ORIGINAL PAPER

# Functional outcomes in patients reconstructed with flaps following surgery for hypopharyngeal cancer

## *Risultati funzionali in pazienti sottoposti a ricostruzione con lembi dopo chirurgia demolitiva per cancro dell'ipofaringe*

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Hypopharynx cancer • Surgical treatment • Reconstructive surgery • Swallowing • Speech

Parole chiave

*Tumori dell'ipofaringe • Chirurgia ricostruttiva • Deglutizione • Fonazione*

Summary

Following oncologic surgery for advanced cancer of the hypopharynx, primary closure of the defect of the upper aerodigestive tract is difficult to achieve. Usually locoregional or free flaps are used, the choice being determined by the extent of the surgical defect, the expertise of the surgeons and the general condition of the patient. Aim of the present study was to evaluate the functional recovery of patients who underwent surgical reconstruction, following hypopharyngeal cancer resection, with pedicled or free flaps. A retrospective analysis was conducted examining hospital records of the patients submitted to surgical treatment for hypopharyngeal cancer and reconstruction with pedicled or free flaps in the period between January 1995 and July 2004. Free flaps showed less severe complications, shorter hospital stay, less time to resume oral feeding compared with pedicled flaps. For this reason, we consider free flaps the gold standard for hypopharyngeal reconstruction, while pedicled flaps as the *pectoralis major* or other locoregional flaps should be used in those cases in which free flap reconstruction is not feasible or contraindicated.

*Riassunto*

*La chiusura di prima intenzione dei difetti delle alte vie digestive conseguenti a chirurgia demolitiva per i carcinomi avanzati dell'ipofaringe è difficile da realizzare. Di solito vengono utilizzati per la ricostruzione lembi locoregionali o lembi liberi, la cui scelta è determinata dall'estensione del difetto chirurgico, dalle capacità tecniche del chirurgo e dalle condizioni generali del paziente. L'obiettivo del nostro lavoro è quello di valutare il recupero funzionale dei pazienti che sono stati sottoposti a interventi di ricostruzione con lembi liberi oppure peduncolati in seguito a interventi demolitivi per cancro dell'ipofaringe. È stata condotta un'analisi retrospettiva dei pazienti sottoposti a trattamento chirurgico per cancro dell'ipofaringe e quindi a ricostruzione con lembi liberi o peduncolati nel periodo compreso tra gennaio 1995 e luglio 2004. I lembi liberi, rispetto a quelli peduncolati, hanno mostrato un minor numero di complicanze, una degenza più breve e un tempo minore per la ripresa dell'alimentazione orale. Per questa ragione, noi consideriamo i lembi liberi come gold standard per la ricostruzione dell'ipofaringe, mentre i lembi peduncolati, come quello di gran pettorale o altri lembi locoregionali, possono essere utilizzati quando non sia possibile o sia controindicata la ricostruzione con lembo libero.*

## Introduction

Hypopharyngeal cancer is associated with a poor prognosis, even when managed in a multidisciplinary setting [1].

While small lesions can be treated by radiotherapy alone, more advanced tumours require a combined approach of surgery and radiotherapy. Resection frequently includes the entire larynx with a portion of the hypopharynx thus resulting in a severe anatomical and functional defect.

Primary closure of the hypopharyngeal defect can rarely be achieved and soft tissue reconstruction is required to minimize the difficulties with, and to provide the right environment for voice restoration [2,3].

Reconstruction can be achieved with locoregional or free flaps, the choice being determined by the extent of the surgical defect, the technical expertise of the surgeons and the general conditions of the patient. The optimal reconstructive procedure would restore speech, swallowing and breathing in a single stage.

Small pyriform sinus defects can be closed primarily using the mucosa of contralateral pyriform fossa. In this case, in fact, the diameter of the neopharynx allows good swallowing to be restored. In early tumours of the posterior wall of hypopharynx, a wide

circumferential or partial excision is made followed by reconstruction with a thin, pliable free flap, usually a radial forearm flap. In the case of circumferential hypopharyngeal reconstruction the main options include the free jejunal, free ileocolic flap, free radial forearm flap and the *pectoralis major* [4-8].
Aims of the study was to evaluate the post-operative course and functional recovery of patients submitted to surgical reconstruction following hypopharyngeal cancer resection with free or pedicled flaps.

