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The Westaby T-Y tracheobronchial stent in otolaryngology

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Abstract
The Westaby T-Y tracheobronchial silicone stent can be used for the relief of upper airway obstruction beyond the limit of a standard tracheostomy tube. We report on our experience in the use of the Westaby tube in 10 patients over a five-year period. The general features of the tube, indications for its use, and its method of insertion are described. The versatility and advantages over other stents are discussed. Two cases reports are described and the clinical course and outcomes of the individual patients are outlined.

Key words: Tracheal stenosis; Surgery, operative; Prosthesis

Introduction

The tracheostomy tube is the workhorse for relief of upper airway obstruction in otolaryngology practice. However, not infrequently, patients are encountered in whom the airway obstruction lies below the thoracic inlet, beyond the limit of standard tracheostomy tubes. Definitive management of this problem has traditionally been the domain of cardiothoracic surgeons, however, such patients often present to the otolaryngologist for emergency airway management. In such situations a safe and effective method of managing patients with obstruction of the lower trachea, carina, or upper main bronchi should be available. The Westaby T-Y tube offers otolaryngologists the ability to manage such patients.

Stephen Westaby first described the T-Y silicone stent (Figure 1) which bears his name, in 1982 (Westaby *et al.*, 1982). Its first use was to preserve airway patency in a patient with tracheobronchial burns who developed critical airway obstruction. A number of subsequent reports of use of the Westaby tube in the management of airway obstruction due to intraluminal and tracheal wall lesions, and in conditions causing external tracheal compression have been described (Westaby and Shepherd, 1983; Westaby, 1985; Munsch *et al*, 1987; Fenton *et al.*, 1995).

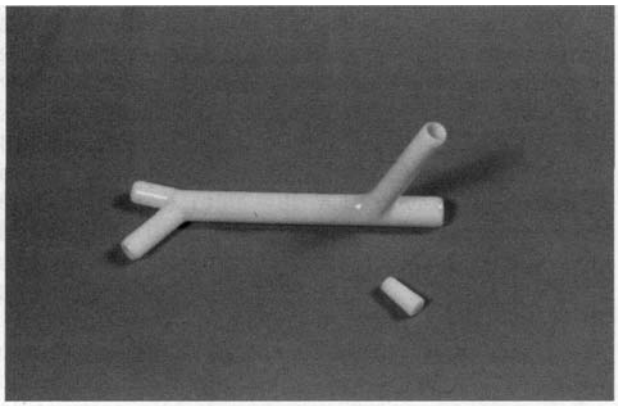

FIG. 1
The Westaby T-Y tracheobronchial silicone stent, complete with side arm plug.

The authors' first experience in the use of this stent was in a patient with a large mid-tracheal intraluminal squamous cell carcinoma, who developed acute critical airway obstruction. Since then we have used Westaby tubes with varying success in nine other patients. We describe the stent, its method of insertion and our experience with its use.

The Westaby tube

The stent (Figure 1) consists of a silicone rubber cylinder designed to lie in the trachea with a bifurcated distal end, to accommodate the carina and upper main bronchi. A side arm at 90 degrees to the plane of bifurcation allows external communication through a tracheostomy. When access to the tube lumen or airway is not necessary, a silicone plug occludes this side arm. The proximal end of the tube can be positioned above or below the vocal folds depending on the extent of proximal stenting required.

The Westaby tube is available in a variety of different sizes. However, there are two critical specifications when selecting a tube for insertion: (1) tube diameter and (2) distance from the side-arm to the tube bifurcation. The tube can be trimmed at the time of insertion to custom fit the airway depending on the specific indications in each case.

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Method of insertion

Although insertion directly via the larynx has been described in a patent with an inaccessible cervical trachea due to inoperable thyroid malignancy (Munsch *et al.*, 1987), in the cases described below, all stents were inserted via a cervical tracheostomy under general anaesthesia.

Airway assessment

The initial assessment determines the exact nature and extent of laryngotracheobronchial disease by rigid bronchoscopy with ventilation using the Venturi technique. The internal dimensions of the trachea are meticulously measured, including the position and dimensions of the obstruction. The essential distances meaured are: (1) from the vocal folds to the carina, (2) from the carina to the planned tracheostomy site, and (3) from the planned tracheostomy site to the glottis. It may be necessary to remove intraluminal tissue using biopsy forceps or laser, to make these measurements.

