British Journal of Plastic Surgery (1993), **46**, 32–35

BRITISH JOURNAL OF PLASTIC SURGERY

Reconstruction of the cervical trachea with a free forearm flap

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SUMMARY. **With the aim of voice restoration after repair of a total defect or obstruction of the cervical trachea, we developed a new method of total cervical tracheal reconstruction with a free forearm flap. The forearm flap is inverted to form a tube and then interposed between the subglottic trachea and an adjacent cutaneous fistula created at the upper portion of the tracheostoma. A permanent tracheostoma is preserved, and an L-shaped silicone tube is inserted in the reconstructed cervical trachea and the tracheostoma as a stent. In two patients, both became able to speak.**

Voice restoration is strongly desirable when the cervical trachea is defective or obstructed but the larynx is preserved.

Many procedures are available for reconstruction of extensive defects of the cervical trachea, but none is universally applicable because a total defect of the cervical trachea is difficult to reconstruct with a single autologous tissue. We present here a simplified method for voice restoration using a free forearm flap after permanent tracheostomy because of defect or obstruction of the total cervical trachea.

Operative method

Through an incision along the original operative scar or a U-shaped incision, scar tissue and crushed cartilages are excised and the end of the cervical trachea is exposed. The subglottic trachea is then opened. Recipient vessels, such as the facial or superior thyroid vessels, are simultaneously dissected and preserved. A forearm flap of the required size is then elevated, inverted to form a tube, and set in the defect between the opened subglottic trachea and the cutaneous opening at the midline of the upper portion of the tracheostoma. A permanent tracheostoma is preserved and a silicone tube is inserted in the reconstructed cervical trachea as a stent. The silicone tube is removed several weeks after the operation, and a permanent L-shaped silicone tube is inserted in the reconstructed cervical trachea and the tracheostoma (Fig. 1).

Case reports

Case 1

A 38-year-old male with an adenoid cystic carcinoma of the cervical trachea had undergone removal of 8 cm of the trachea between a point 2 cm inferior to the subglottis and another 2 cm above the carina. A tracheostoma had been

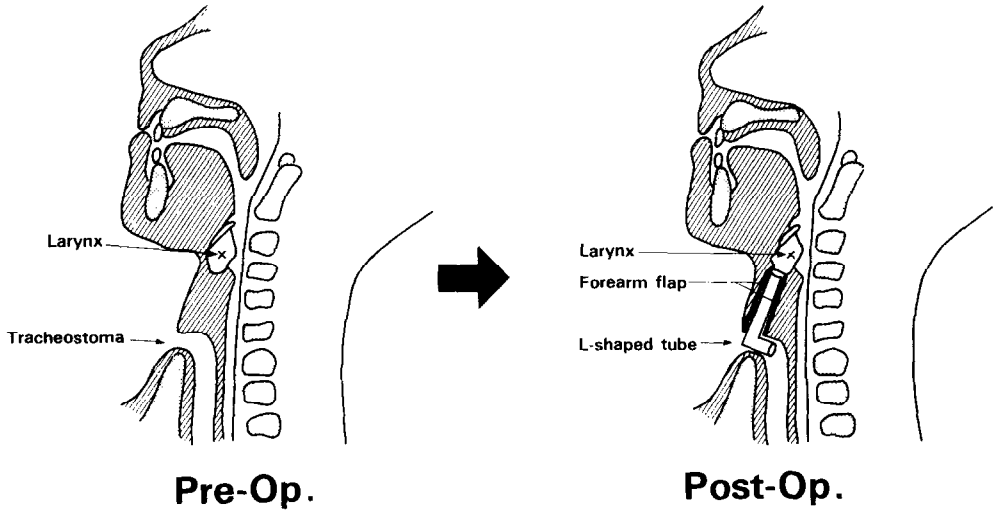

Fig. 1

Figure 1—Use of tubed forearm flap and L-shaped silicone tube is illustrated.

