

Results of reconstruction with free forearm flap following laryngopharyngo-oesophageal resection

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Abstract

The main challenge after total laryngopharyngeal and cervical oesophageal resection for laryngopharyngeal carcinoma, is to provide a suitable feeding conduit which improves the quality of life for the patient. Reconstruction with a tubed free forearm flap can solve the feeding problem to some extent, providing a thin and pliable fasciocutaneous conduit that accommodates well with the thin mucosa of the pharynx and oesophagus.

In this study immediate reconstruction of the pharyngo-oesophagus by free forearm flaps is reported in nine patients with advanced laryngopharyngeal and oropharyngeal carcinoma. The vascularization of the flap is very good, thus rendering this flap to be reliable. The average time for the commencement of oral feeding was 16 days. There was one flap failure (11 per cent), due to venous thrombosis which was replaced by a deltopectoral flap. Long term stenosis did not occur because of the two triangles created at the distal end of the flap which were inserted to the opposite triangular defects at the proximal oesophageal stump.

Donor site morbidities were minimal and scarring of the forearm was acceptable for all the patients.

Key words: Hypopharyngeal neoplasms; Surgical flaps

Introduction

In order to search for an ideal reconstruction of the pharynx and cervical oesophagus different kinds of flaps have been utilized, but it is still a challenge for the head and neck surgeon to reconstruct the defect following total laryngopharyngectomy and cervical oesophagectomy for advanced carcinoma of the laryngopharynx. Among the reconstructive methods, free flaps have gained much popularity in recent years and the success rate with this kind of reconstruction has increased with the developments in microvascular techniques.

For many years staged cervical flaps, deltopectoral flaps, myocutaneous flaps and parts of the alimentary tract have been used for reconstruction of the pharyngo-oesophagus. Cervical flaps are multi-staged and fistula or stricture problems inhibited their use for pharyngo-oesophageal reconstruction (Carpenter *et al.*, 1979). A two-staged method of reconstruction with a medially based deltopectoral skin flap was first introduced by Bakamjian in 1965. However, a high rate of complications and flap necrosis with deltopectoral flaps were reported when the flap was tubed for pharyngo-oesophageal reconstruction (Gilas *et al.*, 1986). Fistulae and stricture problems were also encountered with this flap

(Carpenter *et al.*, 1979). The introduction of the pectoralis major flap by Ariyan has contributed a great deal to head and neck reconstruction (Ariyan, 1979). Nevertheless, experience has shown that this flap was not ideal for reconstruction of the pharyngo-oesophagus (Schuller, 1985; Rees *et al.*, 1986). Transposition of a segment of the alimentary tract is still preferred by some centres; however morbidity and mortality rates are relatively high because of the potential for vascular insufficiencies of the transposed viscera (Shaw, 1976; Harrison, 1991).

With the successful transplantation of a revascularized jejunal segment in a 63-year-old man for a recurrent squamous cell carcinoma of the cervical oesophagus, Seidenberg opened a new era in the field of pharyngo-oesophageal reconstruction (Seidenberg *et al.*, 1959). So far, the success rate has varied from 80 per cent to 97 per cent in different centres with free jejunal autograft reconstruction (Fisher *et al.*, 1985; Gluckman *et al.*, 1985; Flynn *et al.*, 1989; Shangold *et al.*, 1991).

