatation with laser cauterization for the left main bronchus during this round of treatment; however, approximately 70% of the stenosis remained. The perioperative management after the treatment was performed in the same way as that in the initial treatment. His symptoms disappeared quickly and he was discharged from our hospital. Even after 22 months of the treatment, he was free from symptoms and good patency of the trachea was maintained, as revealed by the chest CT examination (Fig. 4c).

3. Discussion and conclusions

Tracheobronchial stenosis can develop in approximately 95% EBTB cases despite adequate anti-tuberculous drug treatment [6]. Patients with airway stenosis secondary to EBTB may develop dyspnea on effort, atelectasis, and obstructive pneumonia, which may reduce the patient's activities of daily living. In addition, airway stenosis is a life-threatening condition, and it is important to treat it using any conceivable means so that normal life can be achieved. Radical surgical resection is the most effective treatment for bronchial stenosis, if possible [7]. It is beneficial as lung function can be preserved even in pulmonary tuberculosis patients with low pulmonary function, as surgical treatment with airway reconstruction can be safely performed now. However, this procedure may not be the first choice in the following cases: 1) high-risk patients, 2) patients with long stenotic segments or severe stenosis at two or more levels, and 3) patients not wishing to undergo invasive procedures. In our case, we could not perform surgery owing to two stenotic portions; one stenosis was accompanied by tracheal cartilage

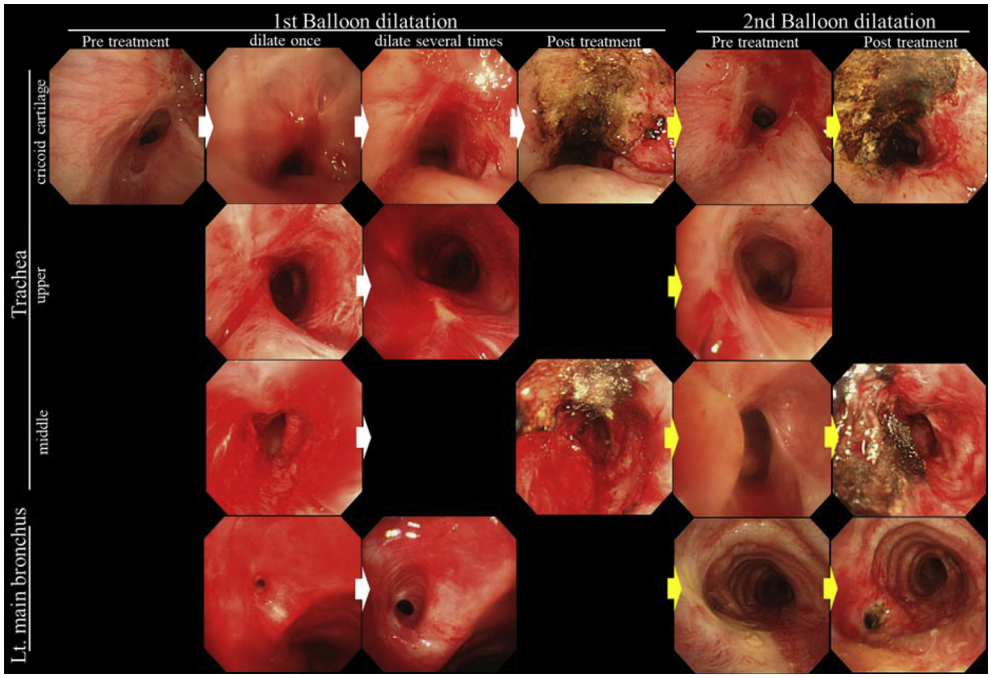

Fig. 2. Photographs showing tracheal and left main bronchial stenosis during treatment. Each line shows the change with treatment at the same site. The horizontal row is in order of treatment progress.

deformation from just beneath the cricoid cartilage to the middle trachea while the other was a marked stenosis of the left main bronchus. In patients without indications for radical resection, it is necessary to provide palliative treatments to improve symptoms using the following procedures: balloon dilatation, laser therapy, electrocautery, cryotherapy, and insertion of metal or silicone stent alone or in combination. However, there is no comprehensive report on the long-term prognosis of noninvasive therapy, and the optimal treatment method remains unknown [8].