## Patients and methods

A retrospective analysis was conducted examining the hospital records of the patients operated for hypopharyngeal cancer and reconstructed with pedicled or free flaps at our Institution in the period between January 1995 and July 2004.
The following parameters were assessed:
- clinical staging of the tumour according to TNM classification [9] (Table I);
- type of surgery and reconstruction;
- early (within the first 15 days of surgery) and late surgical complications;
- length of hospital stay;
- median weight variation in the treatment period (evaluated as pre-operative weight, post-operative weight at 6 and 12 months after surgery);
- ability to orally feed at discharge and at 6 and 12 months post-operatively and the type of diet (classified as liquid, soft or free diet);
- type and quality of voice production, evaluated according to Mendelsohn's scale [10-26].

Student's t test was used to evaluate the differences between the data from the two groups.

## Results

A total of 67 patients (64 male, 3 female), age 45-77 years (mean 58.9, median 60) were suitable for inclusion in this study. Clinical staging of the hypopharyngeal tumour is outlined in Table I.
All underwent reconstruction following total laryngectomy and partial or circumferential resection of the pharynx for squamous cell carcinoma of the hypopharynx (Table II). Of these patients, 12underwent reconstruction with pedicled flaps (group A), while in the other 55 cases, reconstruction was conducted with a free flap (group B) (Table III). All the patients in whom pedicled flaps were used, in the reconstruction, presented vascular or abdominal contraindications for the harvesting of a free flap.
Post-operative survival was 97%. One patient dying on the 3rd and another on the 24th post-operative day, due to cardiovascular complications.
Free flap necrosis was the main complication that occurred in 5 of the 54 patients in group B (9.5%): one partial necrosis of a jejunum flap, treated with resection of the necrotic tissue, one total necrosis of a jejunum flap, treated with harvesting of a second jejunum flap, while in the other 3 cases (1 lateral thigh and 2 jejunum flaps), the necrotic flap was removed and a *pectoralis major* flap was used to reconstruct the hypopharyngeal tract.
Post-operative complications occurred in 10 of the 14 patients (71.3%) of group A, and in 15 of the 51 patients (29.4%) of group B (Table IV), the difference between the 2 groups being statistically significant. The main complication in the group A was salivary fistula which occured in 8 patients. In 4 cases, healing was obtained with conservative treatment while in the other 4 cases a local flap or a second *pectoralis major* flap was necessary to close the fistula.

**Table I.** Clinical staging.

| Stage | No. of patients |
|---|---|
| I | - |
| II | 6 |
| III | 6 |
| IVA | 52 |
| IVB | 3 |
| Total | 67 |

**Table II.** Surgical treatment of the patients considered.

| Type of surgery | No. of patients |
|---|---|
| Hemipharyngectomy + total laryngectomy | 15 |
| Circumferential pharyngolaryngectomy | 40 |
| Circumferential pharyngolaryngectomy + resection of nearby structures (tongue base, thyroid) | 8 |
| Circumferential pharyngectomy* | 4 |
| Total | 67 |

* Patients already laryngectomized.

**Table III.** Type of reconstruction.

| Loco-regional flaps (Group A) | No. of patients |
|---|---|
| Rotational flaps | 1 |
| *Pectoralis major* | 9 |
| *Latissimus dorsi + pectoralis major* | 1 |
| *Latissimus dorsi* | 1 |
| Total | 12 |
| **Free flaps (Group B)** | |
| Jejunum | 47 |
| Forearm | 5 |
| Lateral thigh | 2 |
| Total | 55 |

The mean length of hospital stay was 23.6 days (range 12-41) in group A and 19.2 days (range 9-46) in group B; the difference being statistically significant.

The time taken to resume oral feeding in the 2 groups is shown in Table V. Analysis at the time of discharge was conducted on 14 patients in group A (1 patient died on the 3rd post-operative day, while 3 patients in the group B underwent reconstruction with a pedicle flap after necrosis of the freee flap) and 51 patients in the group B (1 patient died on the 24th post-operative day and 3 flaps failed). At this time, 1/14 (7.1%) patients in group A, and 9/51 (17.6%) patients in group B had resumed a normal diet; 7/14 (50%) patients in group A, and 35/51 (68.6%) patients in group B were able to tolerate a soft diet; while 3/14 (21.4%) patients in group A, and 10/51 (19.6%) patients in group B were discharged on enteral feeding. These differences were not statistically significant.

