Original Article

Use of the Silicone T-tube to Treat Tracheal Stenosis or Tracheal Injury

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Backgound: Tracheal stenosis or tracheal injury is a troublesome disease. Traditional temporary tracheostomy and reconstruction can resolve some problems. However other problems such as subglottic stenosis and supracarinal stenosis, cannot be resolved by simple tracheostomy. The silicone tracheal T-tube presents a subsitute for stent of this complicated disease.

Methods: Eleven patients with tracheal stenosis or tracheal injury were managed with the silicone T-tube prothesis from 1995 to 1999. Among them 5 cases were characterized by subglottic and cervical stenosis, 4 cases supracarinal stenosis, and 2 cases tracheal injury. The silicone T-tube was used for about one year in all patients with satisfactory results.

Results: One patient was excluded from the study because of death due to unrelated disease. The T-tubes were removed successfully one year later. Among them, two patients with granuloma over the subglottic area were treated by CO_2 laser 2 to 4 times. The stoma was closed by repeated silver nitrate application.

Conclusions: The silicone T-tube is a useful prothesis for tracheal stenosis or tracheal injury with minimal complication in place of traditional tracheostomy or complex tracheal reconstruction. (Ann Thorac Cardiovasc Surg 2001; 7: 192–6)

Key words: silicone T-tube, subglottic stenosis, supracarinal stenosis

Introduction

Tracheal stenosis can occur following tracheostomy or translaryngeal intubation with inappropriate cuff pressure. It is due to pressure necrosis at the site of the cuff. Initially, there is inflammation of the damaged mucosa with increased secretion and secondary infection. Prolonged ischemia and secondary infection cause necrosis of the tracheal wall and exposure and sequestration of the cartilaginous rings. This damage results in the formation of granulation tissue and collapse of the tracheal wall. Respiratory obstruction usually develops two to three weeks after decannulation.

Many methods of tracheal stenosis treatment are available. These include tracheal dilation, excision of stricture and end-to-end anastomosis or staged reconstruction with muscle cutaneous flap. Restenosis may sometimes occur, particularly when the stenosis was more than two centimeters in length because of the presence of excessive tension at the line of anastomosis. In addition, delayed surgical correction may increase the severity by repeated and reciprocal irritation.

Montgomery,[1] in 1965, reported the use of the T-tube tracheal stent to repair tracheal injuries and post-trachesotomy tracheomalacia in an infant four and a half months old. In 1974, he reported the silicone T-tube in 94 cases of subglottic and tracheal stenosis.[1] Oliverio et al.[2] reported the use of a T-tube stent in tracheomalacia after circumferential resection of a stenosis. The stent was left in place for about a year. After the removal, complete obstruction occurred because of the formation of granulation tissue.

Here we present our experience of using the T-tube combining a longitudinal incision over the tracheal stenosis area. Compared with traditional tracheostomy, this approach is more likely to keep the normal humidifica-

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Table. Summary of patients treated for tracheal stenosis or tracheal injury

Case	Sex	Age	Primary disease	Days intubated		Cause of stenosis	Location of stenosis	Duration of T-tube (months)	Complication	Result
				Endotrach	Trachostomy					
1	F	50	Toxic goiter	2		Endotracheal injury	Subglottic	12	Nil	Symptom free
2	F	59	Respiratory failure after liver lobectomy	60		Endotracheal injury	Subglottic	12	Granulation	Symptom free
3	F	14	Head injury	46		Endotracheal injury	Subglottic	16	Nil	Symptom free
4	F	22	Tracheal trauma	40		Endotracheal injury	Subglottic	15	Granulation	Symptom free CO_2 laser
5	F	69	Pneumonia		120	Tracheostomy injury	Cervical	11	Nil	Symptom free
6	F	22	Head injury		37	Tracheostomy cuff	Mediastinum	14	Nil	Symptom free
7	F	60	Acute subdural hemorrage		59	Tracheostomy cuff	Mediastinum	4	Nil	Died of CVA
8	M	50	Acute intracerebral hemorrage		72	Tracheostomy cuff	Mediastinum	14	Nil	Symptom free
9	F	73	Pneumonia	22		Endotracheal cuff	Mediastinum	12	Nil	Symptom free
10	F	46	Tracheal cutting injury (irregular)	2		Tracheal injury	Cervical	15	Nil	Symptom free
11	F	41	Tracheal cutting injury (irregular)	1		Tracheal injury	Cervical	10	Nil	Symptom free

tion of the airway, phonation, and little granulation tissue formation.