Choice of stent

An appropriately sized stent is chosen and trimmed so that it will lie within the airway lumen, bypass the obstruction, but not impinge on adjacent uninvolved areas. Silicone is easily cut with a scalpel, and rough edges are smoothed with a diathermy tip cleaner or sterile sandpaper.

Placement of tracheostomy

The bronchoscope, is advanced to the carina and then withdrawn a distance corresponding to the length from the bifurcation of the tube to its side arm (distance (2) above) where a tracheostomy is fashioned. It is important that this measurement is accurate so that the tube, when inserted, will fit snugly within the airway.

With the trachea exposed through a standard tracheostomy incision, the operating theatre lights are then lowered. Inspection of the anterior wall of the trachea will show the bronchoscope light which indicates the precise position for the tracheostomy which is then fashioned.

Insertion of Westaby tube

Two gum elastic bougies passed throygh the stent (Figure 2) are introduced via the tracheostomy and positioned one in each main bronchus, under direct vision with the bronchoscope. The bougies allow accurate placement of the distal, bifurcated end of the stent with each limb in the corresponding main bronchus. Because of the air leak, it is important that there be as little delay as possible during this stage of the procedure. The proximal ends of the bougies protrude from the side arm of the tube so as not to interfere with placement of the proximal end into the upper part of the trachea. This is achieved using an artery forceps through the tracheostomy, although it may be necessary to simultaneously apply traction from above under bronchoscopic guidance.

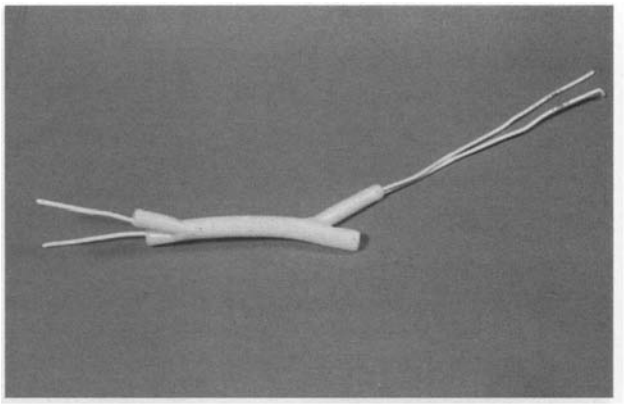

FIG. 2

The stent pre-insertion. The two gum elastic bougies are introduced via the tracheostomy and positioned one in each main bronchus, under direct vision with the bronchoscope.

If the airway obstruction involves the glottic region, the proximal end of the stent can be positioned above the vocal folds using a forceps to advance the stent within the bronchoscope to a level above the glottis, and the bronchoscope is then withdrawn. With no glottic obstruction, the proximal end of the tube is trimmed to lie below the glottis achieving an airway diversion similar to that seen with a fenestrated tracheostomy tube, allowing speech.

Assessment of tube in situ

With the tube in position, ventilation is performed via the side arm. There is invariably an air leak proximally and higher tidal volumes are necessary for effective ventilation. However, with an appropriate sized, well-positioned tube there should be negligible leakage elsewhere. Maintaining effective ventilation is not usually problematic when working closely with an anaesthetist who is familiar with the properties of the stent, and who can anticipate the different ventilatory requirements for each stage of its insertion. The tube and distal airways can now be inspected from within using a flexible or rigid paediatric bronchoscope.

Post-operative care

The patient is transferred to the intensive care or high dependency unit overnight for standard tracheostomy care and observation. Regular suctioning is performed via the side arm. The tip of the suction catheter is directed up or down within the stent by adjusting the angulation of the flexible side arm. Between suctioning, the side arm is plugged to allow speech and nasal breathing, preventing drying of secretions and making blockage less likely.

A post-operative chest X-ray is performed to confirm the position of the stent (Figure 3). Over the next few days the patient and their carers are taught how to manage the tube in preparation for discharge, where possible, depending on the underlying diagnosis.