We chose balloon dilatation combined with laser cauterization as palliative treatment for tracheobronchial stenosis after EBTB, because balloon dilatation is a relatively safer and easier method compared to

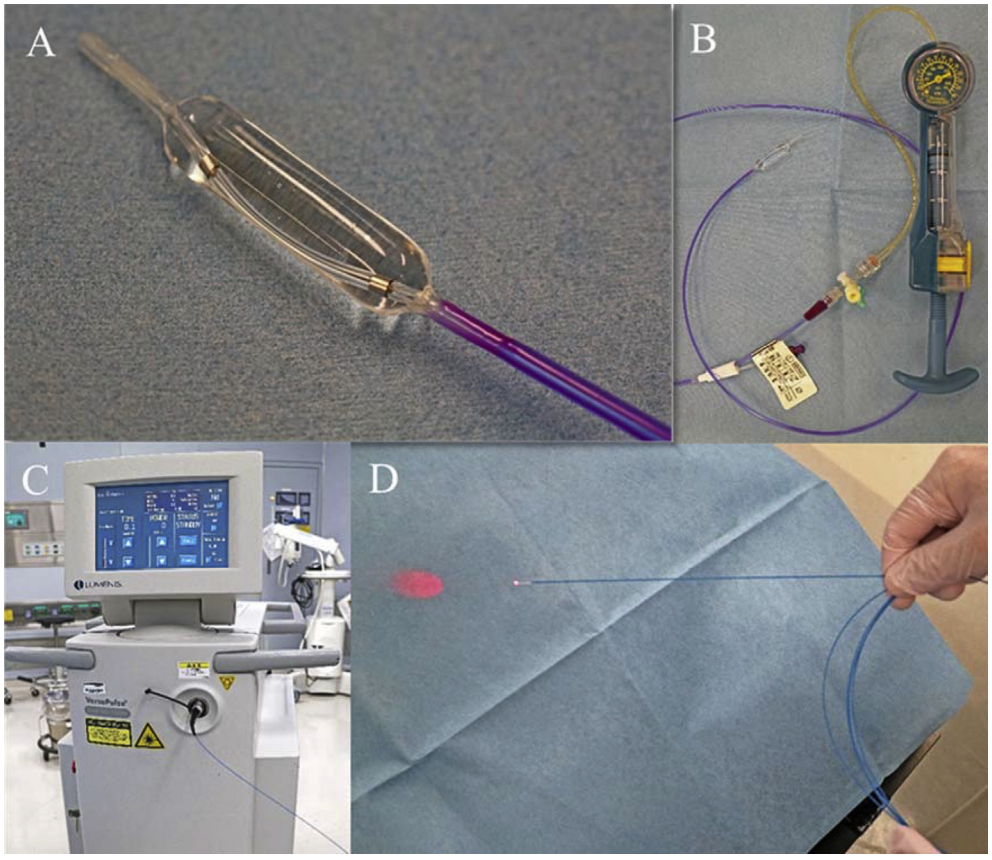

Fig. 3. Photographs showing the balloon dilatation catheter and laser cauterization system used for treatment. The expansion diameter can be controlled in three stages according to the pressure of the inflation device (a, b). The laser system is a powerful combination of 80 Watts Holmium and 100 Watts Nd:YAG lasers. Irradiation is performed with a laser fiber (c, d).

