

## A Case of Cuff Stenosis Following Tracheostomy Responding Well to T-tube Stent Insertion: With Special Reference to Methods of Dilating the Stenosed Site

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A 74-year-old man, receiving home oxygen therapy (HOT), required tracheal intubation and artificial ventilation because of methicillin-resistant staphylococcus aureus (MRSA)-induced pneumonia. Tracheostomy was additionally performed. One month later, he had recovered from pneumonia and the tracheostomy tube was withdrawn, allowing the patient to be discharged. One month after discharge, the patient began to complain of wheezing and difficulty in breathing and was thus admitted again to the hospital. Emergency bronchoscopy revealed cuff stenosis. A bronchofiberscope, 4.8 mm in outer diameter (o.d.), was unable to pass through the stenosed site. After the airway was secured by passing a Mini-Trach II tube (4.0 mm in inner diameter (i.d.) and 5.4 mm o.d.) through the stenosed site via the previous tracheostomy stoma, we changed the inserted tracheal tube every other day, replacing it each time with a tube of progressively larger i.d. and o.d. We went from 5.0 mm i.d. (6.9 mm o.d.) to 6.0 mm i.d. (8.2 mm o.d.), 7.0 mm i.d. (9.6 mm o.d.) and finally to 8.0 mm i.d. (10.9 mm o.d.). In this way, the stenosed site was gradually dilated. Finally, a silicon T-tube with 9.0 mm i.d. (11.0 mm o.d.) was inserted via the tracheostomy hole into the trachea and left there. At present, 2 years after the procedure, the patient is continuing HOT and is being followed at an outpatient internal medicine clinic. Cuff stenosis affects the trachea concentric-circumferentially and often relapses even after laser therapy. For these reasons, stent insertion is usually considered as necessary when dealing with cuff stenosis. Our technique of tracheal dilation is safe and simple, and does not require any special device or tool other than tracheal tubes. We report that silicon T-tube stents are optimal for treatment in cases of cuff stenosis. (*Ann Thorac Cardiovasc Surg* 2006; 12: 184–8)

**Key words:** cuff stenosis, posttracheostomy stenosis, silicon T-tube

### Introduction

Posttracheostomy stenosis of the trachea is one of the complications seen after tracheotomy. Cuff stenosis is one type of posttracheostomy stenosis and involves concentric-

circumferential stenosis. Cuff stenosis is likely to relapse after treatment with laser cautery, balloon dilation or other techniques. Stent insertion is often considered as indispensable when dealing with cases of cuff stenosis. We recently encountered a case of posttracheostomy cuff stenosis successfully treated by insertion of a silicon T-tube stent after dilation of the stenosed site without requiring any other special device or tool. Our technique of dilating the stenosed site before T-tube insertion will be presented in this paper, with reference to the literature.

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## Case Report

The patient was a 74-year-old man, with chief complaints of dyspnea and wheezing while inhaling. In 1999, he was diagnosed as having pulmonary emphysema. In 2001, he began home oxygen therapy (HOT) because of respiratory failure. In February 2003, his condition was complicated by pneumonia due to methicillin-resistant staphylococcus aureus (MRSA) and he was admitted emergently to the department of internal medicine at our hospital because of severe dyspnea. On admission, arterial blood gas analysis (Table 1) revealed signs of hypoxemia (PaCO<sub>2</sub> 41.2 mmHg, PaO<sub>2</sub> 43.5 mmHg). Tracheal intubation was therefore performed, to begin artificial assistance for ventilation. His MRSA pneumonia persisted, and it was difficult to wean the patient from the respirator. Seven days after tracheal intubation, a tracheostomy was performed. A low pressure cuff tube, with 8.0 mm i.d. (10.9 mm o.d.) was used for the tracheostomy. It was about one month later that the tracheostomy tube could be withdrawn, allowing the patient to be discharged from the hospital. About one month after discharge, however, the patient began to complain of wheezing while inhaling and difficulty in breathing. On May 28, 2003, he was again admitted emergently to the department of internal medicine because of severe dyspnea.

