HEAD AND NECK

Functional results of microvascular reconstruction after hemiglossectomy: free anterolateral thigh flap *versus* free forearm flap

Risultati funzionali delle ricostruzioni microvascolari in seguito ad emiglossectomia: lembo libero anterolaterale di coscia versus lembo libero radiale

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SUMMARY

The aim of the present study is to assess functional outcomes after hemiglossectomy and microvascular reconstruction. Twenty-six patients underwent primary tongue microvascular reconstruction after hemiglossectomy. Twelve patients were reconstructed using a free radial forearm flap and 14 with an anterolateral thigh flap. Speech intelligibility, swallowing capacity and quality of life scores were assessed. Factors such as tumour extension, surgical resection and adjuvant radiotherapy appeared to be fundamental to predict post-treatment functional outcomes. The data obtained in the present study indicate that swallowing capacity after hemiglossectomy is better when an anterolateral thigh flap is used. No significant differences were seen for speech intelligibility or quality of life between free radial forearm flap and anterolateral thigh flap.

KEY WORDS: Hemiglossectomy • Free anterolateral thigh flap • Free radial forearm flap • Functional outcomes • Microsurgery

RIASSUNTO

Lo scopo del presente studio è di valutare i risultati funzionali delle ricostruzioni linguali microvascolari in seguito ad emiglossectomia. Venti sei pazienti sono stati sottoposti a ricostruzione microvascolare primaria. Dodici di questi sono stati ricostruiti usando il lembo libero radiale e quattordici usando il lembo anterolaterale di coscia. L'intellegibilità del linguaggio, la capacità deglutitoria e la qualità della vita sono stati i parametri considerati nella valutazione dei risultati. Variabili legate all'estensione del tumore, alla resezione chirurgica ed al trattamento adiuvante sono risultati essere fondamenti nel predire i risultati funzionali post-operatori. I dati ottenuti da tale studio hanno mostrato come la capacità deglutitoria sia sensibilmente migliore nelle ricostruzioni con il lembo libero anterolaterale di coscia rispetto al lembo radiale. Non altrettanto significative sono risultate le differenze tra le due modalità ricostruttive per quanto riguarda l'intellegibilità del linguaggio.

PAROLE CHIAVE: *Emiglossectomia • Lembo libero anterolaterale di coscia • Lembo libero radiale • Risultati funzionali • Microchirurgia*

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Introduction

The most common sites of primary oral squamous cell carcinomas (OSCCs) are the tongue and the floor of the mouth [1]. Surgery remains the mainstay for oral cavity cancer treatment. Approximately 40% of all OSCC patients referred for treatment require resection of the tongue to varying degrees [2]. Immediate reconstruction should be performed after complete excision of the tumour. Quality-of-life (QoL) studies have shown that speech, chewing and swallowing are the most important factors for patients undergoing head and neck surgery [3].

With respect to these functions, significantly poorer results are achieved in patients who have undergone total or partial glossectomy than in those who have undergone resection of the soft palate [4]. The severity of functional impairment is influenced not only by the site of the tumour, but also by the extent of surgical resection. Reconstruction of the tongue is necessary when oral cavity obliteration, palatal contact and mobility will adversely affect normal swallowing and speech [5].

Owing to advancements in microsurgical techniques, more extensive resections are now possible. The aim of reconstruction is to maximize oral functions and aesthetics with less morbidity, and preserving speech, swallowing and reducing donor site morbidity [6]. The current theories about oral reconstruction advocate microsurgery as standard treatment for restoring oral functions in both young and elderly patients [7 8]. A defect orientated approach may

be helpful for deciding which type of flap should be used for reconstruction of the head and neck [9-12].

For years, the free radial forearm flap (FRFF) has been the first choice to restore soft tissue ablation in the oral cavity [13] despite several disadvantages, such as sacrifice of the most important artery of the hand [14].

Recently, the anterolateral thigh flap (ALTF) has challenged the superiority of FRFF [15]. ALTF can be thinned, it does not need a skin graft and does not risk damage to tendons or hands [16].

The heterogeneous functional data reported in the recent literature about speech and swallowing after tongue microvascular reconstruction prompted the present study. To assess differences between FRFF and ALTF, this investigation compares functional outcomes after hemiglossectomy and microvascular reconstruction.