Analysis of nutritional intake, at 6-months post-operative follow-up was made on all the remaining 14 patients in group A and on 18 patients in group B (3 other patients had already died by that time). One of the 14 patients (7.1%) in group A was feeding normally compared to 32/48 (66.6%) in group B; 8/11 (72.7%) in group A and 11/48 (22.9%) in group B had resumed soft diet; 2/11 patients (18.2%) in group

**Table IV.** Post-operative complications.

| Type of complication | | Group A No. (%) | Group B No. (%) |
|---|---|---|---|
| Early | Salivary fistula | 3/14 (21.4) | 6/53 (11.3) |
| | Salivary fistula + haemorrhage | 1/14 (7.1) | – |
| | Salivary fistula + wound dehiscence | 3/14 (21.4) | – |
| | Wound dehiscence | – | 1/53 (1.9) |
| | Systemic infection (EBV) | – | 1/53 (1.9) |
| | Gastric haemorrhage | – | 1/53 (1.9) |
| | Necrosis | – | 3/53 (5.6) |
| Late | Salivary fistula | 1/14 (7.1) | 4/53 (7.5) |
| | Stenosis | 2/14 (14.3) | 2/53 (3.8) |
| | Necrosis | – | 2/53 (3.8%) |
| Total | | 10/14 (71.3) | 20/53 (37.7) |

**Table V.** Nutritional assessment.

| Type of feeding | Discharge | | 6 months | | 1 year | |
|---|---|---|---|---|---|---|
| | Group A No. (%) | Group B No. (%) | Group A No. (%) | Group B No. (%) | Group A No. (%) | Group B No. (%) |
| Normal | 1 (9.1) | 9 (16.7) | 1 (9.1) | 32 (62.7) | 1 (9.1) | 32 (74.4) |
| Soft | 7 (36.6) | 35 (64.8) | 8 (72.7) | 11 (21.5) | 9 (81.8) | 11 (25.6) |
| Feeding tube | 3 (27.3) | 10 (18.5) | 2 (18.9) | 8 (15.7) | 1 (9.1) | – |
| Total | 11* (100) | 54* (100) | 11 (100) | 51‡ (100) | 11 (100) | 43# (100) |

* 1 patient in each group died in post-operative period; ‡ another 3 patients died; # another 8 patients died.

A and 8/48 (16.6%) patients in group B still required enteral nutrition. The differences were statistically significant.

At 1-year post-operative follow-up, analysis of nutritional intake was made on all the 11 patients in group A and on 40 patients in group B (the other 8 patients had died). One patient out of 11 (79.1%), in group A, was on a free diet compared to 32/40 (80%) of group B. At the same time 9/11 (81.8%) in group A and 11/40 (27.5%) in group B still require a soft diet. One patient of group A (9.1%) but none of the patients in group B, required enteral feeding. The differences were statistically significant.

The analysis of weight variation showed a reduction of body weight, in the immediate post-surgical period, in both groups, this was not statistically significant. Likewise, no significant difference was found in results analysed at 6 months (Table VI). In group A, the mean pre-operative weight has not been reached, after 12 months while in group B, the mean weight after 1 year was higher than prior to surgery. The statistical comparison, at 1 year, showed a statistically significant difference.

None of the patients achieved a good oesophageal voice. Secondary tracheo-oesophageal voice restoration was not performed in the 11 patients in group A on account of the contraindication due to the thickness of the pedicled flap; while 15/43 remaining patients reconstructed with free-flaps were submitted to surgical voice rehabilitation with the positioning of the Provox™ voice prosthesis, one year after primary surgery. The quality of the prosthetic voice, according to the Mendelsohn's scale [26], was considered good in all the 15 patients (Table VII).

## Discussion

Reconstruction of the hypopharyngeal defect following pharyngolaryngectomy is a challenging problem. The hypopharynx moves the food bolus by a series of coordinated muscular contractions, while distension and vibration of the pharyngeal walls is responsible for phonation [10]. The aim of reconstruction is to restore these two main functions of the hypopharynx, namely swallowing and speech. A number of reconstructive options are available including locoregional and free flaps, the technique chosen depends on the extent of the defect and the experience of the surgeon.

Locoregional myocutaneous flaps, such as the *pectoralis major* and *latissimus dorsi*, are the most suitable for reconstruction of hypopharynx [8 11]. Flap harvest is straightforward and transposition into the neck is easily achieved. These flaps can either be used as a patch to repair partial defect or tubed to reconstruct a circumferential defect. The disadvantages of the *pectoralis major* flap include its excessive bulk, particularly when it is used to repair circular pharyngolaryngectomy, and the gravitational strain on the cutaneous patch leading to post-operative complications such as dehiscence and salivary fistula. *Latissimus dorsi* pedicled flap has a larger skin paddle but presents the same disadvantages as the *pectoralis major* flap.