On admission, he showed exertional respiration. Wheezing was heard during both inspiration and expiration. The scar created by the tracheostomy could be seen on the anterior of his neck, but the stoma for the tracheostomy had closed. No noteworthy abnormalities were observed in the hematological test, urinalysis or biochemical workup. Signs of hypoxemia (PaCO<sub>2</sub> 44.6 mmHg and PaO<sub>2</sub> 50.2 mmHg) were noted again in the arterial blood gas analysis (Table 1). Bronchofiberscopy disclosed no stomal stenosis in the cervical segment of the trachea where the stoma had previously been created for the tracheostomy. As the fiberscope was advanced, scarred stenosis was observed, in the form of concentric circles, allowing a diagnosis of cuff stenosis to be made (Fig. 1A). Our attempt to insert the bronchofiberscope (4.8 mm o.d.) beyond the stenosed site failed, making it impossible to observe the lumen distal to the cuff stenosis. The extent of the stenosis along the major axis thus remained unknown. Based on the judgment that the patient had dyspnea due to severe cuff stenosis, we attempted to secure the airway by percutaneously inserting a Mini-Trach II tube (Portex, Ltd., Kent, England) into the trachea via the point previously used for tracheostomy. This tube had

**Table 1. Changes of the arterial blood gas analysis (room air)**

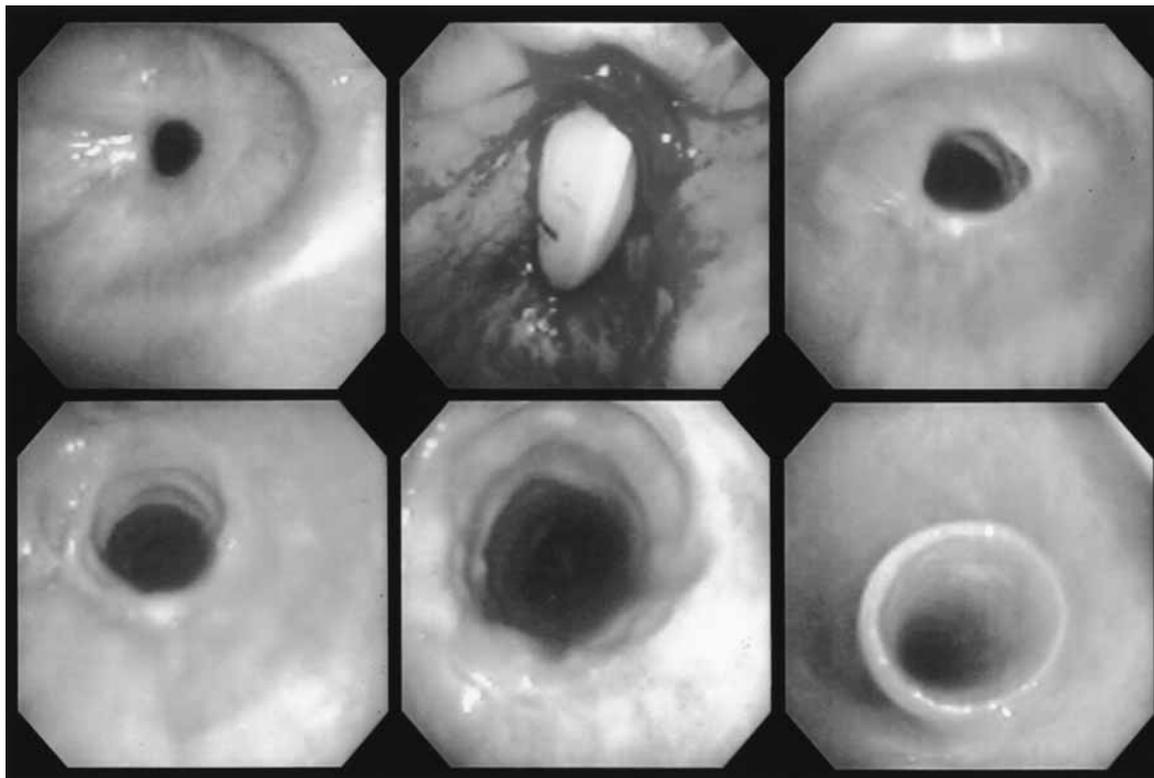
Patient's condition	MRSA pneumonia	Cuff stenosis	T-tube insertion
pH	7.404	7.420	7.396
PaCO <sub>2</sub> (mmHg)	41.2	44.6	48.7
PaO <sub>2</sub> (mmHg)	43.5	50.2	78.9
HCO <sub>3</sub> <sup>-</sup>	25.7	28.9	29.8
BE (mmol/L)	1.5	4.4	4.5

