Int. J. Oral Maxillofac. Surg. 2018; 47: 316–323
https://doi.org/10.1016/j.ijom.2017.11.012, available online at https://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Clinical Paper
Reconstructive Surgery

Soft palate functional reconstruction with buccinator myomucosal island flaps

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O. Massarelli, L.A. Vaira, R. Gobbi, A. Biglio, G. Dell'aversana Orabona, G. De Riu: Soft palate functional reconstruction with buccinator myomucosal island flaps. Int. J. Oral Maxillofac. Surg. 2018; 47: 316–323.

Abstract. Oropharyngeal reconstruction after ablative surgery is a challenge. The results of a retrospective study of 17 patients who underwent total or sub-total soft palate reconstruction with a buccinator myomucosal island flap, between 2008 and 2016, are reported herein. An analysis of flap type and size, harvesting time, and postoperative complications was performed. Patients underwent standardized tests to assess the recovery of sensitivity, deglutition, quality of life (QoL), and donor site morbidity, at >6 months after surgery or the end of adjuvant therapy, if performed. All flaps were transposed successfully. Only minor donor and recipient site complications occurred. The sensitivity assessment showed that touch, two-point discrimination, and pain sensations were recovered in all patients. Significant differences between the flap and native mucosa were reported for tactile ($P = 0.004$), pain ($P = 0.001$), and two-point discrimination ($P = 0.001$) thresholds. The average deglutition score reported was 6.1/7, with only minimal complaints regarding deglutition. The QoL assessment showed high physical (24.6/28), social (25/28), emotional (19.1/24), and functional (24.6/28) scores. No major donor site complications were noted in any patient; the average donor site morbidity score was 8.1/9. Buccinator myomucosal island flaps represent a valuable functional oropharyngeal option for reconstruction, requiring a short operating time and presenting a low donor site morbidity rate.

Key words: oropharyngeal reconstruction; soft palate reconstruction; buccinator myomucosal flap; cheek myomucosal flap; FAMM; t-FAMMIF; BAMMIF; facial artery myomucosal island flap; buccal artery myomucosal island flap.

Accepted for publication 23 November 2017
Available online 8 December 2017

The goals of head and neck cancer treatment are cure, organ preservation, restoration of form and function, reduction of the morbidity associated with therapy, and improvement or maintenance of quality of life (QoL)[1].

The functional restoration of large soft palate defects poses a reconstructive challenge, due to the complex velopharyngeal anatomy and physiology. This organ is responsible for proper speech articulation and resonance, and is intimately associated with complex functions such as swallowing and respiration. Dysfunction of the soft palate following ablative surgery or trauma, leads to the impairment of speech and swallowing, which have a devastating impact on the patient's QoL[2]. Reconstruction of the soft palate is complex because the dynamic fibromuscular structure cannot be duplicated with current capabilities,

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which focus on the restoration of proper integrity, bulk, and sensation.

Several reconstructive techniques have been proposed, including the use of soft palate obturators[3] and local[4–6], regional[7–9], and distal free flaps[10–12]. Radial forearm free flaps are currently the first choice for soft palate reconstruction, allowing a satisfactory functional rehabilitation[13–15].

However, the ideal reconstruction should be accomplished with the same or similar type of tissue as the original one. Buccinator myomucosal island flaps comprise well-vascularized, thin, sensate, pliable, and mobile tissue with the potential for dynamic function, and thus allow a 'like with like' defect restoration[16–21].

This study was performed to investigate and report the functional outcomes of 17 patients who underwent the restoration of total or sub-total soft palate defects with buccinator myomucosal island flaps.

Materials and methods

A retrospective study was conducted involving patients with soft palate post-ablative defects, who underwent reconstructive surgery with buccinator myomucosal island flaps between January 2008 and June 2016 in the Maxillofacial Surgery Unit of the University Hospital of Sassari. Flap harvesting was performed as described in previous reports[16–21]. All patients underwent standardized tests to assess the recovery of sensitivity, deglutition, QoL, and donor site morbidity, at >6 months after surgery or the end of adjuvant therapy, if performed.

The recovery of sensitivity was tested in a quiet room using different sensory tasks to determine the presence of tactile sensitivity and its pressure threshold, static and dynamic two-point discrimination, pain sensitivity, sharp/blunt discrimination, and temperature sensitivity. The subjects were blindfolded during all tasks. All sensory tests were conducted both on the reconstructive flap and on the intact opposite side to the defect. For patients who presented defects involving the whole soft palate, the results could obviously not be compared with a healthy side.

