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Sensory recovery of myomucosal flap oral cavity reconstructions

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Abstract

Background: Sensory restoration of the oral cavity is a primary aim of reconstructive surgery in posttraumatic or postablative defects. Sensitivity plays a key role in oral function, whose impairment strongly affects the patient's quality of life. Cheek myomucosal flaps provide a reliable and tissue-like reconstruction of these regions but their sensitive recovery, which we still know little about, deserves thorough assessment.

Methods: In this retrospective study, the myomucosal cheek flaps were tested for different aspects of sensory recovery: touch; 2-point discrimination; pain; sharp/smooth discrimination; ability to feel hot/cold stimulus; stereognosis; and taste.

Results: Fifty-two myomucosal flap reconstructions were investigated. All sensitivity tests showed positive results. When comparison was possible, sensitivity seemed significantly close to the contralateral healthy side. Sensory recovery proved to be even better than that reported on reinnervated microvascular free flap reconstructions of the oral cavity.

Conclusion: Myomucosal flap reconstruction demonstrated a high degree of sensory recovery.

KEYWORDS

cheek flap, oral cavity reconstruction, myomucosal flap, sensitivity assessment, sensory recovery

1 | INTRODUCTION

Sensory recovery of the oral cavity mucosa should be one of the primary aims of reconstructive surgery in patients with posttraumatic or postablative defects. Mucosal sensitivity plays a key role in vital functions, such as chewing, swallowing, and speech, whose impairment strongly affects the patient's quality of life.[1–6]

In the era of functional reconstructive surgery, it seems unacceptable to associate the success of oral cancer treatment with only disease-free survival. The steady increase in patients' long-term survival rate leads to the need to preserve the functionality of the oral cavity in order to ensure as high a quality of life as possible. Currently, the reconstruction of oral and oropharyngeal mucosal defects is typically performed with local, regional, or distant flaps. This latter technique provides a large amount of viable tissue but may impair the functional result. In most cases, the transplanted tissues are too bulky and might not provide the same sensitivity, mobility, volume, or texture as the native tissue. The ideal reconstruction should be carried out with the same or similar type of tissue as the original one. Cheek myomucosal flaps, based either on the facial artery musculomucosal or buccal artery (Bozola et al[7], seem to conform to this premise because they carry thin, mobile, well vascularized, and sensitive tissue, like the one that was excised or lost.[8] However, these techniques allow the surgeon to reconstruct only small

Olindo Massarelli and Luigi Angelo Vaira are co-first authors and contributed equally to this study.