MRSA, methicillin-resistant staphylococcus aureus; PaCO<sub>2</sub>, arterial pressure of carbon dioxide; PaO<sub>2</sub>, arterial pressure of oxygen; BE, base excess.

been held in our inventory, with 4.0 mm i.d., and 5.4 mm o.d. We barely succeeded in passing the tip of the Mini-Trach II tube through the cuff stenosis and securing the airway (Fig. 1B). Then, oxygen therapy, delivered through spontaneous respiration, resulted in improved respiration (Table 1). After the airway was secured with the Mini-Trach II, we changed the inserted tracheal tube (Fig. 1C) every other day, replacing it each time with a tube of progressively larger i.d. and o.d. We went from 5.0 mm i.d. (6.9 mm o.d.) (Fig. 1D) to 6.0 mm i.d. (8.2 mm o.d.), 7.0 mm i.d. (9.6 mm o.d.) (Fig. 1E) and finally 8.0 mm i.d. (10.9 mm o.d.). In this way, the cuff stenosis was gradually dilated by probing of the trachea (the cuff was not inflated during this process). No special device other than the tracheal tube was employed for dilation of the trachea. After confirming that the tracheal lumen had dilated adequately, a silicon T-tube, with 9.0 mm i.d. (11.0 mm o.d.), was inserted from the tracheostomy stoma and left within the trachea (Fig. 1F). After T-tube insertion, the patient followed a favorable course (Table 1) and was able to breathe through his nose, to speak and to have sputum remaining in his trachea aspirated. Thus, the QOL of the patient was improved. The patient was discharged from the hospital 10 days after T-tube insertion. At present, 2 years after discharge, he is being managed as an outpatient at the department of internal medicine, while receiving HOT through the still intact T-tube.

## Discussion

Diseases or conditions which can induce scar-formation or granulomatous lesions of the central airway include tuberculosis, airway burns, traumatic bronchial tear, stenosis after tracheostomy or tracheal intubation, granulation after sleeve lobectomy and bronchial stump granulation after lobectomy. The incidence is reported to be highest for posttracheostomy stenosis and second highest for



**Fig. 1.** Changes of the bronchoscopic view of a cuff stenosis in the cervical segment of the trachea.

<b>A</b>	<b>B</b>	<b>C</b>
<b>D</b>	<b>E</b>	<b>F</b>

- A:** It was impossible to insert the bronchoscope (4.8 mm o.d.) beyond the cuff stenosis.
- B:** The tip of the Mini-Trach II was passed through the cuff stenosis via the previous tracheostomy stoma.
- C:** The cuff stenosis was gradually dilated by the Mini-Trach II (5.4 mm o.d.).
- D:** The cuff stenosis was gradually dilated by the tracheal tube (6.9 mm o.d.).
- E:** The cuff stenosis was gradually dilated by the tracheal tube (9.6 mm o.d.).
- F:** A silicone T-tube (11.0 mm o.d.) was inserted from the tracheostomy stoma and left within the trachea.

granulation after sleeve lobectomy.<sup>1)</sup> This means that scar-formation or granulomatous stenosis of the central airway is mostly iatrogenic in nature.

Various types of tracheal stenosis can develop after tracheostomy. Grillo<sup>2)</sup> divided posttracheostomy stenosis into four types: (1) subglottic stenosis developing on the oral side of the hole created; (2) stomal stenosis developing around the hole; (3) cuff stenosis developing in the part of the tracheal tube in contact with the cuff; and (4) tube-tip stenosis affecting the part in contact with the tip of the tracheal tube. Of these four types of posttracheostomy stenosis, cuff stenosis has been reported as the most frequent type, followed by stomal stenosis. The present case also developed cuff stenosis. Regarding the mechanism for development of cuff stenosis, it has been estimated that the high pressure cuff induces ischemic necrosis of the tracheal wall and that the tracheal collapse develops from ischemic necrosis of the tracheal wall, leading to

fibrosis and eventually to scarred necrosis in a concentric manner.

The number of patients developing such iatrogenic airway stenosis following airway management has been on the rise following increases in the number of surgically treated patients with compromised lung function and the opportunity for receiving long-term assistance of respiration by tracheal intubation or tracheostomy. The present case was a patient with compromised lung function who was receiving HOT. In this case, long-term artificial assistance of ventilation after tracheostomy for the treatment of MRSA pneumonia led to complication by cuff stenosis.