Patients and methods

Twenty-six patients underwent primary tongue microvascular reconstruction after hemiglossectomy from June 2006 to April 2011 at the Maxillofacial Department of Bologna University. All patients were afflicted with OSCC. No bone involvement was diagnosed. Tumour excision was performed through a trans-mandibular approach or pull-through technique. The extension of the resection was hemiglossectomy or hemipelviglossectomy in all cases. With respect to the surgical procedure, hemiglossectomy was defined as resection of at least 50% of the mobile tongue. The base of the tongue was preserved in all cases. No bone resections were performed. TNM stage and defect size are listed in Table I. All patients underwent neck dissection. Neck dissection was modified neck dissection (MRND) in 20 patients and selective neck dissection (SND) in the remaining 6 patients. Bilateral neck dissection was performed in 2 patients (Table I). Neck dissection on the contralateral side was usually selective neck dissection (SND). In all patients, both hypoglossal nerves were preserved at the level of the digastric muscle above the carotid triangle.

Adjuvant therapies were required in 15 of the 26 patients. None of the patients had neo-adjuvant therapy (Table I). Twelve patients were reconstructed using a FRFF

Table I. TN classification and treatment modality.

TN classification	No. of patients (%)
T2	4 (15)
T3	16 (62)
T4	6 (23)
N0	6 (23)
N1	12 (46)
N2	8 (31)
Treatment	
Extent of resection	
Hemiglossectomy	16 (62)
Hemipelviglossectomy	10 (38)
Neck dissection	
MRDN	20 (77)
SND (SOHND)	6 (23)
Bilateral (MRND+SND)	2 (7)
Adjuvant therapy	
Radiation therapy (55-59 Gy IMRT)	11 (42)
Chemo-radiation therapy	4 (16)
No adjuvant therapy	11 (42)

MRDN: modified radical neck dissection; SND: selective neck dissection; SOHND: supraomohyoid neck dissection; IMRT: intensity-modulated radiation therapy.

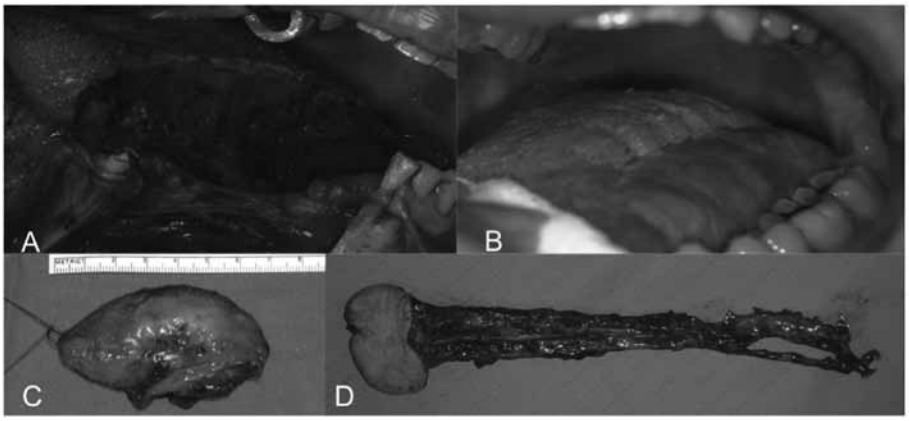

Fig. 1. A. hemiglossectomy through a trans-mandibular approach. B. Tongue appearance after microvascular reconstruction using a free radial forearm flap at 12 months post-operatively. C. Surgical specimen. D. Free radial forearm flap.

Fig. 2. Tongue reconstruction after hemiglossectomy. Left side: hemiglossectomy through a trans-mandibular approach. Right side: Tongue appearance after microvascular reconstruction using an anterolateral thigh flap at 12 months post-operatively.

(group A) (Fig. 1) and 14 employing an ALTF (group B) (Fig. 2). Microvascular reconstructions were performed by the Plastic Surgery team at the same University Hospital.