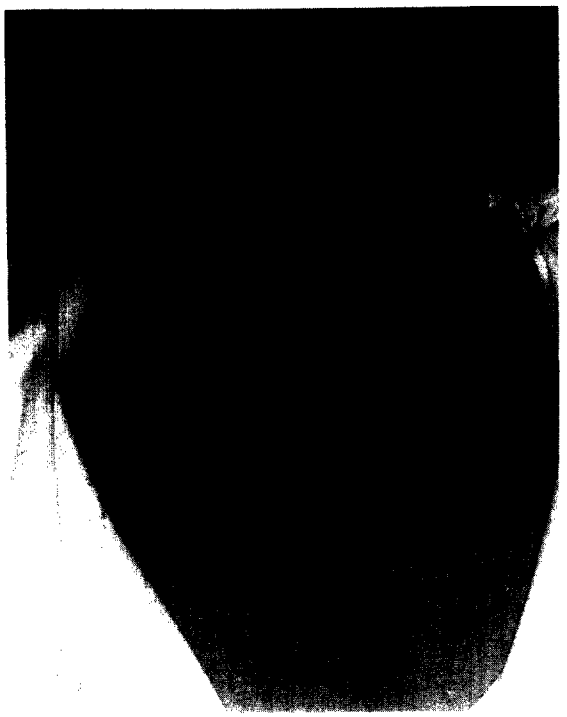

Fig. 2

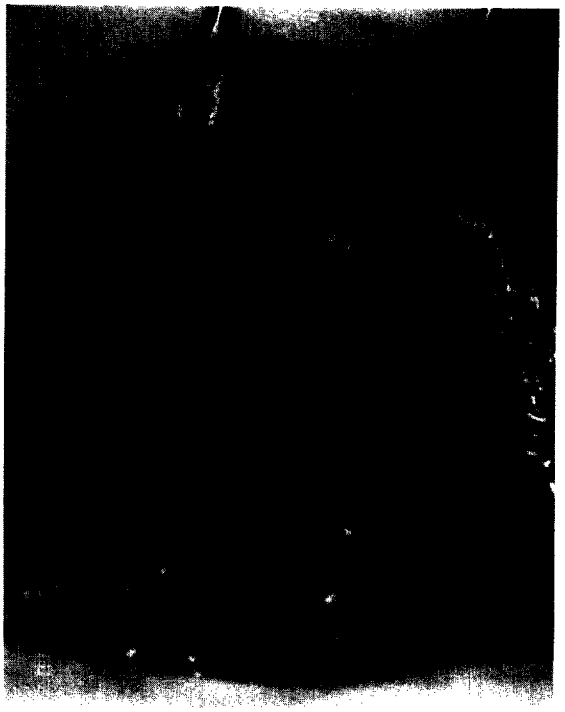

Fig. 3

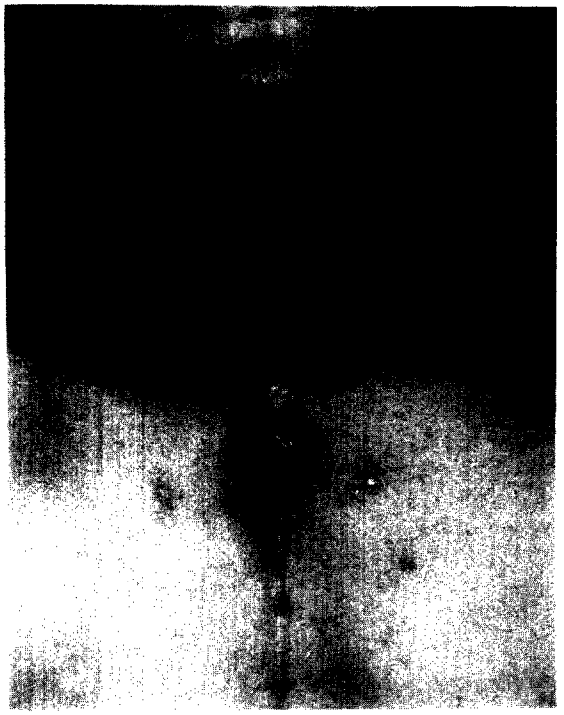

Fig. 4

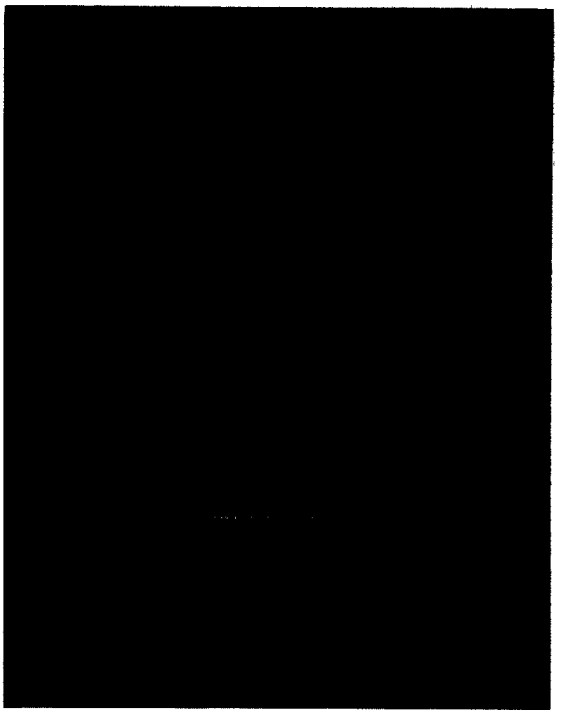

Fig. 5

Figure 2—*Case 1.* Preoperative view of a 38-year-old male with total cervical defect after tumour resection. Patient underwent tracheostomy at upper part of the sternum. **Figure 3**—Intraoperative view of tracheal defect. Arrow indicates subglottis. **Figure 4**—Postoperative anterior view of the cervical tracheal reconstruction at 1 month. **Figure 5**—An L-shaped silicone tube. It is inserted into reconstructed cervical trachea and tracheostoma.

created at the upper part of the sternum from which bone had been removed, and a free skin graft was placed between the surface skin and the end of the mediastinal trachea at another hospital (Fig. 2). He was admitted to our hospital where endoscopic examination showed the vocal cords to be moving. The cervical trachea was reconstructed with a 7×8 cm free radial forearm flap by the procedure already described. The radial vessels were anastomosed to the facial vessels. Two horseshoe-shaped cartilages fabricated from the 7th and 8th rib cartilages were grafted (Fig. 3). A silicone tube 13 mm in diameter was inserted to maintain the lumen. The tube was replaced with an L-shaped silicone tube 13 mm