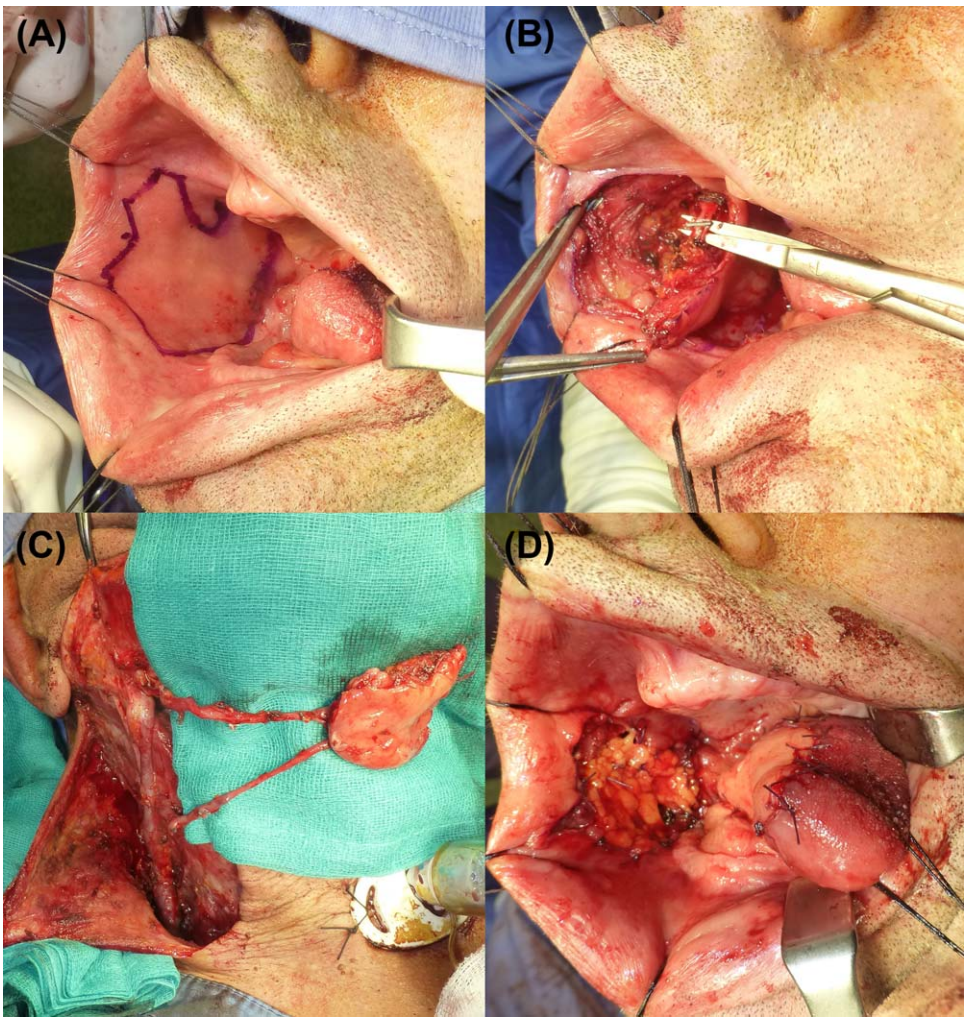

FIGURE 1 Tunnelized-facial artery myomucosal island flap harvesting technique. A, The defect shape is reported on the cheek mucosa preserving Stensen's duct and oral commissure. B, The facial artery and vein are isolated, ligated in the distal portion, and then dissected until their origin. C, The flap is pulled out in the neck through a paramandibular tunnel. D, The flap is finally taken back inside the oral cavity through the floor of the mouth and then sutured to the recipient site. The donor site on the cheek is covered with pedicled buccal fat pad [Color figure can be viewed at wileyonlinelibrary.com]

defects and the bulky pedicle reduces their versatility in dentate patients. To overcome these limitations, some technical amendments have been proposed in order to allow the harvesting of the entire cheek as an island flap.[8–11]

In this study, the functional outcome was evaluated in a series of 52 patients who underwent reconstructive surgery with buccinator myomucosal island flaps. Tests were carried out on the reconstruction flap and on the contralateral healthy side, taking into consideration all the possible aspects of sensitivity: touch; pressure threshold; pain; taste; 2-point discrimination; thermal sensitivity; and stereognosis.

2 | PATIENTS AND METHODS

This is a retrospective study in patients with oral cavity posttraumatic or postablative defects who underwent reconstructive surgery with buccinator myomucosal island flaps, based on the facial or the buccal artery, at the Maxillo-facial Surgery Department of the University of Sassari in the last 10 years (2006-2016). Flap harvesting was performed as described in previous reports[8–11] (see Figure 1).

Sensory recovery assessment was executed at least 4 months after surgery or 4 months after the end of adjuvant therapy, if performed. Mean follow-up at the evaluation time was 39 months.

The study was approved by the University of Sassari Ethical Committee and conducted in accordance with the Helsinki Declaration of 1973, as revised in 1983. All the patients enrolled in this study signed informed consent forms.

2.1 | Procedures

2.1.1 | Sensory function

Subjects were tested by 1 examiner in a quiet room on the following different sensory tasks: the presence of tactile

sensitivity and its pressure threshold; static and dynamic 2-point discrimination; pain sensitivity; sharp/smooth discrimination; temperature; and shape recognition. The subjects were blindfolded during the presentation of all tasks. All sensory tasks except for stereognosis and taste were conducted on the reconstructive flap and on the intact opposite side of the defect. For 13 patients who presented defects involving the median region of the anterior floor of the mouth, the results were obviously not comparable with the healthy sides.