All subjects enrolled in this study were assessed by a speech therapist before and after ablative surgery. Patients started a swallowing and speech rehabilitation programme as soon as their clinical condition allowed correct receptivity, usually 1-2 weeks after surgical reconstruction. Functional outcomes were assessed 6, 12 and 24 months after reconstruction.

Functional evaluations

Information on demographic characteristics, TNM classification, stage of disease, treatment methods, microvascular and donor-site complications, postoperative recovery, speech intelligibility, swallowing capacity and quality of life scores were recorded. Speech was evaluated postoperatively by one of the authors (AT) according to the method described by Taguchi [17], in which the patient's speech was rated on a scale of 1 to 5 according to its understandability during conversation. The scores are defined as follows: 1. speech can be clearly understood; 2. speech is occasionally misunderstood; 3. speech is understood only when the context of the text is known to the listener; 4. speech is occasionally understood; and 5. speech cannot be understood at all. To grade the results and to analyze the final outcome in relation to other clinical factors, speech intelligibility was classified more broadly as either good (scores 1-2), acceptable (score 3) or poor (scores 4-5).

A swallowing ability scale system (SAS) [18] was used to assess swallowing capacity. The scoring system is based on the MTF classification: the method of food intake (M), the time required for food intake (T) and the consistency of the food that can be ingested (F). For each of these parameters, 5 subgroups are identified and scored, as given in the following. The method of food intake (M) is classified and scored as follows: M5, capacity for swallowing is unlimited (5 points); M4, capacity for swallowing anything, but care must be taken to avoid aspiration (4 points); M3, capacity to eat anything if the food is prepared in a suitable form (3 points); M2, capacity to eat small portions of food, but tube feeding is the main means of ingestion (2 points); and M1, tube-feeding is the only method of ingestion (1 point). The time required for food intake (T) is assessed according to the average time required to eat a daily meal (irrespective of its nature and consistency). This parameter is classified and scored as follows: T5, normal food intake time, < 15 min (5 points); T4, intake of food requires 15 to 25 min (4 points); T3, intake of food requires 25 to 35 min (3 points); T2, intake of food requires 35 to 45 min (2 points); and T1, intake of food requires more than 50 min, or is impossible (1 point).

The consistency of the food that a patient is able to ingest (F) is classified and scored as follows: F5, capacity to eat food of any consistency (5 points); F4, capacity to eat soft, chewable food, such as cooked rice or cooked vegetables (4 points); F3, capacity to eat gruel (3 points); F2, capacity to swallow viscous fluids (2 points); and F1, capacity to swallow only no viscous fluids (1 point). To grade the results and to analyze the final outcome in relation to other clinical factors, outcome was classified more broadly as either poor (MTF score ≤ 6 points), acceptable (MTF score 7-8 points), or good (MTF score 9-15 points).

Video-fluoroscopic examination was performed for only 6 patients in the study (5 from group B and 1 from group A). Video-fluoroscopic examinations were not considered in the results because they were partial compared to the total cohort.

Patient-reported functional outcomes and quality of life were compared between groups using the Head and Neck 35 module of the European Organisation for Research and Treatment of Cancer (EORTC H&N35) quality of life questionnaire [19]. QoL data were recorded at 6, 12 and 24 moths after surgery.

Reconstructive complications were evaluated. Complications were divided into donor-site and flap complications using Classen and Ward's [20] classification. The numbers of patients who developed donor-site complications were compared between groups. Flap complications were classified as major (requiring surgical re-exploration) or minor (all others), and frequencies were calculated for each group.

Statistical analysis

Univariate and multivariate statistical analyses were performed. Chi-square analysis with Fischer's exact test was performed to determine the influence of the reconstruction (group A or B) on speech, swallowing, QoL and patient-reported functional outcomes. Statistical significance was defined as $p < 0.05$. All statistical analyses were performed using the SPSS® Advanced Statistical™ software package (ver. 13; SPSS Inc., Chicago, IL, USA).

Results

Demographics and reconstructive outcomes

The age of patients ranged from 24 to 76 years with a median age of 50 years; 66% of patients were men. Fifteen patients had a partner, and F58% of the sample smoked at inclusion. Ten patients had no alcohol consumption at tumour diagnosis; 10 patients had a comorbidity.