Originally described by Song, the free forearm flap has been used for defects following resection of the laryngopharynx and cervical oesophagus (Song *et al.*, 1982; Pech *et al.*, 1984; Harii *et al.*, 1985; Evans and Lampe, 1987; Takato *et al.*, 1987; Delaere *et al.*,

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TABLE I
RESULTS OF FREE FOREARM FLAP RECONSTRUCTION IN LARYNGOPHARYNGEAL CARCINOMA PATIENTS

Case (Age, Sex)	Lesion (TNM)	Surgery	Radiation	Complications	Post-operative oral feeding time	Follow-up
1 (36,F)	Hypopharynx (T2N0M0)	TLFO, ND, tubed FFF	6000 rads post-operative	Recurrence at oesophagus; chemotherapy begun	10 days	Dead, 28 months
2 (56,F)	Hypopharynx (T2N1M0)	TLFO, ND, tubed FFF	6000 rads post-operative	Internal fistulae; healed with conservative treatment	18 days	Alive, NED 36 months
3 (58,M)	Oropharynx (T3N0M0)	Partial oropharyngectomy, ND, patched FFF	5500 rads post-operative	Aspiration, total laryngectomy done	35 days	Alive, lung metastases 31 months
4 (53,M)	Larynx invading pyriform sinus (T4N1M0)	TL, PF, ND, Patched FFF	6000 rads post-operative	Fistula; healed with conservative treatment	24 days	Alive, NED 30 months
5 (48,F)	Hypopharynx (T2N1M0)	TLFO, ND, tubed FFF	—	Venous thrombosis and flap necrosis; replaced with deltopectoral flap	—	Dead; regional metastases 3 months
6 (60,F)	Hypopharynx (T3N1M0)	TLFO, ND, tubed FFF	6000 rads post-operative	None	10 days	Alive, NED 29 months
7 (51,F)	Hypopharynx (T2N0M0)	TLFO, ND, tubed FFF	6000 rads post-operative	None	10 days	Alive, NED 24 months
8 (36,F)	Hypopharynx (T3N0M0)	TLFO, bilateral ND, tubed FFF	5500 rads pre-operative	Fistula; carotid blow-out	—	Dead 10th day
9 (45,F)	Hypopharynx (T3N1M0)	TLFO, bilateral ND, tubed FFF	6000 rads post-operative	None	10 days	Alive, NED 16 months

TLFO : Total laryngopharyngectomy and cervical oesophagectomy.

PF : Partial pharyngectomy.

ND : Neck dissection (Radical or functional).

FFF : Free forearm flap reconstruction.

NED : No evidence of disease

1988). The radial forearm flap is a thin and pliable fasciocutaneous flap which is easy to suture to the thin mucosa of the pharynx and oesophagus, where excessive bulk of tissue is not needed. The large calibre of vessels and a rich blood supply ensures the reliability of the reconstruction (Harii *et al.*, 1985). The free forearm flap is easily harvested while another team is resecting the tumour. The absence of an abdominal and/or thoracic surgery decreases the mortality and morbidity of the patient.

Materials and methods

This study reflects an analysis of seven hypopharyngeal, one oropharyngeal and one laryngeal carcinoma which had invaded the pyriform sinus and lateral pharyngeal wall. There were two male and seven female patients and the age range was 36–60 years. All the tumours were staged according to the American Joint Committee on Cancer (AJCC) classification (AJCC, 1987). Total laryngopharyngeal and cervical oesophageal resections were performed in seven patients. Partial pharyngeal resection was added to total laryngectomy in one patient and oropharyngeal resection was performed in the remaining patient. The defects were reconstructed with tubed free radial forearm flaps in seven and with patched flaps in the remaining two patients. Bilateral neck dissections were performed in all patients (Table I).

Operative technique

Before the elevation of the radial forearm flap, an Allen test and Doppler ultrasound were used to ensure the patency of the ulnar artery. The trapezoidal-shaped forearm flap was elevated with a long pedicle consisting of radial artery and cephalic vein (Figures 1 and 2). The distal end of the flap was prepared as two triangles in order to create a larger lumen, as described in an earlier paper (Akin *et al.*, 1994).