2.1.2 | Presence of tactile sensitivity

To determine if some tactile sensitivity was present, the flap was touched with a cotton ball and the subject was then asked to raise his/her hand if the touch was felt.

2.1.3 | Threshold of tactile sensitivity

Eight different Semmes-Weinstein monofilaments (North Coast Medical, Morgan Hill, CA) were used progressively, from 0.0354 g/mm^2 to 732.8 g/mm^2, to determinate the tactile threshold. Each monofilament was applied perpendicular to the examined surface, pressing enough to make the nylon wire bend in a C shape for approximately 1.5 seconds.[12] The patients should have sensed the monofilament by the time it bowed. For this examination, which was modified according to Komiyama et al,[13] Semmes-Weinstein monofilaments were shortened and recalibrated in order to easily reach the deeper regions of the oral cavity. Positive responses and pressure thresholds were then recorded.

2.1.4 | Two-point discrimination

Two-point discrimination is the ability to determine that 2 points of tactile stimulation are felt as separate. For this test, sterilized staples with the tips set apart at predetermined distances were used.[14] The staples were calibrated from 1 to 30 mm width and applied onto the oral mucosa, holding them with a Mayo needle holder. Subjects were asked if they felt 1 or 2 separate stimuli. Dynamic 2-point discrimination was also assessed by scratching the staples on the surface to evaluate the fast-adapting receptor response.

2.1.5 | Pain (prick test)

To assess the presence of pain perception, microtissue forceps were used to pinch the flap surface having the patients identify whether they felt that they were pinched or not.

2.1.6 | Sharp/smooth discrimination

Two different tools were used for this task: a cotton ball and a dental probe. These tools were applied multiple times onto the surfaces, in random order, asking the subject if he could distinguish between a sharp or a smooth object.

2.1.7 | Temperature

Temperature was tested holding different small cotton balls against the examined surfaces. Some cotton balls were cooled up to 3 °C with ice spray and the others were soaked in hot water around 70 °C. The small cotton balls were then applied onto the surface in random order. Small cotton balls at room temperature were also used as a control.

2.1.8 | Stereognosis

Stereognosis is the ability to determine the shape of an object without visual cues. In this study, we used 6 different shapes (square, rectangle, triangle, circle, semicircle, and ellipse). These objects were approximately 4 mm thick and 10 mm long. These shapes had been cut from raw carrots to avoid the risk of accidental ingestion and also to increase the patient's comfort instead of using metal or acrylic objects. Subjects were presented with pictures of all potential forms and allowed to study the images. During the test, patients moved the shapes in their mouth until ready to indicate on the picture display what was placed in their mouth. A total of 9 objects were presented in a random order for each subject. Then 2 parameters were recorded: oral stereognosis ability response time, which is the time needed to give the answer, and the oral stereognosis ability score. The latter was obtained by giving 2 points for the correct answer, 1 point if close to a similar shape, or 0 if incorrect.[2]

2.1.9 | Taste

A modification of the test proposed by Loewen et al[15] was adopted. Four basic taste sensations, salty, sweet, sour, and bitter were tested. In addition, a neutral solution (distilled water) was used as a control. Thirty milligrams of table salt were added to 1 liter of distilled water to make the sodium chloride solution. Thirty milligrams of refined sugar were dissolved in 1 liter of distilled water to make the sweet solution. The sour solution was composed of 90 mL of commercial lemon juice added to 1 liter of distilled water. Unsweetened decaffeinated coffee was used as the bitter solution. Each solution was kept at room temperature. During the trial, 1 mL of each solution was dropped from a medicine dropper onto the center of the tongue of the subject. A different dropper was used for each of the solutions. The center of the tongue was chosen, as it is difficult to isolate a solution to specific areas of