Meterials and Methods

From 1995 to 1999, there had been a total of 11 patients underwent insertion of the T-tube stent for tracheal stenosis or tracheal injury in our hospital. Ten were female and one was male. The patients ranged from 22 to 73 years of age, with a mean of 46. The types of obstruction included subglottic stenosis due to endotracheal injury or prolonged tracheostomy in 5 patients, mediastinal tracheal stenosis in 4 patients, and complex tracheal cutting injury in 2 patients (Table). Endotracheal intubation was placed for ventilation before operation in 10 patients, only 1 patient had upper airway stridor without endotracheal tube insertion.

The preoperative work-up included blood cell routines, biochemistry study, chest radiography, bronchoscopy and computed tomogram (CT) scan of the neck and chest. General anesthesia was performed by suitable endotracheal tube insertion. The length and size of the T-tube depended on the location and diameter of the trachea. The majority were 12 or 13 mm T-tubes in diameter. After anesthesia, a longitudinal incision was performed over the midline of neck upward or downward depending on the obstructed site. Sometimes a partial sternotomy was performed for the lower tracheal stenosis near the carina. After mobilizing the stenotic trachea, we made longitudinal extension of the tracheotomy from the preexisting tracheostomy or newly created tracheal stoma to the distal part of the narrowest trachea. At the same time, the granulation tissue in the trachea was debrided and resected. We then stopped the ventilation and removed the endotracheal tube under adequate monitoring. At the same time, the T-tube was inserted into the trachea. Another endotracheal tube, appropriately preselected, was placed from the horizontal limb to the lower limb of the T-tube to increase rigidity (Fig. 1). After insertion of the T-tube, we used the fiberbronchoscope to check that the endotracheal T-tube was in the appropriate position. We closed the tracheal incision wound

Fig. 1. Insertion of the T-tube; the endotracheal tube Fr 5.0 was placed from the horizontal limb to the lower limb of the T-tube to increase rigidity and to act as a guidance for T-tube insertion.

and fixed the horizontal limb of the T-tube with 3-0 Dexan, and then closed the neck wound with 3-0 nylon.

The postoperative management included prophylactic antibiotics for one week, and steam inhalation and airway hygiene every 4 to 6 hours for 2 weeks. After discharge, the cleaning procedure with cotton tip applicators dipped in normal saline was performed 3 times a day, or more often if necessary, to dislodge tenacious mucus and crusts. In addition, the skin around the stoma was treated with antibiotic ointment at least 3 or 4 times a day. The horizontal limbs of the T-tube were plugged, if possible, as soon as the patient has recovered from ventilation anesthesia to maintain the normal humidification and phonation. The fiberbroncoscope was performed under local anesthesia every month to check the T-tube condition and clean the tracheal airway. When the chest and neck showed no tracheal stenosis usually 11-16 months, we then removed the T-tube under local anesthesia. After removal, the wound was applicated with silver nitrate was applied to the wound to close the stoma (Fig. 2).