Tactile sensitivity was evaluated using eight shortened Semmes–Weinstein monofilaments (Premier Products, Kent, WA, USA). These were used in sequence, from 0.0354 g/mm^2 to 732.8 g/mm^2, to determine the tactile threshold. Each monofilament was applied perpendicular to the surface examined, applying sufficient pressure to make the nylon wire bend in a C shape for approximately 1.5 s[22,23]. Static and dynamic two-point discrimination were investigated using sterilized office staples pre-shaped to a threshold range of 1–30 mm and held with a Mayo needleholder[20]. The staple, starting with the lowest width, was pressed lightly on the surface being examined and the patient was asked if they had felt one or two stimuli. Wider staples were then used in succession until the patient could discriminate the two points. Temperature sensitivity was tested with three cotton swabs: one was immersed in warm water (70 °C), one was cooled with ice spray (3 °C), and one was left at room temperature. The small cotton balls were then applied to the surface in random order. The presence of pain sensitivity was assessed with a prick test using micro-tissue forceps to pinch the surface, and the patients were asked whether they felt pain. The pain threshold was determined with Semmes–Weinstein monofilaments starting from the tactile threshold data. The stimulus was applied in the same way as for this latter test, but the patient was instructed to open their eyes and raise their hand as soon as they felt not only pressure but also pain in the test area. If the participant had no positive response for the thickest monofilament (732.8 g/mm^2), this value was recorded as the threshold[22]. Sharp/smooth discrimination was assessed using a cotton bud and a dental probe. These tools were applied multiple times onto the surfaces, in random order, and the patient was asked whether they could distinguish a sharp or a smooth object.

Deglutition was evaluated objectively by placing different types of food in the patient's mouth and testing whether the subject could spontaneously swallow and clear the palate; this method has been described previously by Teichgraeber et al.[24]. The score could range from 1 (severe complaints and unable to swallow) to 7 (no complaints).

QoL was assessed using the Functional Assessment of Cancer Therapy – Head and Neck questionnaire[25]. Donor site morbidity was evaluated using five parameters: mouth opening, oral commissure symmetry, inner vestibule restoration, cheek mucosal lining, and the aesthetic result[26]. This clinical evaluation was performed by a blinded panel of two clinicians and the patient themselves, assessing each parameter with a score ranging from 0 to 3. The three scores for each parameter were summed to obtain a score reflecting the overall parameter assessment.

Data collected were analysed using IBM SPSS Statistics version 24.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics for quantitative variables are given as the mean ± standard deviation (SD). The statistical analysis of differences in the sensitivity threshold between the flap and the native mucosa was performed with the Wilcoxon signed-rank test. The level of statistical significance was set at $P \leq 0.05$ with a 95% confidence interval.

The study was approved by the Ethics Committee of the University of Sassari and was conducted in accordance with the Declaration of Helsinki of 1973 as revised in 1983.

Results

Twenty-three patients underwent soft palate reconstruction with a buccinator myomucosal flap between January 2008 and June 2016. One of these patients died from pulmonary recurrence and five patients did not show up for the study. These patients were excluded from the evaluation. The remaining 17 patients were recruited. Demographic data, tumour pathology, the type and size of reconstructive flap, harvesting times, postoperative recipient and donor site complications, use of adjuvant radiotherapy, and follow-up durations are reported in Table 1.

The tumour was classified as T1 in one patient, T2 in eight patients, T3 in seven patients, and T4 in one patient. Tumour resection was combined with bilateral lymph node neck dissection according to the criteria for radical surgical treatment. In 12 patients with disease classified as cN0, the facial vessels were preserved during neck dissection, so the buccinator myomucosal island flap was based on the facial artery. In one case, a patient classified as cN0 was re-classified as pN2b after histological evaluation (Table 1; case 16). In two cases staged as cN2b (Table 1; cases 3 and 8), the buccinator myomucosal island flap was based on the contralateral facial artery, taking advantage of its useful pedicle length (Fig. 1). A buccinator myomucosal island flap based on the buccal artery was used in two cases staged as cN2c (Table 1; cases 10 and 15) and in one case in which the facial artery had accidentally been resected and ligated (Table 1; case 1) (Fig. 2). The mean flap harvesting time was 47.6 min.