TABLE 1 Patient characteristics

Characteristics	No. of patients
Age, years	
<55	7 (13.5%)
55-74	26 (50%)
>75	19 (36.5%)
Sex	
Male	39 (75%)
Female	13 (25%)
Etiology	
Squamous cell carcinoma	47 (90.4%)
Adenoid cystic carcinoma	2 (3.85%)
Mucoepidermoid carcinoma	2 (3.85%)
Trauma	1 (1.9%)
T classification	
T1	6 (11.7%)
T2	18 (35.3%)
T3	18 (35.3%)
T4	9 (17.7%)
N classification	
N0	30 (58.8%)
N1	9 (17.7%)
N2	12 (23.5%)
N3	0
Radiotherapy	
Yes	20 (38.5%)
No	32 (61.5%)
Type of reconstruction	
Ipsilateral myomucosal flap	40 (76.9%)
Contralateral myomucosal flap	4 (7.7%)
Myomucosal flap + microvascular free flap	8 (15.4%)
Type of neck dissection	
Unilateral	
Selective	16 (31.4%)
Modified radical	5 (9.8%)
Bilateral	
Selective + selective	21 (41.2%)
Selective + modified radical	8 (15.6%)
Modified radical + modified radical	1 (2%)

the mouth due to the natural spread of fluid. Subjects indicated whether the solution placed in the center of their tongue was salty, sweet, sour, bitter, or neutral. The solutions were presented in a random order, excluding the bitter taste, which was always presented last because it tends to alter subsequent taste perception.[15] Between each trial, the subject was given 30 mL of distilled water to rinse. One trial of each taste was presented and responses were recorded as either correct or incorrect.

FIGURE 2 The right tunnelized-facial artery myomucosal island flap donor site 4 months after surgery [Color figure can be viewed at wileyonlinelibrary.com]

3 | RESULTS

Of the 52 patients who met the inclusion criteria, 39 were men and 13 were women. Defects were due to oncologic resections in 51 cases, whereas just 1 case was subsequent to a traumatic injury of the premaxilla. In 8 of these patients, a combined reconstruction with an additional flap (6 fibula free flaps, 1 iliac crest free flap, and 1 rectus abdominis myocutaneous muscle flap plus iliac crest bone graft) was necessary because of the defect size and the involvement of surrounding structures (mandible, maxilla, or through-and-through defect of the cheek). Twenty patients (38.5%) underwent adjuvant radiochemotherapy. An overview of patient characteristics is reported in Table 1.

No major complications were detected. The donor site, covered with a layer of pedicled buccal fat pad, rapidly

TABLE 2 Defect characteristics

Site	No. of patients	Average defect size
Anterior FOM	13	6.1 × 5.3 cm
Lateral FOM	3	6.8 × 4.7 cm
Tongue	9	6.9 × 5.4 cm
Hard palate	7	5.6 × 5 cm
Soft palate	6	6.3 × 5.2 cm
Retromolar trigone	7	6.8 × 6.1 cm
Maxillary alveolar ridge	3	5.7 × 4.8 cm
Mandibular alveolar ridge	2	5.5 × 4.5 cm
Cheek	2	6.5 × 5 cm
TOTAL	52	6.9 × 5.7 cm

Abbreviation: FOM, floor of the mouth.

TABLE 3 Threshold of average tactile sensitivity on the flap compared to the contralateral healthy side

Site	No. of patients	Flap g/mm^2	Healthy side g/mm^2
Anterior FOM	13	0.43 ± 0.55	. . .
Lateral FOM	3	0.37 ± 0	0.14 ± 0.19
Tongue	9	0.70 ± 0.56	0.14 ± 0.16
Hard palate	7	0.41 ± 0.45	0.22 ± 0.18
Soft palate	6	0.35 ± 0.48	0.25 ± 0.39
Retromolar trigone	7	0.48 ± 0.56	0.23 ± 0.18
Mandibular alveolar ridge	2	0.37 ± 0	0.20 ± 0.24
Maxillary alveolar ridge	3	0.37 ± 0.19	0.26 ± 0.19
Cheek	2	0.37 ± 0	0.20 ± 0.23

Abbreviation: FOM, floor of the mouth.

healed with spontaneous re-epithelization within a few days, showing negligible morbidity (see Figure 2).

Patients were grouped according to 9 different defect sites: anterior floor of the mouth (FOM); lateral FOM; tongue; hard palate; soft palate; retromolar trigone; maxillary alveolar ridge; mandibular alveolar ridge; and cheek. An overview of the defect sites and sizes is shown in Table 2.