The flap was then tubed and left in place (Figure 3) until the other team completed the neck dissections and resection of the tumour. As soon as this

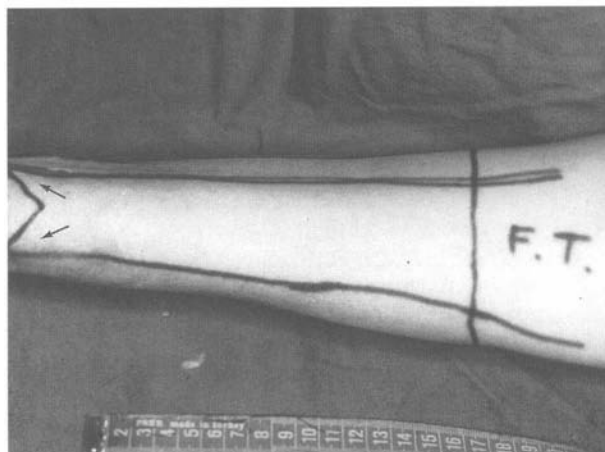


FIG. 1

Design of the trapezoidal shaped forearm flap. Note the triangles at the distal end (arrows).



FIG. 2

The forearm flap after elevation. Arrows show the vascular pedicle.

was accomplished, the vessels in the pedicle were transected and the flap was placed into the recipient site. End to end microvascular anastomoses were performed under an operating microscope with 9-0 monofilament sutures. The proximal end of the flap was sutured to the pharyngostoma. At the distal end, two triangles were sutured to the opposing triangular defects at the oesophagostoma. A smaller patched flap was elevated to cover the defect after the resection of tumours in *Cases 3 and 4*.

Oesophagograms were taken on the 10th post-operative day and an oral soft diet was given, if no fistula or pouch was observed (Figures 4 and 5). The viability of the flaps was monitored endoscopically after the operation (Figure 6). Post-operative radiotherapy was given to the patients between the third and sixth post-operative weeks except *Case 8* who had pre-operative radiotherapy.

All patients were followed-up for a minimum of three and a maximum of 36 months.

Results

Recurrence at the proximal end of the oesophagus was observed in the first patient with hypopharyn-

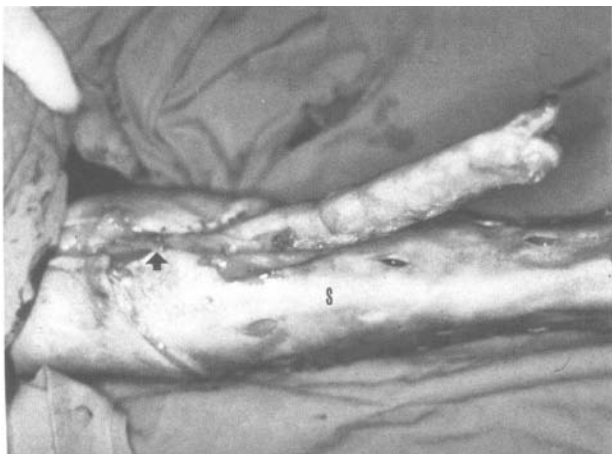


FIG. 3

The forearm flap after tubing. The vascular pedicle is not transected until the tumour is resected (arrow). S: Defect on the forearm is covered by split thickness.