No major complications or flap loss were detected in this series. Minor complications occurred in two cases: one case of venous stasis, which resolved spontaneously, and one case of minor suture dehiscence. Local or distant recurrence was not reported for any patient.

The sensitivity assessment showed that touch, two-point discrimination, and pain sensations were recovered in all patients.

Table 1. Patient characteristics.

Patient No. Sex/age at surgery	Diagnosis Tumour size (according to UICC)	Site of defect	Type of flap	Flap size (cm) Flap side	Flap harvesting time (min)	Recipient site complications	Donor site complications	Adj. RT	Follow-up (months)
1 F/58 years	SCC pT2N0M0	Left retromolar trigone + hemipharynx + soft hemipalate	BAMMIF	6 × 4 Left	45	None	None	None	95
2 M/76 years	SCC pT1N0M0	Uvula + left soft hemipalate	t-FAMMIF	4 × 3 Left	45	None	None	None	82
3 F/54 years	SCC pT4N2bM0	Left soft hemipalate + maxillary tuberosity + retromolar trigone + left pharynx	t-FAMMIF	7 × 5 Contralateral	50	None	None	Yes	69
4 M/67 years	SCC pT2N0M0	Uvula	t-FAMMIF	6 × 3 Right	60	None	None	None	68
5 M/50 years	SCC pT2N0M0	Right soft hemipalate + retromolar trigone	t-FAMMIF	6 × 5 Right	40	None	None	None	68
6 M/59 years	SCC pT3N0M0	Total soft palate	t-FAMMIF	7 × 5 Right	60	None	None	None	59
7 M/61 years	SCC pT3N0M0	Left soft hemipalate + hard palate	t-FAMMIF	5 × 3 Left	45	None	None	Yes	48
8 M/56 years	SCC pT3N2bM0	Right 2/3 hard palate + soft palate	t-FAMMIF	6 × 4 Contralateral	75	Venous stasis	None	Yes	40
9 M/63 years	SCC pT2N0M0	Right soft hemipalate	t-FAMMIF	6 × 5 Right	45	None	None	None	39
10 M/64 years	SCC pT2N2cM0	Left soft hemipalate	BAMMIF	5 × 4 Left	40	None	None	Yes	34
11 F/58 years	SCC pT2N0M0	Right soft hemipalate	t-FAMMIF	7 × 5 Right	45	None	None	None	33
12 M/72 years	SCC pT3N0M0	Right soft hemipalate + hard palate	t-FAMMIF	7 × 6 Right	40	None	None	None	28
13 M/72 years	SCC pT3N0M0	Total soft palate	t-FAMMIF	6 × 5 Left	45	None	None	None	25
14 F/75 years	SCC pT2N0M0	Left soft hemipalate	t-FAMMIF	6 × 5 Left	45	None	None	None	19
15 M/54 years	SCC pT2N2cM0	Right soft hemipalate	BAMMIF	6 × 5 Right	40	None	None	Yes	17
16 M/62 years	SCC pT3N2bM0	Right soft hemipalate + retromolar trigone	t-FAMMIF	6 × 5 Right	50	None	None	Yes	12
17 F/70 years	SCC pT3N0M0	Left soft hemipalate	t-FAMMIF	6 × 5 Left	40	Minor suture dehiscence	None	None	8

Adj. RT, adjuvant radiotherapy; BAMMIF, buccal artery myomucosal island flap; F, Female; M, Male; SCC, squamous cell carcinoma; t-FAMMIF, tunnelized facial artery myomucosal island flap; UICC, Union for International Cancer Control.