The gold-standard for reconstruction of both partial and circumferential hypopharyngeal defects are the jejunal free flap, the lateral thigh and radial forearm free flaps [4 5 12-17]. The advantages of the free flaps include their pliability and excellent vascularity, large areas of tissue can be transferred and the specific

**Table VI.** Weight variations.

| Period of evaluation | Group A Mean weight (kg) | Group B Mean weight (kg) |
|---|---|---|
| Pre-operative | 64 | 65 |
| Post-operative | 61.2 | 61.7 |
| 6 months after surgery | 62.3 | 64 |
| 1 year after surgery | 61.85 | 66.9 |

**Table VII.** Evaluation (mean ± SD) of speech in patients with voice prosthesis using Mendelsohn's scale [26].

| Intelligibility | Pleasantness | Acceptability | Global quality of speech |
|---|---|---|---|
| 4 ± 0.82 | 4.15 ± 0.73 | 4.23 ± 0.89 | 4.37 ± 0.65 |

flap is chosen on the basis of the character of the tissues of the donor that are best suited to the needs of the recipient site. The free jejunal flap has a reliable vascular pedicle, and as a visceral flap it matches the characteristics of the hypopharyngeal mucosa most closely, it is pliable and has some isoperistaltic motility. The lateral thigh and forearm flap can be used for reconstruction of either partial and/or circumferential defects. The former has a wider skin paddle and is excellent for larger defects, but it cannot be harvested in obese patients on account of the thickness of the subcutaneous fat tissue. The latter is smaller, thinner and more pliable and can be harvested even in obese patients. The only difference with the jejunal flap is that the vertical suture employed to close the cylinder used for hypopharyngeal reconstruction becomes another point of potential weakness and dehiscence.

Our results show a difference in the post-operative complications between pedicled (group A) and free flaps (group B), when used for hypopharyngeal reconstruction. The use of pedicled flaps is complicated by a high percentage of salivary fistulae, that are probably related to a combination of the differences in the thickness of the recipient and donor tissues and the constant gravitational strain on the tissues [11 18]. Complications are more frequent when the flaps are used for circumferential reconstruction or when they are placed against the *praevertebralis fascia* [8]. The lower percentage of salivary fistulas observed with the free flaps is probably due to the greater pliability and tissue match of the free flaps, that make them more adaptable to reconstruct the three-dimensional characteristics of the hypopharyngeal region.

On the other hand, free flaps are more exposed to the risk of necrosis due to thrombosis of the pedicle. This dramatic complication can be managed in the hands of a trained and skilled surgical team, with prompt salvage surgery with another free or a pedicled flap without significantly prolonging hospitalization time.

A more rapid recovery leads to a shorter "hospital stay", with a reduction of the health costs and this is better achieved with the use of free flaps [19 20-25].

Of the patients who underwent reconstruction with free flaps, 62% resumed almost normal feeding after 6 months, compared to 9.1% of patients in the pedicled flap group resuming normal feeding in the same period. This difference is mantained at 12-month follow-up. The poor results of patients with locoregional flap reconstruction may be related both to the thickness of the locoregional flaps, that interferes with the transit of solid foods, and cicatricial stenosis associated with pedicled flaps.

No difference were found between the average weights of the patients in the two groups, at discharge, since during hospital stay, nourishment was identical in both groups. The similarity in weight of the two groups, at six months, is probably related to the use of high-protein and high-caloric substitute compounds by patients reconstructed with pedicled flaps. After a year, patients reconstructed with free flaps weight more than they did pre-operatively, this is statistically different compared to the pedicled group whose average weight does not continue to improve after six months.

Analysis of voice restoration shows that oesophageal voice is impaired in the patients reconstructed with free or pedicled flaps. Pedicled flaps are too thick and stiff to vibrate during air-passage from the stomach to the mouth; free jejunal flap does allow air-passage because of its intrinsic peristaltic activity and the free forearm flap, although thin and pliable, needs high air pressure to vibrate.

The shunt between trachea and the flap used to reconstruct the hypopharynx, thanks to the high expiratory pressure guaranteed by the lungs, induces vibration of the walls of the free flaps (free forearm or jejunum), but it is insufficient to force the resistance offered by the walls of the pedicled flaps. For this reason, prosthetic voice restoration is possible only in patients reconstructed with free flaps, while patients with pedicled flaps are condemned to a persistent difficulty in communication.

## Conclusions

Free flaps are the gold standard for hypopharyngeal reconstruction. They guarantee low frequency of post-operative complications, shorter hospital stay, better rehabilitation of swallowing and speech. When reconstruction of circumferential defects becomes necessary, the jejunal flap should to be considered as first choice since it more closely matches the characteristics of the hypopharyngeal mucosa. Therefore, radial forearm and lateral thigh flaps represent valid alternatives.

In our opinion, on account of their major risk of post-operative salivary fistulas and less satisfactory swallowing and speech results, the *pectoralis major* and other locoregional flaps, should be used only in patients in whom free flap reconstruction is not possible or contraindicated.

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