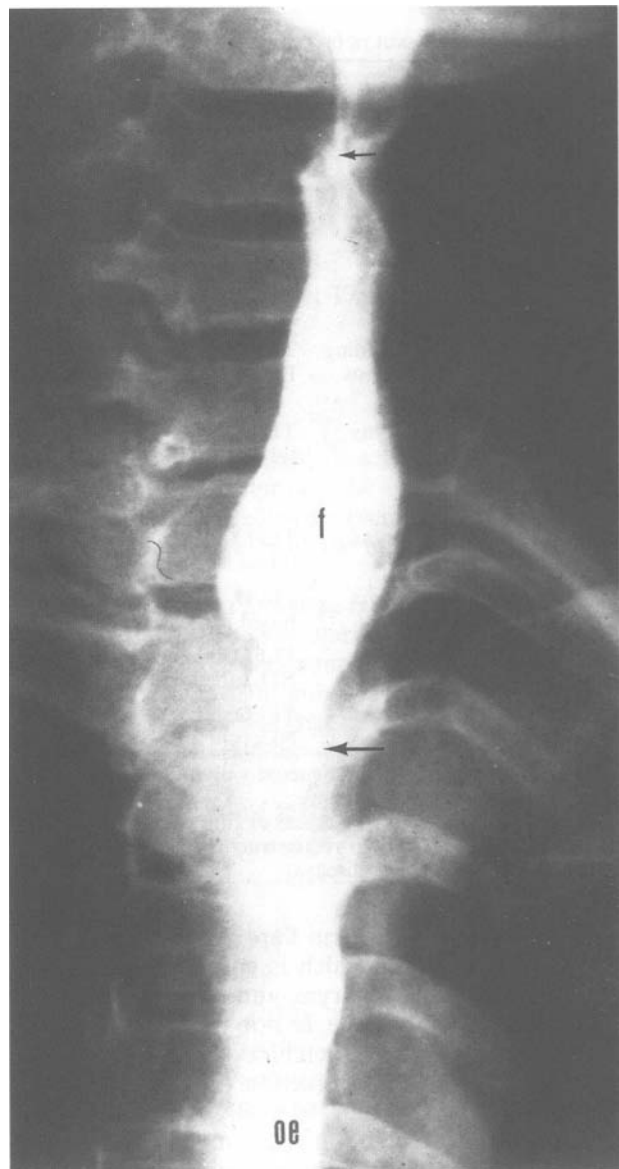


FIG. 4

Barium swallow roentgenogram taken six months post-operatively of *Case 6*. f is indicating the forearm flap between two arrows. oe: Oesophagus.

geal carcinoma, 20 months after the operation (Table I). She was given six courses of chemotherapy and died eight months later. In the second patient an internal fistula occurred at the upper anastomosis line, the week following the operation. This was resolved with conservative treatment and the patient began oral feeding on the 18th post-operative day. The patient is alive 36 months after the operation. The defect was reconstructed with a patched free forearm flap in the patient with oropharyngeal carcinoma (*Case 3*). Aspiration occurred post-operatively and this patient had to undergo a total laryngectomy who weeks after the operation. In another patient, a pharyngocutaneous fistula originating from the upper anastomotic site was healed with conservative treatment and oral feeding was commenced at the 24th post-operative day (*Case 4*). A flap failure due to venous thrombosis 48 hours after the operation occurred in the fifth patient. This