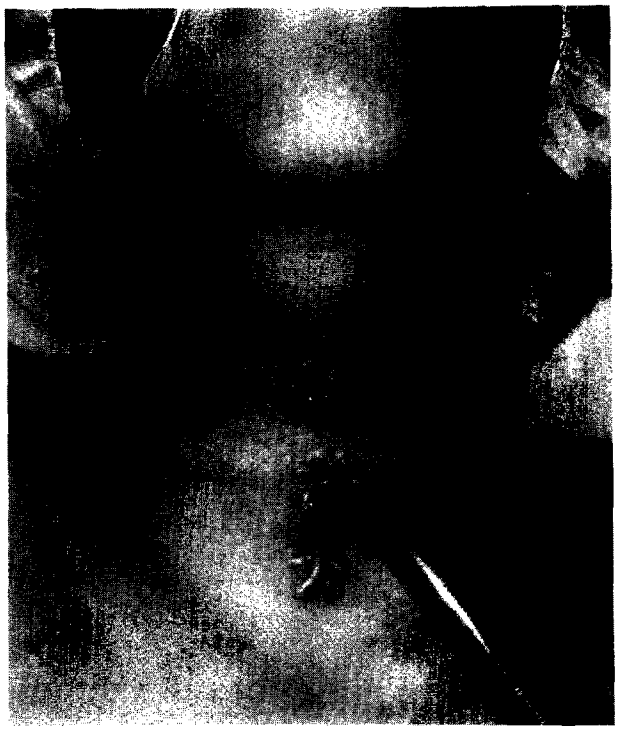

Fig. 6

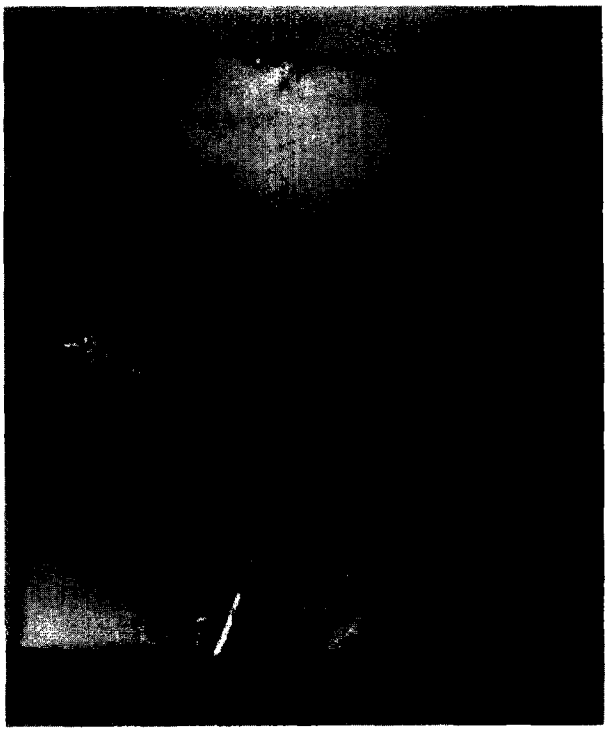

Fig. 7

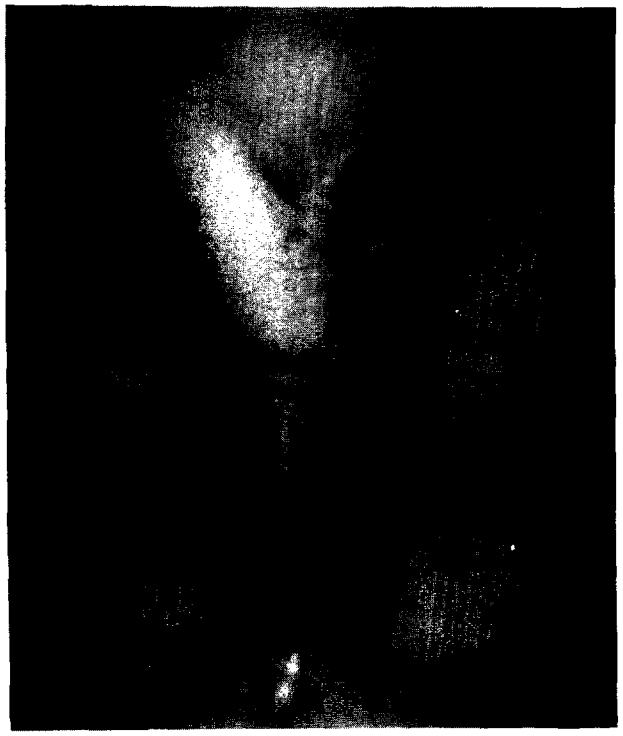

Fig. 8

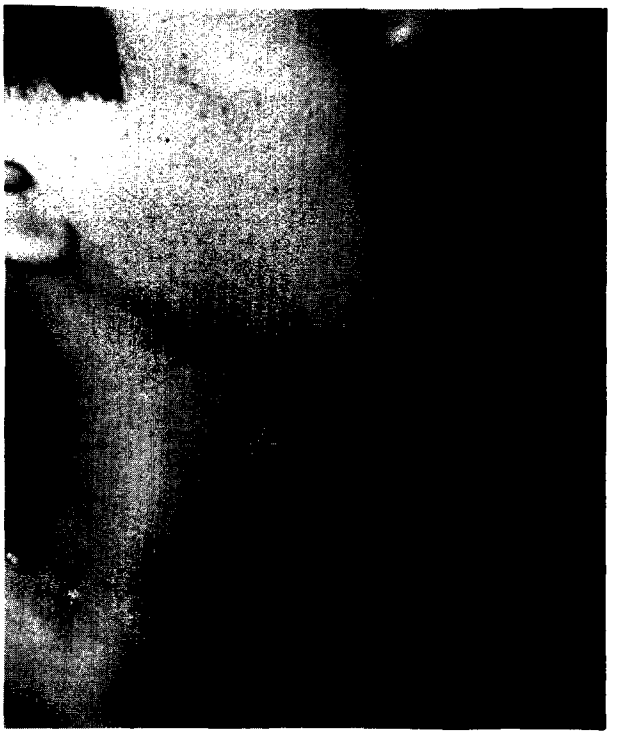

Fig. 9

Figure 6—*Case 2.* Preoperative view of 16-year-old male with total cervical obstruction after trauma. **Figure 7**—Cervical trachea is reconstructed with forearm flap and without cartilage graft. **Figure 8**—Postoperative anterior view at 4 months. **Figure 9**—Patient is capable of speech while blocking stent window with finger tip.

in diameter 4 weeks after the operation. The patient was able to speak almost normally after placement of the L-shaped tube (Figs 4, 5). He breathes comfortably, has a normal voice, and has returned to work.