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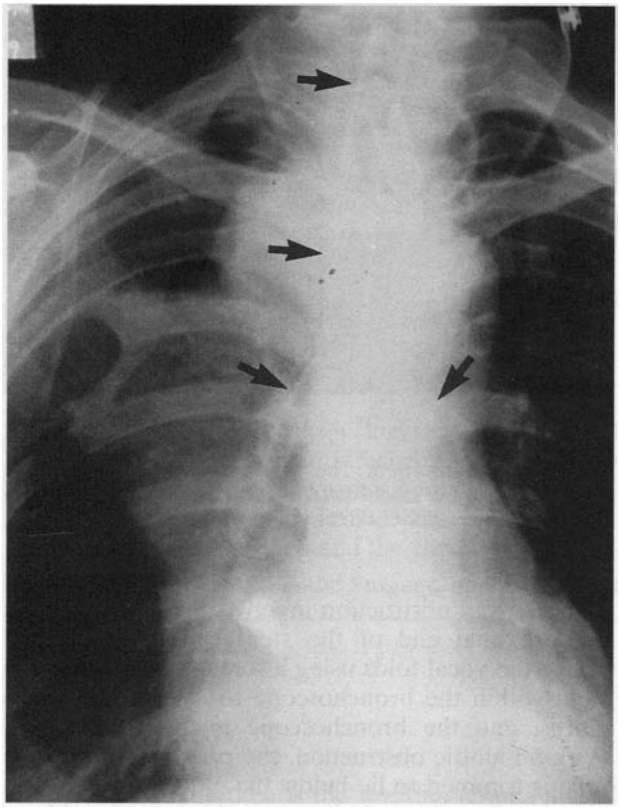

FIG. 3
Post-operative chest X-ray of patient with Westaby tube in situ (arrows).

Results (refer to Table I)

Ten patients have been treated with 14 Westaby tubes over a five-year period. One patient (case E) had a benign lesion (inhalation burns), the other nine having malignant conditions. Of these, five were lesions causing airway obstruction from within (cases A, B, G, H and J), two compressed the airway externally (cases C and F) and two lesions caused obstruction by a combination of internal obstruction and external compression (cases D and I).

One patient died in hospital, (case A; see case report below) but the other nine were discharged. Of these eight were successfully managed at home for variable periods of time and the one other patient (case G) was transferred from hospital for hospice care and died four months later.

Two patients remain well at most recent follow-up, including one after treatment of lymphoma (case D) and one who suffered inhalation burns, (case E). Both patients had their Westaby tubes removed although case D still has a fenestrated tracheostomy tube in situ for residual subglottic stenosis.

The first patient treated, (case A) required a change of Westaby tube twice (see case report below) and two others required second tube insertions because of tube blockage. No complications directly related to the tube were encountered after discharge.

Case reports

Case 1 (Case A from Table I)

A 56-year-old female, in poor general medical condition, was admitted with biphasic stridor secondary to tracheal narrowing. Rigid bronchoscopy revealed a polypoid mass in the mid-trachea, beyond the limit of a standard tracheostomy tube, causing 70

TABLE I
10 PATIENTS TREATED WITH 14 WESTABY TUBES OVER A 5-YEAR PERIOD

	Sex/Age	Clinical details	No. of stents	Results	
A	Female 56	Tracheal SCC with 70% narrowing in distal trachea	3	Developed tracheal candidiasis, Major vessell erosion and died in hospital	Died 4 weeks
B	Female 48	Bronchogenic SCC. Circumferential tumour of lower trachea extending into right main stem bronchus	2	Developed tracheo-oesophageal fistula during out-patient palliative radiotherapy. Died from pneumonia	Died 6 weeks
C	Female 52	80% occlusion from extrinsic compression by cervical lymphoma	1	Successful stenting. Chemotherapy. Died of systemic disease.	Died 12 weeks
D	Male 51	Combined compression from lymphoma in Hashimoto's thyroiditis	1	Chemotherapy for lymphoma. Tube removed after treatment. Alive and well	Alive 6 years
E	Female 58	Burns, Inhalation injuries. Tracheal fibrosis and stenosis after multiple tracheostomy tubes	1	Stent removed after 18 months. Residual tracheostomy for subglottic stenosis	Alive 8 years
F	Female 57	Bronchogenic SCC compressing trachea. Acute obstruction while undergoing palliative radiotherapy.	1	Good initial result. Poor general condition and transferred to hospice for terminal care.	Died 16 weeks
G	Female 53	Bronchogenic SCC. Intraluminal mass at carina. Debulked with Nd-YAG laser and tube inserted	1	Good initial result. Inoperable tumour. Discharged home	Died 12 weeks
H	Male 64	Bronchogenic SCC with large intraluminal mass	1	Good initial result. Inoperable tumour. Discharged home	Died 21 weeks
I	Female 68	Anaplastic thyroid carcinoma Combined compression. Tube inserted when unable to maintain airway at diagnostic bronchoscopy	1	Good initial result, Terminal disease. Transferred to hospice	Died 8 weeks
J	Male 61	Oesophageal SCC invading posterior mid-trachea. Obstruction during palliative radiotherapy	2	Inoperable tumour. Discharged home. Developed pneumonia	Died 9 weeks

(SCC: squamous cell carcinoma.)