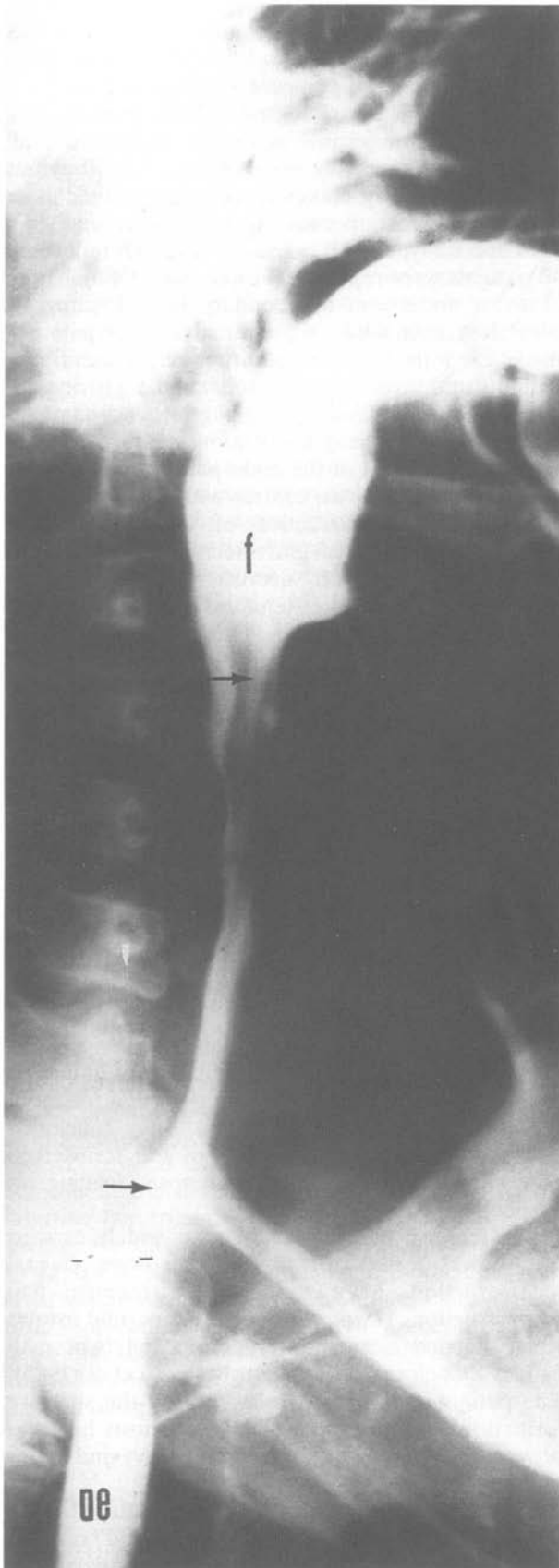


FIG. 5

Barium swallow roentgenogram in *Case 1* taken ten days post-operatively. The forearm flap is seen between two arrows. f indicates pharynx; oe oesophagus.

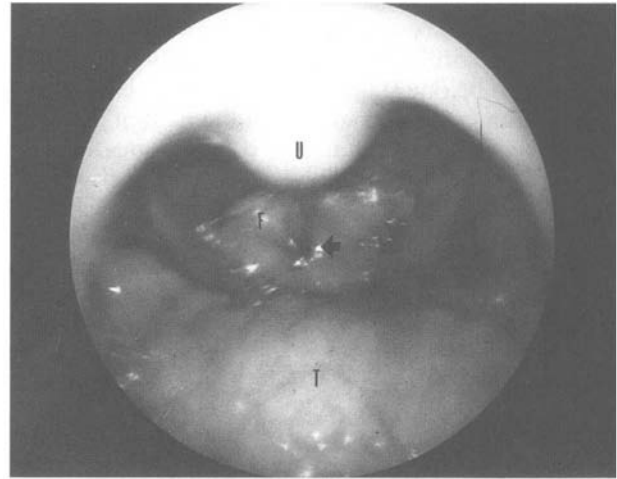


FIG. 6

Endoscopic view of the forearm flap. U indicates uvula; T-tongue base; and F-forearm flap. The lumen of the flap is clearly visible (arrow).

led to necrosis of the forearm flap which was replaced with a deltopectoral flap. The patient was discharged with a nasogastric tube in the oesophagus. The patient died three months later because of excessive bleeding from her stoma due to regional metastasis. Another patient (*Case 8*), who had had pre-operative radiotherapy, developed a major fistula originating from the upper anastomosis line in the week following the operation. This led to carotid artery rupture and death of the patient on the 10th post-operative day. The post-mortem examination revealed that the microvascular anastomoses were patent.

Six patients are alive with functioning flaps by the time this study is written. The results of reconstruction were successful in eight out of nine flaps (89 per cent). All the patients are on normal diet without any complaint of dysphagia. There was no long term stenosis in any of the living patients. The average time for the patients to begin a soft diet was 16 days. Hand morbidities were minimal but almost all patients complained of hypoesthesia of the thumb which gradually diminished after six months. The donor site scar was acceptable for all the patients.