Case 2

A 16-year-old male was admitted to our clinic after a motorcycle accident in which he was struck in the neck. An emergency endotracheal intubation was performed because of the sudden development of dyspnoea. Bilateral haemothorax was identified and a tracheotomy was performed. Two months later, NMR indicated complete occlusion of the total cervical trachea. Endoscopic examination revealed the vocal cords to be arrested in the intermediate position (Fig. 6). Five months later, a tracheostoma was created at

the upper end of the sternum. The occluded cervical area was opened and it was found that the cricoid cartilage and cervical trachea were crushed. After the scar and crushed cartilages were excised, the cervical trachea was reconstructed with a 6.0×6.5 cm radial forearm flap by the method described above (Fig. 7). One month after the operation, an L-shaped tube with a round window at the angle was inserted to replace the silicone tube stent. He was able to take food without leakage of saliva and food particles into the trachea. Some fluid flows into the trachea when he drinks, but he can easily expel it from the window of the stent. He can speak while closing the window of the stent with a finger tip (Figs 8, 9). Because of the cord paralysis his speech is aphonic but he can speak with a turbulent noise sound source. He breathes comfortably and has returned to work.

Discussion

Long tracheal defects caused by stricture and neoplasm can be difficult to reconstruct. Various methods of reconstruction have been performed, with varying success. These include resection and primary anastomosis (Grillo, 1965, 1983), periosteal flap from the chest wall (Narodick *et al.*, 1964), transposition of the hyoid bone on the sternohyoid muscle (Eliachar *et al.*, 1979), composite costal cartilage-perichondrium grafts (Pashley *et al.*, 1984), superiorly based sternocleidomastoid myocutaneous flap (Eliachar and Moscona, 1981), bone, cartilage, and strap muscle grafts (Whited, 1984), thyroid cartilage as a myochondrial flap based on the sternothyroid muscle (Fry *et al.*, 1985), vascularised iliac bone graft carrying a skin graft (Kambic *et al.*, 1986), free jejunal transfer (Jones *et al.*, 1986), and a tubed pectoralis major myocutaneous flap (Fleischer and Khafif, 1989). These method are mainly used in cases of laryngotracheal stenosis. Satisfactory results achieved in the case of patients with limited defects are not matched by those of circumferential total reconstruction of the cervical trachea. In the cervical region, skin tubes created from cervical local flaps can be tailored to replace a tracheal defect (Konno *et al.*, 1976; Hirose *et al.*, 1986). Plastic rings or cartilages have been incorporated within the wall of the neotrachea to provide these tubes with the required rigidity (Keim and Newark, 1970). Since the cervical trachea is very flexible and exposed to secretion from the oral cavity and trachea, a foreign body faces the hazards of exposure, and rib cartilages or bone do not have flexibility. After 1 or 2 years, a tracheal wall made from a skin flap becomes soft and there is the possibility of tracheal stenosis. A costal cartilage graft was used in our first case, but it was not able to maintain the cervical airway without the silicone tube stent. As a silicone tube is required to support the lumen of the reconstructed trachea, we do not believe any longer that cartilage grafts are necessary.

Our operative method is relatively simple, involves one-stage reconstruction, and can be useful when recurrent nerve paralysis is also present. Restoration of voice is rapid following the operation, without complicated rehabilitation. There is no risk of airway obstruction because a silicone tube supports the lumen of the reconstructed trachea and preserves the tracheostoma. The disadvantage of this method is that the tracheostoma cannot be closed and a permanent silicone stent is required which must be cleaned every day.

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Paper received 24 February 1992.
Accepted 18 May 1992, after revision.