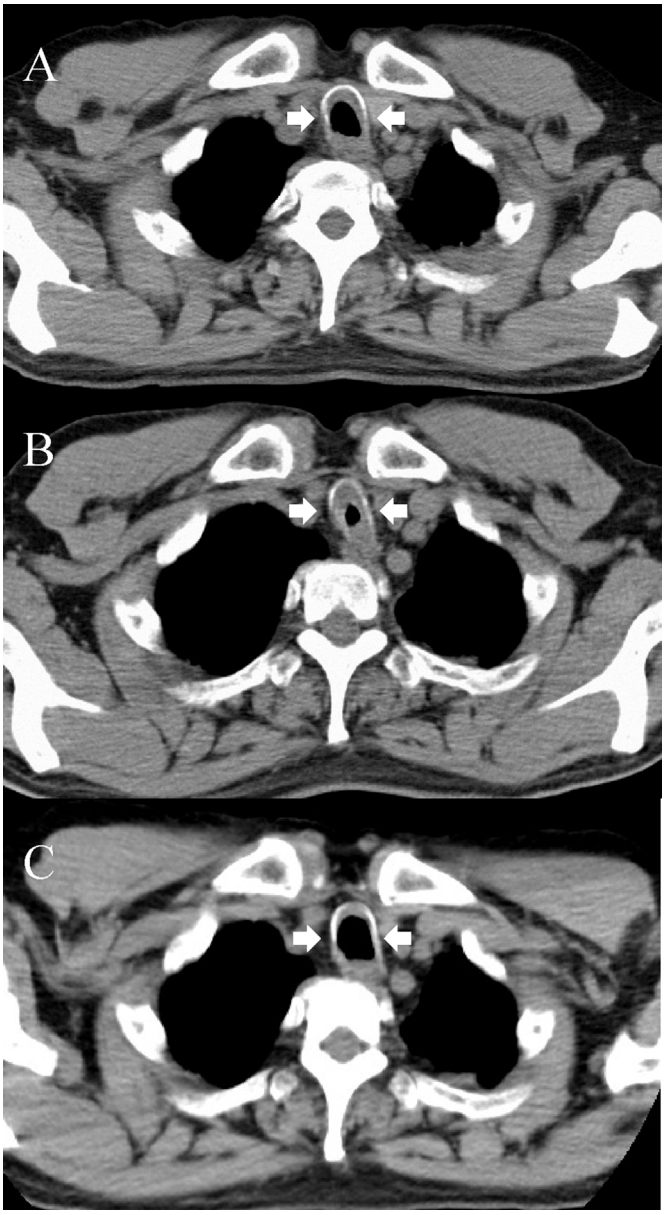

Fig. 4. Chest computed tomography (CT) findings during the follow-up period after the first balloon dilatation. The image shows mildly improved tracheal stenosis (arrow) after initial dilatation (a), restenosis after 2 months of initial treatment (b), and no restenosis even after 22 months (c).

other treatments [9], and furthermore, it is repeatable. In balloon dilatation, it is thought that the inner diameter of the bronchus is expanded by putting a crack in the bronchial wall, which is maintained by granulation formation of the cracked part. In addition, laser cauterization was used in combination with balloon dilatation for better effectiveness. It is reported that excision of fibrotic tissue with electrocautery prior to balloon dilatation eliminates the need for high expansion pressures, which can cause complications [10], and also decreases the incidence of restenosis, which may require further treatment [4]. Although many studies have reported the success of balloon dilatation combined with laser cauterization in the bronchus, only few such cases have been reported on its effectiveness in the trachea [3,4]. In fact, the optimal expansion pressure and balloon diameter to be used for balloon dilatation in the trachea are still unclear. One of the many case reports of balloon dilatation for bronchial stenosis had reported that high dilating pressure and long dilating time are effective for prevention of restenosis in the bronchus without causing mucous membrane necrosis or bronchus slit [3]. However, it is essential to limit the dilating time, as breathing is stopped during balloon dilatation. Furthermore, the trachea should be carefully observed after cicatricial repair, which may restrict all the tractional forces; it may exhibit a different behavior owing to reduction in its elasticity and strength [11]. Now it is possible to use a tracheal/bronchial balloon whose diameter changes with 3 stages of expansion pressure. A large mismatch between the balloon catheter diameter and the inner diameter of the airway stenosis may cause edema of the airway walls, bronchial spasm, deep ulceration [10], cartilage fracture, and airway rupture [11]; therefore, it is useful to gradually expand the inner diameter, as predicted by chest CT. In our case, the balloon diameter for dilatation was selected so as to not exceed the tracheal diameter predicted by chest CT, and the pressure required to obtain the expanded diameter was taken as the expansion pressure. As a result, expansion of the trachea was obtained without complications.

Bronchoscopic findings reveal ulceration in most EBTB cases at the beginning of chemotherapy, polyps with granulation approximately 1 month later, and fibrocicatrization in most parts resulting in stenosis approximately 3 months later [12]. If the tracheobronchial wall in EBTB cases shows stenosis due to thickened fibrous tissue, balloon dilatation combined with laser cauterization is a good option. However, stenosis of the tracheobronchial wall in EBTB cases is due not only to thickened fibrous tissue but also disappearance of bearing capacity due to destruction and deformation of the bronchial cartilage caused by inflammation [13]; an additional stent placement is necessary to prevent restenosis in such cases, because our method of balloon dilatation combined with laser cauterization alone is not sufficient. Although it was impossible to place the Dumon stent in our case as the silicon stent itself could not expand sufficiently owing to the residual stenosis, restenosis was not observed during the follow-up. Treatment was necessary twice, but as a result, good patency of the airway was obtained over the long-term only with conservative management because the main cause of stenosis in our case was thought to be the thickened fibrous tissue. It is important to determine the treatment policy after fully understanding the condition of the airway and that of the patient.

In conclusion, conservative treatment should be performed for post EBTB tracheal stenosis in cases where surgical resection cannot be performed. However, a typical treatment method has not been established yet. The balloon dilatation combined with laser cauterization that was performed in this case is relatively easy to repeat and can be effective for cases where surgical treatment cannot be performed. In cases where tracheobronchial cartilage destruction is remarkable, stent placement should be considered and strict observation should be carried out after balloon dilatation.

Declarations

Ethics approval and consent to participate.
Not applicable.

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Availability of data and material

The data are not available for public access because of patient privacy concerns, but are available from the corresponding author on reasonable request.

Conflicts of interest

The authors declare that they have no competing interests.

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Authors' contributions

JH is the main and corresponding author for this article. MO, YO, KO, and RK edited and approved the final version of the case report. All authors have read and approved the final manuscript.

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