Discussion

Although microvascular surgery has improved with new reconstruction techniques and the use of free flap reconstruction has gained wide acceptance, there are still challenging problems in major surgery of the laryngopharynx and cervical oesophagus. Experienced teamwork is of utmost importance in order to overcome these problems. One of the aims of surgery for laryngopharyngeal carcinoma is to provide safe margins with dissection of the lymphatic areas through which the tumour may spread. The other important aim is to choose the best reconstructive method to form a new feeding conduit.

In the past, multiple procedures have taken months to create a feeding tube and as a consequence of this lengthy hospitalization period, the

remaining quality of life of the patients has been reduced. According to Carpenter, ideally reconstruction should be one stage, allow adequate resection of the tumour, employ tissue out of the field of any pre-operative radiation, require no simultaneous abdominal or thoracic surgery and allow healing without undue morbidity from complications (Carpenter *et al.*, 1979). Furthermore, some authors stress the importance of the time required to complete a hypopharyngeal reconstruction, especially if one is *considering the use of post-operative irradiation* (McConnel *et al.*, 1981).

Carpenter reported a series of 13 patients who needed an average of three operative procedures and 60 days with a range of 25–210 days for hypopharyngeal reconstruction with cervical flaps. In this series, another 17 patients who had deltopectoral flap reconstruction required an average of four operative procedures; the range being two to 15 operations. The average time for completion of reconstruction for these 17 patients was 68 days with a range of 30–330 days.

The colon interposition of 14 patients required an average of 33 days with a range of 15 to 90 days for completion of reconstruction. Patients who had colon interposition required an average of two operative procedures for reconstruction, with a range of one to six operations (Carpenter *et al.*, 1979).

In comparison to these previously mentioned flaps, hospitalization time has decreased sharply with the free flap transfer. It is reported that the average time taken for the patient to be able to swallow was 12 days with free jejunal grafts (McConnel *et al.*, 1981). In another report, Gluckman mentioned the importance of early rehabilitation with free jejunal graft reconstruction of the pharyngo-oesophagus which is a single-stage procedure (Gluckman *et al.*, 1985). These patients' average hospital stay was 18 days.

Similarly to the above results, the average time to begin oral intake was reported to be eight days with the free forearm flap for hypopharyngeal reconstruction (Deleare *et al.*, 1988). Pech mentioned five hypopharyngeal tumours which were reconstructed by free forearm flaps (Pech *et al.*, 1984). Their post-operative oral feeding time was an average of 21 days. Although they did not give an average time for 33 hypopharyngeal tumours with free forearm flap reconstruction Takato *et al.* reported that fluids were given after barium swallow roentgenograms two weeks post-operatively if no sign of fistula was detected (Takato *et al.*, 1987).

Free bowel transfer is a very reliable method, but its combination with abdominal surgery is the drawback of this reconstruction. Complications from the intraabdominal donor site occurred in six per cent of patients in a study with free bowel autograft reconstruction after resection for carcinoma of hypopharynx (Flynn *et al.*, 1989).

In a review of 555 cases with free jejunal transfers to the hypopharynx, abdominal wound dehiscence, bowel obstruction and gastrointestinal haemorrhage were the most common complications and the

overall incidence of abdominal complications was 5.8 per cent (Shangold *et al.*, 1991). According to this literature review 18 per cent fistulae, 10.9 per cent stricture and 8.9 per cent graft failures occurred in a total of 672 free jejunal autografts and the overall perioperative mortality was 4.4 per cent. Previous abdominal surgery makes the operation difficult or may cause a post-operative ileus (Harii *et al.*, 1985).

In one study, eight free jejunal autograft failures in 40 patients were reported (Fisher *et al.*, 1985). Three of them underwent a secondary jejunal autograft transplantation, while of the remaining five patients, three died in the perioperative period and two patients underwent a gastrostomy and a gastric pull-up procedure. Infection of the graft, secondary to fistula formation, was the leading cause of jejunal graft failures in six of the eight patients.