Minor flap complications, which did not require surgical revision, were observed in 3 patients. Two of these were in group A and the other in group B. Total flap loss never occurred in this series.

No complications afflicted the donor site for ALTF. Two weeks was the mean time for complete healing of the thigh

donor area. Mean time for healing for the forearm donor site area was 4 weeks. Two forearm donor sites healed for second intention in approximately 30% of the grafted area, probably due to intense tendon mobility.

Speech intelligibility

All 26 patients underwent postoperative speech therapy according to the hospital's protocol. The last speech evaluation was conducted 24 months after surgery. The evaluation revealed speech intelligibility to be good in 15 patients (57.5%), acceptable in 10 (38.5%) and poor in 1 (4%).

The relationship between free flap reconstruction, surgical resection, neck dissection, adjuvant therapy and speech intelligibility is shown in Table II. Group A had better speech intelligibility outcomes: 9 patients had a "good score", and 3 patients had an "acceptable score". The difference for speech intelligibility between groups was not statistically significant (Fischer's exact test p = 0.73). Adjuvant radiotherapy (p = 0.045) and resection extended to the floor of the mouth (p = 0.049) were predictive of worst speech intelligibility.

Patients reported functional outcomes assessed 24 months after treatment using the EORTC H&N35 quality of life questionnaire showed a better result for patients in group A. Indeed, patients reconstructed using FRFF had a score of 62, while patients reconstructed using ALTF had a score of 57. However, this difference was not statistically significant (p = 0.14).

Swallowing capacity

Swallowing therapy was initiated at the time the patients were first permitted to drink water, namely, 7 to 10 days after surgery. Feeding was initially supplemented by nasogastric intubation in all patients. Perioral ingestion without supplementary feeding was achieved in all patients. During the rehabilitation period, swallowing function and degree of aspiration were monitored using videofluoroscopy for only six patients (1 in group A and 5 in group B). The final evaluation of swallowing capacity was however based on the clinical MTF scores and the EORTC H&N35 questionnaire. The last evaluation of swallowing capacity was conducted at 24 to 36 months after surgery (average, 30 months). No patients had a poor outcome at the time of the functional evaluation. The outcome was considered to be acceptable in 7 patients. All of these were in group A. The outcome was considered to be good in 19 patients (5 in group A, and 14 in group B).

The relationship between MTF and the various treatment factors is shown in Table III. Group B had a significantly better MTF score than group A (p = 0.046).

With regard to surgical resection, multivariate analyses showed that pelvectomy (p = 0.039) and adjuvant radiotherapy (p = 0.040) were predictive factors of worse swallowing capacity at 24 months after treatment. No significant differences were recorded with regard to the type of neck dissection (p = 0.28). The EORTC H&N35 quality of life questionnaire showed better patient reported outcomes for group B (score, 65 points) compared to group A (score 59).

Table II. Speech intelligibility in relation to free flap, surgical resection, neck dissection and adjuvant therapy.

Factor	Good	Acceptable	Poor	p value
Free flap				
Group A	9	3	0	
Group B	6	7	1	p = 0.73
Surgical resection				
Hemiglossectomy	12	4	0	
Hemipelviglossectomy	3	6	1	p = 0.049*
Neck dissection				
MRND	10	9	1	
SND	5	1	0	p = 0.80
Adjuvant therapy				
Yes	5	9	1	p = 0.045*
No	10	1	0	

Statistically significant

Table III. MTF scores in relation to free flap, surgical resection, neck dissection, adjuvant therapy.

Factor	MTF Good	MTF Acceptable	MTF Poor	p value
Free flap				
Group A	5	7	0	
Group B	14	0	0	p = 0.046*
Surgical resection				
Hemiglossectomy	13	3	0	
Hemipelviglossectomy	6	4	0	p = 0.039*
Neck dissection				
MRND	13	7	0	
SND	6	0	0	p = 0.28
Adjuvant therapy				
Yes	8	7	0	p = 0.040*
No	11	0	0	

Statistically significant

Discussion

In the present study, speech intelligibility and swallowing capacity of 26 patients who had undergone hemiglossectomy either with or without pelvectomy (with preservation of base of the tongue) and free flap reconstruction using FRFF (group A) or ALTF (group B) for OSCCs were evaluated. Speech intelligibility and swallowing capacity were satisfactory (acceptable or good) in more than 90% of patients. Although not statistically significant, differences in speech intelligibility between groups were identified in favour of group A. QoL data confirmed this trend. The possible explanation of these results could be that a thinner and more pliable flap as FRFF may restore speech articulation more easily than ALTF. Both more extensive surgical resection (pelvectomy) and adjuvant radiotherapy are factors predictive of worse speech intelligibility recovery.