Cuff stenosis is treated by dilating the tracheal lumen and keeping the lumen dilated. Methods available to dilate the lumen include laser cauterization<sup>3)</sup> and balloon dilation.<sup>4)</sup> Fujisawa et al.<sup>3)</sup> reported that re-stenosis occurred after Nd:YAG laser therapy in 6 of the 7 cases. This means

that the cuff stenosis, which looks like membranous stricture at a glance, often spans 21-30 mm along the major axis of the granulomatous lesion and that Nd:YAG laser therapy is unlikely to be indicated for cases where the tip of the stenosed site remains unidentified. Furthermore, in cases where hypoxemia is present and oxygen supply is needed, like the present case, the use of Nd:YAG laser involves the danger of inducing explosion in the presence of high concentration oxygen, thus requiring particular care in the application of this therapy.<sup>5)</sup> Unlike balloon dilation at the level of bronchi, balloon dilation for tracheal stenosis can be applied only for a short time during which the patient can endure the lack of ventilation. For this reason, balloon dilation for tracheal stenosis is expected to be often ineffective. Iioka et al.<sup>6)</sup> reported that balloon dilation was ineffective in all cases of tracheal stenosis where the procedure was attempted. Of complications which can develop after balloon dilation, tracheal injury is particularly problematic. Adequate care is needed when applying balloon dilation to the trachea in which the membranous portion seems likely to tear longitudinally.<sup>7)</sup> Kani et al.<sup>8)</sup> reported that a deep tear was produced in the membranous part of the trachea in 2 of the 3 cases of tracheal stenosis treated by balloon dilation.

Because none of these existing techniques of dilation seemed to be very effective for the present case, we adopted the new dilation method described in this paper. Specifically, the airway was first ensured with a Mini-Trach II tube. We changed the inserted tracheal tube every other day, replacing it each time with a tube of progressively larger inner and outer diameters. This method is useful and safe since it allows tracheal bougienage simultaneously with securing the airway. Furthermore, this technique requires no special device or tool other than tracheal tubes to dilate the stenosed site of the trachea. It is thus a very simple technique of dilation.

Once the affected airway has been dilated, a stent often needs to be inserted to keep the lumen dilated. Although various stents (silicon, metal, compound and other stents) have been developed and their usefulness has been reported to date, there are still many unresolved problems with the stents used for this purpose.<sup>9,10)</sup> Regarding the selection of a stent, we believe that a removable silicon stent is the stent of first choice when dealing with airway stenosis due to benign disease. Requirements for ideal tracheal stents include: (1) adequate supportive power and durability; (2) easy to keep inserted; (3) unlikely to stimulate or injury the airway wall and induce

adverse reactions; (4) unlikely to fall off; (5) capable of preventing the growth of granulation; (6) unlikely to suppress the airway cleaning mechanism of the host; (7) can be removed noninvasively when withdrawal is needed; and (8) low cost. Silicon T-tubes seemed to satisfy all of these requirements, and we selected this type of tube for the present case. It is rare that silicon T-tubes become broken or dislocated during use. Thus this type of tube can be kept inserted for prolonged periods of time. Furthermore renewal of the stent is possible under local anesthesia. Because a part of the stent needs to be exposed out of the body, the daily living of the patient may be restricted slightly, but this may be utilized for tracheal aspiration if sputum is difficult to expectorate.<sup>11,12)</sup> If these features of silicon T-tube stents and the disadvantages of other stents<sup>13,14)</sup> are taken together, we may say that silicon T-tube stents are optimal for treatment in cases of cuff stenosis.

## Conclusion

Cuff stenosis affects the trachea concentric-circumferentially and often relapses even after laser therapy. For these reasons, stent insertion is usually considered as necessary when dealing with cuff stenosis. In the present case, however, we succeeded in dilating the stenosed site and subsequently inserting a T-tube into the dilated area, without using any special device or tool other than tracheal tubes. Our technique of tracheal dilation is safe and simple, and does not require any special device or tool other than tracheal tubes. This type of tube allows aspiration of the trachea in cases where sputum is difficult to expectorate. A T-tube insertion improved the QOL of this patient. We conclude that silicon T-tube stents are optimal for treatment in cases of cuff stenosis.

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