3.1 | Tactile sensitivity

Recovery of tactile sensitivity was detectable in 100% of the tested reconstructive flaps.

3.2 | Sensory threshold

The average overall value detected on the flaps was 0.83 ± 1.89 g/mm^2. The threshold of tactile sensitivity average value, which was assessed on lateral reconstructions, was 0.451 g/mm^2, whereas on the contralateral healthy side it was 0.160 g/mm^2, with a recovery rate of 35.55%.

The difference proved to be significant ($P = .005$) on the Student's t test statistical analysis (95% confidence interval). Results are shown in Table 3 and in Figure 3.

3.3 | Two-point discrimination

The average 2-point discrimination value, assessed on the whole group of reconstructive flaps, was 10.7 ± 4.8 mm for static and 8.1 ± 4.16 mm for dynamic. Two-point discrimination average values, which were assessed on lateral reconstructions, were 10.33 mm (static) and 7.79 mm (dynamic), whereas on the contralateral healthy side they were 4.79 mm (static) and 3.82 mm (dynamic) with a recovery rate of 46.36% and 49.03% for the static and the dynamic tests, respectively.

The difference proved significant ($P = .001$) on the Student's t test statistical analysis (95% confidence interval). Table 4 and Figure 4 shows a summary of the results of this test.

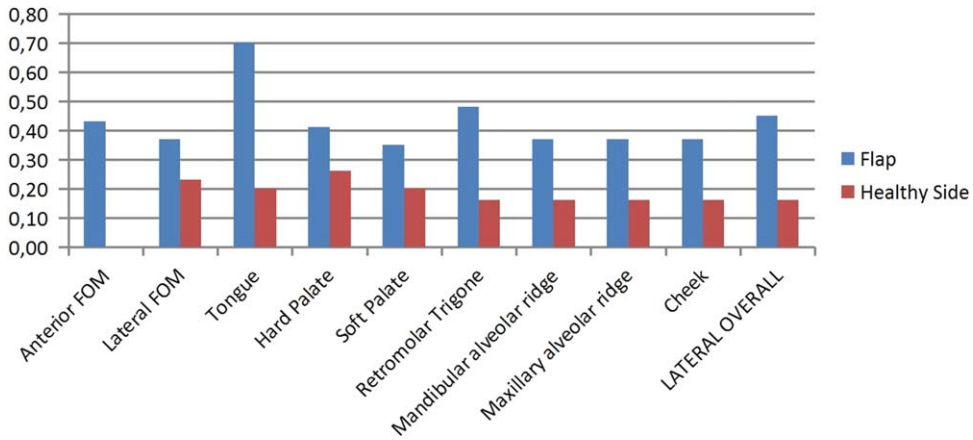

FIGURE 3 Representation of the threshold of the tactile sensitivity assessed on the flap and on the contralateral healthy side divided by the site of the defect. On Y axis, the values are expressed in g/mm^2. FOM, floor of the mouth [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 4 Static and dynamic 2-point discrimination thresholds assessed on the flap and on the contralateral healthy side

Site	No. of flaps	Flap 2-point static, mm	Flap 2-point dynamic, mm	Healthy side 2-point static, mm	Healthy side 2-point dynamic, mm
Anterior FOM	13	12.1 ± 5.4	9.3 ± 4.3	. . .	. . .
Lateral FOM	3	15.6 ± 5.5	13.3 ± 5.7	5.2 ± 2.2	4.1 ± 1.3
Tongue	9	12.6 ± 4.6	10 ± 4.5	3.4 ± 1.6	2.9 ± 0.7
Hard palate	7	10.2 ± 2.8	8.2 ± 2.8	4.3 ± 1.9	3.5 ± 1.6
Soft palate	6	8.1 ± 2.4	5.8 ± 2.3	4.6 ± 2	3.7 ± 1.7
Retromolar trigone	7	10.5 ± 5.8	7.1 ± 3.4	5.3 ± 2.1	5 ± 3.3
Mandibular alveolar ridge	2	6.5 ± 0.7	5 ± 1.4	3	2.5 ± 0.7
Maxillary alveolar ridge	3	7.3 ± 3.2	4.6 ± 1.5	4.3 ± 0.5	3.5 ± 0.5
Cheek	2	6 ± 1.4	3.5 ± 0.7	3.5 ± 0.7	3

Abbreviation: FOM, floor of the mouth.