Results

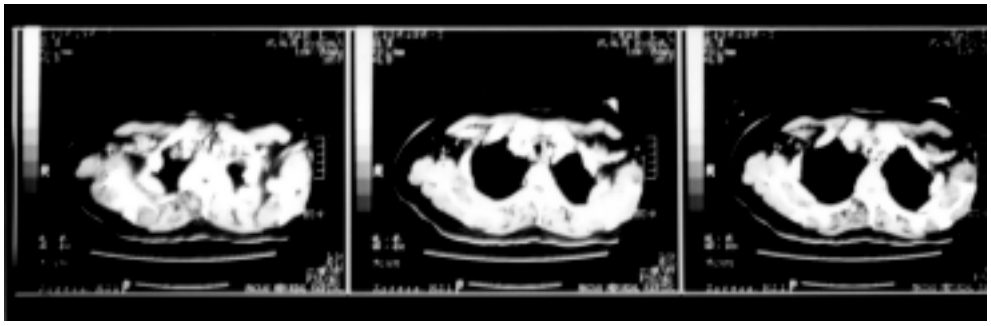
Eleven patients were treated with the T-tube for tracheal

Fig. 2. The T-tube stoma was closed by repeated $AgNO_3$ application.

stenosis (Table), including four cases of subglottic stenosis due to intubation, one case of cervical stenosis due to tracheostomy, four cases of mediastinal stenosis due to cuff pressure, and two cases of complex tracheal injury due to tracheal cutting injury. Follow-up ranged from 4 months to 60 months, with an average of 27.2 months. All patients benefited from the operation, with relief of respiratory distress and reverse of phonation. Unfortunately one patient died due to a cerebrovascular accident 4 months after operation. The other 10 patients were followed up until July 2000. Two patients (cases 2 and 4) had granulation tissue formation in the tracheal lumen at the upper end of the T-tube, which was removed by CO_2 laser therapy. The other 8 patients were free of upper airway obstruction at the last follow-up.

Three of four cases of subglottic stenosis suffered from respiratory failure with endotracheal tube ventilation for more than 40 days. Subglottic stenosis was suspected after removing the endotracheal tube, which was proved by brochoscopy and neck computer tomography. During tracheoplasty with the T-tube insertion procedure we localized the upper limb of the T-tube below the vocal cord via the bronchoscope. Unfortunately , 1 to 2 months later, granulation tissue obstructed the upper limb of the T-tube just near the vocal cord in 2 patients (cases 2 and 4). This was removed by CO_2 laser therapy. About 1 to 1.5 years later all 4 patients were free from upper airway problems after removing the T-tube.

The 4 cases of mediastinal stenosis were suspected during changing of the tracheotomy tube. Bronchoscopy and chest computer tomography proved that the mediastinal tracheal fibrosis was 1.5 cm above the carina (Fig. 3a). Under general anesthesia with small endotracheal



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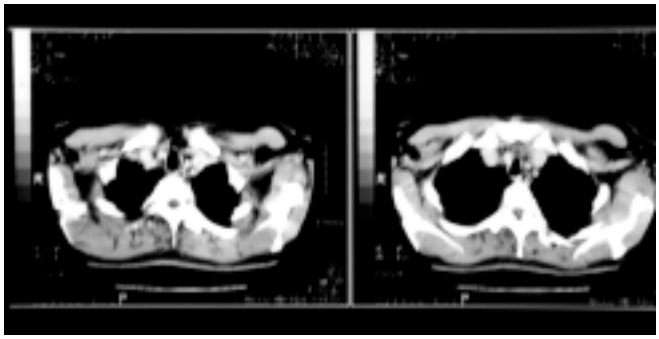

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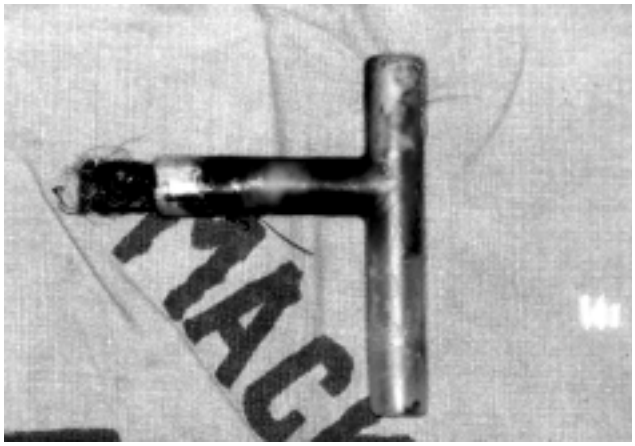