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per cent airway occlusion. The tumour was partially debulked using biopsy forceps and a poorly differentiated squamous cell carcinoma confirmed on histology.

Corticosteroids were given post-operatively to reduce inflammation. The patient's stridor was relieved but recurred over five days necessitating repeat bronchoscopy. The tumour was further debulked, but again, after initial improvement, her biphasic stridor recurred. Her condition deteriorated and a further bronchoscopy showed critical airway obstruction at the tumour site. The bifurcated distal end of a Westaby tube was trimmed and the tube inserted to relieve the obstruction. The stent was of narrow diameter (12F) and blocked off within 24 hours necessitating emergency removal and insertion of another tube of larger diameter (14F). The patient developed a post-operative pneumonia and required intermittent ventilatory support via the tube side arm over the following week. The tube became blocked four days later, was removed and another one of the same diameter inserted (Figure 3). This provided good relief of the patient's airway obstruction over the next three weeks. However, with her poor general condition, she developed tracheal candidiasis, and eventually succumbed following a massive tracheal bleed secondary to tumour erosion into a major thoracic vessel.

Case 2 (Case H from Table I)

A 64-year-old male with a left main stem bronchus squamous cell carcinoma, and left vocal fold palsy, developed progressive stridor 14 months after palliative radiotherapy. Bronchoscopy revealed an intraluminal tumour almost completely obstructing his left main stem bronchus and extending proximally to involve the carina and posterior tracheal wall. After initial tumour debulking, a Westaby tube was custom fitted by removal of its proximal end and right limb of the bifurcated distal end and inserted via a tracheostomy. He had an uneventful post-operative recovery with a dramatic improvement in his stridor and was discharged home one week later, self-caring for his tube and talking with the side arm plugged.

Discussion

Flow rate through a cylinder is inversely proportional to the fourth power of its radius. Thus, small reductions in airway diameter produce large reductions in airflow. This is why progressive upper airway obstruction not uncommonly presents late, often with rapid deterioration in the patient's condition and the extremely distressing symptoms of asphyxiation requiring urgent intervention.

Although rare causes of temporary airway inflammation can cause such airway obstruction, the underlying diagnosis is most commonly an inoperable malignancy. Only palliative care should be offered to such patients as their prognosis is almost universally dismal. However, other outcomes can often be improved with the use of a Westaby tube. These include:

(1) Quality of life: Avoiding endotracheal intubation obviates the need for intensive care and confinement to an acute hospital setting. Patients enjoy improved comfort, better ability to communicate with family, medical, and nursing staff, and retain the ability to feed orally. Patients can be cared for on the general ward, at home, or in a hospice. The distress that a patient's family has to endure may also be reduced for the same reasons.
(2) Appropriateness of care and cost: A substantial cost reduction to the care provider is achieved by avoiding intensive or high dependency care. This cost reduction may allow for the distribution of resources to other areas.

The otolaryngologist is frequently consulted in the emergency situation to manage complicated airway problems where endotracheal intubation may be impossible or undesirable, and a standard tracheostomy would be ineffective. The Westaby tube affords the opportunity to deal with such complicated airway problems, and relieve the patients of their distressing symptoms. In this series, seven patients had untreatable malignancies, which would have led to their rapid demise had stents not been inserted. Six of this group were discharged from hospital. Mean survival of this group was 12.3 weeks (range six to 21).

In the other group of patients with 'curable' diseases such as inflammatory conditions and treatable lesions causing external compression, the stent allows temporary airway bypass during treatment. Both patients in this series with treatable causes of airway obstruction (cases D and E) were successfully managed and are alive at most recent follow up (July 1998). As in the original case report of its use, (a patient with a tracheobronchial burn) (Westaby *et al.*, 1982) the Westaby tube, in these conditions, obviates the need for long-term endotracheal intubation or repeated surgical procedures to maintain airway patency, and should be regarded as the treatment of choice in such circumstances.