3.4 | Pain

The pain test was positive in 100% of the cases.

3.5 | Sharp/smooth discrimination

Of the patients, 92.15% were able to discriminate between the sharp and the smooth tool.

3.6 | Temperature

Sensitivity to cold sensitivity was present in 96.15% patients. Six patients (11.5%) could not discriminate between the hot small cotton ball and that used as a control.

3.7 | Stereognosis

The 52 patients reported an average oral stereognosis ability score of 15.86 ± 2.43 and oral stereognosis ability response time of 74.82 ± 35.28 seconds. Table 5 shows a summary of the results.

3.8 | Taste

Taste was fully maintained in 47 patients (90.38%), whereas in 5 patients who had undergone adjuvant radiotherapy, 1 or more basic taste sensations were altered. In 3 of these patients who underwent radiotherapy in the last 6 months, at least 1 patient among the sour, sweet, and salty tastes, was confused with the bitter taste.

4 | DISCUSSION

When evaluating the sensitive recovery of the oral reconstructive flaps, it is crucial to rate the quality of the reconstruction itself.[16]

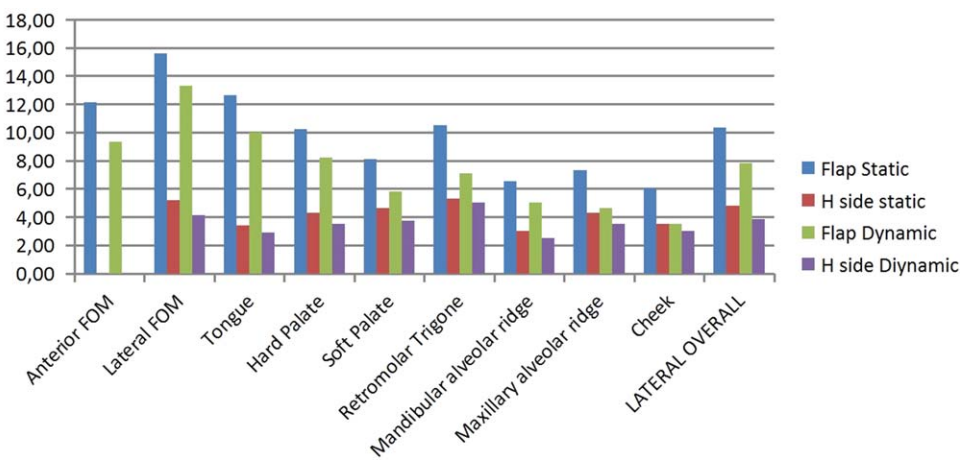

FIGURE 4 Representation of the 2-point discrimination threshold assessed on the flap and on the contralateral healthy side. On Y axis, the values are expressed in millimeters. FOM, floor of the mouth; H, healthy side [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 5 Stereognosis ability evaluation results

Site	Oral stereognosis ability score	Oral stereognosis ability response time, seconds
Anterior FOM	14.2 ± 2.8	85.23 ± 39.00
Lateral FOM	16.3 ± 1.15	51.6 ± 14.64
Tongue	15.77 ± 2.38	82.44 ± 57.90
Hard palate	14.28 ± 3.09	69.14 ± 30.55
Soft palate	16.83 ± 1.60	76.66 ± 19.54
Retromolar trigone	17.71 ± 0.48	62.42 ± 13.20
Mandibular alveolar ridge	18	67.5 ± 3.53
Maxillary alveolar ridge	17 ± 1	79.33 ± 34.56
Cheek	16.5 ± 0.71	61.5 ± 21.92

Abbreviation: FOM, floor of the mouth.