Swallowing capacity outcomes were better for patients reconstructed using ALTF (group B). The tongue is crucial for propelling a food bolus toward the pharynx. The role played by the anterior part of the tongue in speech is linked to the pressure it exerts on the palate. These functions call for reconstructed tissue volumes that are sufficiently large to cover the defect, ensure minimal scarring and furnish an adequate residual bulk that will compensate for long-term shrinkage. It is probable that the oral phase of swallowing can benefit from a more bulging reconstruction, which restores the physiological contact tongue-palate. Another goal of the anterior part of the reconstructed tongue is to optimize the residual "finger function". Finger function is the ability of the tongue to sweep and clear the buccal, labial and alveolar sulci, and protrude past the coronal plane of the incisors [21].

As shown by Kimata [22], the shape and the bulk of the reconstructed tongue are closely correlated with postoperative swallowing capacity. These functions were better in patients with a protuberant or semi-protuberant reconstructed tongue than in those with a flat or depressed one. On the basis of these findings, the authors advocated the use of broad, thick flaps. In clinical practice, however, it is extremely difficult to control the subsequent volume reduction and sagging of the flap, in particular when postoperative radiotherapy is performed.

More extensive surgical resections comprehensive of floor of the mouth showed poorer outcomes considering swallowing function. This occurred regardless of the type of reconstruction. The post-surgical changes in hyoid and laryngeal elevation could occur as a result of surgical detachment of the anterior attachment of the floor of mouth muscles. These muscles are generally considered responsible for the forward and upward movement of the hyoid and larynx. Cutting or damaging these muscles may have significantly changed their line of pull upward on the hyoid and larynx. This possible interpretation was also postulated by Paulosky in 1995 [23].

For both groups, radiotherapy was a predictive factor for worse functional prognosis. For patients undergoing adjuvant radiotherapy, the negative effect related to radiation also involved the oropharyngeal phase of swallowing. Movement of the tongue base and posterior pharyngeal wall toward each other until full contact is achieved is the key element in producing pharyngeal bolus driving pressure and effective bolus clearance through the pharynx [24]. When the field of postoperative radiotherapy includes the oropharynx or neck, the pharyngeal constrictors and tongue base will be included in the treatment volume. Increased fibrosis of the pharyngeal musculature after completion of radiotherapy may be expected to have a negative impact on pharyngeal bolus clearance, even in patients whose resections are limited to the anterior oral cavity.

With regard to reconstructive complications in our study cohort, we observed two minor complications for group A and one for group B. According to the recent literature [25], we observed better aesthetic results and minor donor site morbidity for ALTF. However, some modified closure techniques have recently been developed to reduce skin tension that provides subsequent improvement of the cosmetic appearance of the forearm donor site [26].

Recently, some authors have shown that the ulnar artery is dominant at the elbow, but after originating its collateral branches, the radial artery becomes the dominant artery in the distal forearm and, consequently, is the major source of vascularization to the hand [88]. Consequently, FRFF always sacrifices the major artery of the limb and leads to unattractive scars in the forearm region. This may produce not only objective complications like stiffness, pain or numbness, but also subjective complaints such as poor cosmetic intolerance.

In conclusion, functional results are difficult to assess in the heterogeneous oral cancer population. Factors such as surgical resection and adjuvant radiotherapy are fundamental to predict post-treatment functional outcomes. Data obtained in the present study indicate that swallowing capacity after hemiglossectomy or hemipelviglossectomy is better when an ALTF is used. No significant differences were seen for speech intelligibility between FRFF and ALTF. To establish the optimal treatment protocol for patients undergoing major glossectomy, however, further prospective studies and quality of life assessments involving greater numbers of patients are necessary.

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