The authors' initial fears that such a long tube would easily block with secretions were unfounded. Tube blockage occurred in three cases. On each occasion, it was felt that this occurred at least partly because the side arm of the stent was left unplugged for prolonged periods causing crusting. In case A it appears that the initial tube selected was too narrow, as the subsequent insertion of a larger diameter tube was well tolerated. This tube also blocked, but at this stage the patient had poor respiratory effort, was unable to clear her own secretions, and required intensive care admission for ventilatory support.

Despite the lack of an epithelial lining, Westaby tubes rarely block when inserted in carefully selected patients. Our experience concurs with evidence previously reported (Montgomery, 1974; Westaby, 1985; Cooper *et al.*, 1989), that blockage of these types of tubes occurs because of a number of predictable factors: if the side arm is left unplugged, drying of secretions and crusting predisposes to blockage. This is more likely if a patient is unable to clear their own secretions due to poor expiratory

effort, production of excessive amounts of secretions from conditions such as chronic bronchitis, or a combination of both. Finally, smaller diameter tubes block more easily. As large a diameter tube as possible should always be chosen to prevent this but also to reduce airway resistance and to eliminate dead space between tube and the surrounding airway. Lack of an inner tube makes blockage more likely than with a standard tracheostomy tube. However, the tube can be readily inspected via the side arm using a fibre-optic nasopharyngoscope or bronchoscope. If the tube blocks off and cannot be cleared with suction, the stent can be quickly removed by pulling on the side arm. Urgent medical help should be sought as the patient is likely to require prompt tube re-insertion.

Westaby *et al.*, in their original paper (Westaby *et al.*, 1982) describe their stent as 'an extension of the Montgomery T-tube . . .' which Bill Montgomery first described in 1968 for the management of patients with subglottic stenoses (Montgomery, 1968). The Westaby tube has an advantage over the Montgomery T-tube in being able to deal with more distal airway obstructions by virtue of its Y-shaped distal extension. A wide range of stents are commercially available to deal with obstruction at different sites in the upper tracheobronchial tree. They differ in size, shape, and construct material, and choice of stent is determined mainly by the site of obstruction. The Westaby tube can be substituted for the majority of these stents by trimming it to custom fit the airway, and thereby bypass only the obstruction, while avoiding damage to the adjacent upper airway mucosa. This obviates the need to stock a large number of different tubes. The Westaby tube also allows external access to the airway and its own lumen, via its side arm. In the authors' opinion, this versatility makes the Westaby tube the best choice of commercially available stents.

Metal upper airway prostheses may cause a marked inflammatory reaction and granulation formation, particularly at the limits of the stents (Harkins, 1952; Pagliero and Shepherd, 1974). Silicone, an inert material, produces little inflammation, and unlike standard tracheostomy tubes it moulds better to airway contours by virtue of its shape and appears to produce less granulations. In this series, no troublesome granulation formation was observed despite intubation for as long as 18 months (case E), as has been reported in other series using silicone tubes (Montgomery, 1974; Westaby, 1985; Cooper *et al.*, 1989).

Unlike stronger, rigid, metal stents, which require a much larger tracheostomy for insertion, silicone is pliable. However, there were no instances where the tube became significantly compressed in situ. This appears to be because the continuity of the tube has always maintained at the site of obstruction allowing distribution of the constricting forces over all of its circumference.

The authors have had recent experience in the use of Nitinol (NDC, Fremont, CA) superelastic mesh stents for relief of airway obstruction. While these offer advantages of being easier to insert and thinner than silicone stents, they are permanent and fail to adequately deal with obstructions at, or around, the carina.

A number of points about insertion of this tube are important. Firstly, meticulous measurement of the airway is essential for accurate tube placement. Secondly, complications are avoided by a team approach with particular attention to close co-operation between anaesthetist and surgeon. As with any new procedure a learning curve exists but the authors have found it a safe and effective procedure and recommend its use by otolaryngologists. Finally, we recommend that any patient fitted with a Westaby tube should always have the silicone plug either sutured to the side arm or worn as a necklace to prevent loss which occurred in a number of earlier cases.

Conclusion

The authors have used the Westaby tube in 10 patients with complicated airway problems where a standard tracheostomy tube would be ineffective. It offers distinct advantages over other airway stents and the authors recommend its use by otolaryngologists in carefully selected patients.

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