The results from two centres with 52 cases of free jejunal graft reconstruction of the hypopharynx revealed four cases of graft necrosis (Gluckman *et al.*, 1985). The graft necrosis was successfully replaced by a portion of jejunum in one patient but the remaining three died. They had five fistulas which healed spontaneously, six stenosis, one redundant-bowel syndrome and two functional disturbances which led to gastrostomies.

In another study, post-operative deaths in three patients (eight per cent), which represented the consequences of graft failure in two and massive haemorrhage at the intraabdominal donor site in one patient were reported (Flynn *et al.*, 1989). In this study 19 patients experienced dysphagia and 13 of them were examined radiographically for swallowing dysfunction. The findings included dysfunction secondary to resection in six patients, stricture in five, dysmobility and graft diverticulum in the other two patients.

With the experience of 17 patients that had undergone free jejunal transplantation it was found that solid food dysphagia, regurgitation of liquids or transient difficulty in swallowing persisted for more than one year (Harii *et al.*, 1985). They concluded that this was a hyperperistalsis of the transferred bowel which resulted in a stenosis leading to dysphagia.

The forearm flap has not been as widely used as free bowel transplants for pharyngo-oesophageal reconstruction. In a series of 12 forearm flap reconstructions Harii reported two persistent fistulas which needed surgical intervention and two small fistulas that closed spontaneously (Harii *et al.*, 1985). The patients had no stenosis, because the stricture formation at the oesophageal anastomosis line was prevented by making the suture line wavy and larger in diameter.

In another report of 33 radial forearm flaps for the reconstruction of the hypopharynx and cervical oesophagus, one partial necrosis, two persistent fistulas, four small fistulas and five stenosis of the oesophageal anastomosis were observed (Takato *et al.*, 1987). Later in their experience the stenosis problem was overcome by using the Z-plasty technique at the oesophago-cutaneous anastomosis line.

In another study, the authors reported no flap necrosis with the radial forearm flap for hypopharyngeal reconstruction in nine patients (Delaere *et al.*, 1988). The only death resulted from a cerebral complication after the replacement of the forearm flap by a colon-loop interposition for a recurrent hypopharyngeal carcinoma.

In our series there was one flap failure (11 per cent) due to venous thrombosis which was replaced by a deltopectoral flap. Therefore, our success rate for transplantation of the flap is nearly 89 per cent. There were no strictures or swallowing problems with our patients and oral feeding was begun at an average of 16 days. In our experience stenosis at the lower anastomosis may be prevented by inserting two triangles to the oesophagostoma. The overall operation time decreased from 12 hours to eight hours, as the experience of our team increased.

Morbidities of the donor hand is minimal, except for a small hypoaesthetic area on the dorsum of the thumb, due to severance of the lateral cutaneous antebrachii nerve (Harii *et al.*, 1985). In our patients the hypoaesthesia on the dorsal surface of the thumb gradually disappeared after the operation. Evans reported delayed healing with exposure of one or more flexor tendons in two patients (Evans and Lampe, 1987). The wounds granulated and epithelialized within four weeks with no loss of function in this series.

Conclusion

When the low survival of hypopharyngeal tumours is considered, a method which has relatively low complications, morbidity and mortality that increases the quality of the remaining life of the patient should be used in order to reach the goals of reconstruction of the hypopharynx and cervical oesophagus.

Free radial forearm flap reconstruction for laryngopharyngeal tumours is preferred by our team and as more experience is gained, the overall operating time decreased from 12 hours to eight hours. Stenosis at the lower anastomosis is prevented by inserting two triangles to the oesophagostoma. The average time for oral intake after the operation was 16 days. The lack of abdominal and thoracic surgery is an important advantage, which keeps the patient from the complications of these procedures. We think that the free radial forearm flap is a reliable kind of reconstruction after laryngopharyngeal and cervical oesophageal resection.

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