To assess the quality of myomucosal flap reconstructions of oral cavity defects, an evaluation protocol was specifically set to cover all the functional aspects. In this preliminary work, we report only the results regarding the restoration of sensitivity, whereas also speech, swallowing, chewing, and the patient's quality of life have been assessed and will be the topic of a future report. A considerable amount of reports concerning sensory recovery in fasciocutaneous free flaps is available in literature.[15,17–22]

However, the only work that focused on the topic of the sensory recovery of myomucosal flaps was an interesting report, which was published in French literature by Wolber et al.[23] Although that work was carried out on a limited number of patients and not all of the aspects of sensitivity were investigated, the results were nevertheless reported as satisfactory with the recovery rate comparable to the contralateral healthy side.

Our study was based on a larger group of patients and the tests were more comprehensive, assessing all the aspects of sensitivity. Results comply with expectations; sensitivity seems to play a key role in all oral functions because the patients with the worst results in sensitivity tests also showed impairment of swallowing, chewing, and speech.

In our series, all the flaps recovered tactile sensitivity with an average threshold value of 0.81 ± 1.89 g/mm^2 (Table 3).

In addition, pain sensitivity recovered in 100% of the patients of our series and, regarding the thermal sensitivity, buccinator myomucosal flaps showed 96.1% positive responses for sensitivity to cold and 88.4% for sensitivity to heat.

In our series, the site of reconstruction significantly affects stereognosis ability (Table 5). In fact, patients with anterior FOM and hard palate reconstructions showed significantly lower oral stereognosis ability score values (-15.67%) compared with others. The hard palate is crucial in the evaluation of physical characteristics of food when it is ready to be swallowed. Palatine tactile receptors allow us to detect sharpness that can damage the first part of the digestive tract. Patients with anterior FOM reconstruction have less mobility of the tongue due to the scar shrinking, which affects food manipulation.

Finally, in all of the tongue reconstructions of our series, even in patients who underwent adjuvant radiochemotherapy, taste sensitivity seemed to be substantially unaltered.

Definitely, myomucosal flaps proved to be a very suitable and versatile reconstructive option for oral cavity soft tissue defects up to 8 to 9 cm in diameter. Thanks to the dense anastomotic network between the facial and buccal artery, it is possible to raise almost all the cheek as an island flap. In our experience, this good amount of tissue can properly reconstruct wide defects, such as hemiglossectomy, total soft palate defects, or total anterior oral floor and ventral tongue defects (see Figure 5).

Moreover, they showed excellent results in sensory recovery, which may be related, in our opinion, to the low fibrotic retraction of the buccinator muscle flaps that favors nerve sprouting from the surrounding tissues.

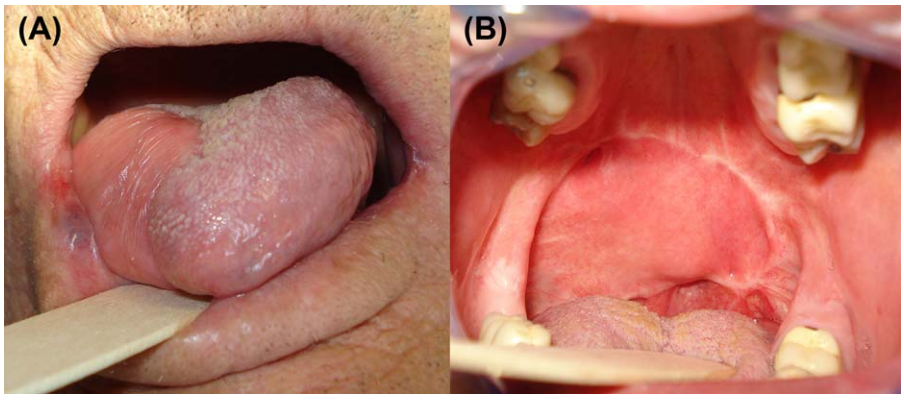

FIGURE 5 A, Hemiglossectomy reconstruction. B, Total soft palate reconstruction [Color figure can be viewed at wileyonlinelibrary.com]

5 | CONCLUSIONS

The results of this study show that cheek myomucosal flaps lead to satisfactory sensory recovery.

Myomucosal flaps proved to be a very suitable and versatile reconstructive option for oral cavity soft tissue defects up to 8 to 9 cm in diameter, providing high sensory recovery that, consequently, improves the patient's overall quality of life.

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