c

Fig. 3. This 22-year-old female was a case of mediastinal tracheal fibrosis about 1.5 cm above the carina. a: The stenosis was found over the mediastinal trachea by chest CT before operation, b: The chest CT showed no stenosis over the mediastinal trachea after removing the T-tube 14 months later, c: The T-tube was found with no obstruction over the lumen, which was cleaned by frequent endo-suction and fiberbronchoscope.

tube ventilation, neck exploration and partial upper sternotomy were performed. Along the previous stoma,we made a longitudinal incision and partial excision of stenosis. The T-tube was inserted beyond the stenotic area just above the carina. After 1 year, all of these patients except case 7 were free from upper airway obstruction, which was proved by bronchoscopy and chest computer tomography (Fig. 3b, c).

The 2 cases of complex tracheal cutting injury were treated with endotracheal intubation through the neck for ventilation in the emergency room. During the operation procedure a large defect of trachea or an irregular cutting wound of trachea was noted, which precluded primary repair and resection. Thus the T-tube was used for a stent. Ten months later, the T-tube was removed without causing any problem.

Discussion

In our study, nine cases of tracheal stenosis had a common denominator – they developed after a cuffed endotracheal or tracheostomy intubation in a closed system with assisted ventilation. Formation of granulation tissue and loss of cartilaginous support caused circumferential narrowing. The main sites of tracheostenosis were in the subglottic area, just at the location of the tracheal inlet and the cuffed area of the endotracheal or tracheostomy tube. The tracheomalacia predominately occurred at the area of the cuff,[3] whereas granulation and trap door formation predominated at the tracheostomy site.

Treatment of tracheal stenosis or tracheal injury is rather difficult and frequently complicated with external or internal trauma of the main airway. Since tracheal reconstruction is often a highly risky surgery, a simpler approach with the T-tube is preferred. It offers patients an adequate airway and physiological larynx. The lower airway does not lose humidity and daily care is simple. Obstruction of the upper end of the T-tube by granulation tissue is a common complication. The horizontal limb of the T-tube usually needs to be opened for respiration. It usually results from persistent subglottic edema in the early postoperative stage or from late granulation for-

mation which is due to the upper end of the T-tube coming into contact with the tracheal wall. The tracheal wall can be easily irritated by laryngeal movement which causes it to be hit by the upper tip of the tube. If obstruction is suspected, bronchoscopy should be performed as early as possible. The granulation tissue can easily be treated with CO_2 laser therapy. Alternatively, the upper end of the T-tube can be projected just above the vocal cords if the subglottic stenosis is close to the vocal cord.[4-6] With the tube in this position, the voice is diminished in intensity but is adequate for normal conversation. Aspiration is not a problem after the first several days because the epiglottis covers the top of the tube during swallowing.[6]

Obstruction of the lower end of the tube is uncommon. If the T-tube is left for more than 6 months, it is frequently coated with thick mucus, and occasionally causes partial obstruction of the lumen. We suggest that bronchoscopy should be performed at least once a month to check the stented airway and reassure the absence of the granulation tissue.[4]

It has long been emphasized that the T-tube can be used as a definitive treatment. In our study, the T-tube was usually removed 10 months after operation. Although an expanding wire stent without a horizontal side arm has been suggested as an alternative to the silicone rubber T-tube in benign strictures of the upper airway,[7] it is poorly tolerated because of inflammation and insufficient sputum toilet.[8] Sometimes it migrates into the upper airway and is difficult to remove.[9] A satisfactory stent for the treatment of tracheal stenosis is characterized by little or no tissue reaction, physiological respiration and phonation, sufficient support to the stenotic segment of the trachea, and easy insertion and change.[3] Therefore,we conclude that the silicone T-tube is useful for complex tracheal stenosis or tracheal injury.

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