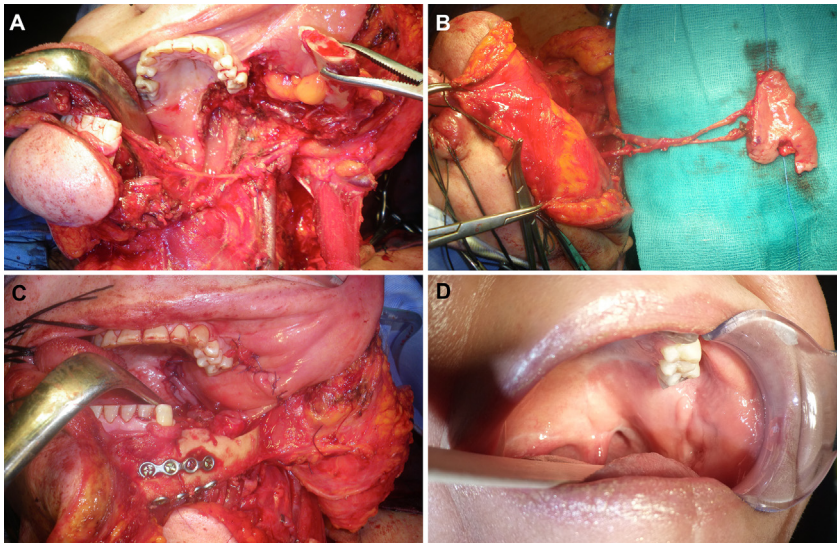

Fig. 1. Case 3, a 54-year-old female patient. (A) Post-ablative defect involving the left hemipalate and ipsilateral maxillary tuberosity, lateral pharyngeal wall, retromolar trigone, and base of the tongue. (B) A tunnelized facial artery myomucosal island flap (t-FAMMIF) was harvested from the contralateral cheek. (C) The flap was pulled back into the oral cavity and sutured at the recipient site. (D) Follow-up at 26 months.

Significant differences between the flap and native mucosa were reported for tactile ($P = 0.004$), pain ($P = 0.001$), and two-point discrimination ($P = 0.001$) thresholds. Three patients were not able to discriminate between sharp and blunt stimuli, while two patient did not report thermal sensitivity (Table 2). Most of the patients presented minimal deglutition complaints and were able to swallow the bolus without any difficulty. The average deglutition score reported was 6.1 (Table 3). The QoL assessment showed high physical, social, emotional, and functional well-being (Table 4). In all cases, the donor site was repaired with a buccal fat pad harvested from the cheek. Donor site morbidity was very low; the average donor site morbidity score was 8.1 (Table 5).

Discussion

Alterations to the complex anatomy of the soft palate, such as those resulting from resective surgery, easily lead to velopharyngeal insufficiency, which negatively impacts speech, swallowing, and patient QoL. Soft palate reconstruction has two primary goals to deal with this problem: (1) closure of the oronasal communication with adequate tissue quantity, (2) re-creation of a functional myomucosal velum, which needs a sensate, pliable, and mobile tissue with the potential for dynamic function[4].

Palatal obturators have been used to close soft palate defects, but their lack of mobility along with the surrounding muscular pharyngeal tube, results in ineffective sealing during dynamic motion in speech and swallowing. Moreover, edentulous patients often experience difficulty

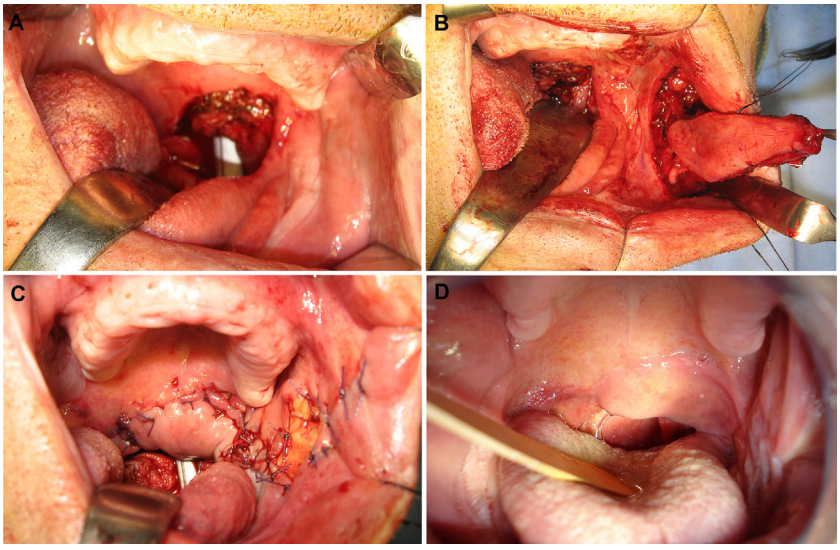

Fig. 2. Case 10, a 64-year-old male patient. (A) Left hemipalate defect following tumour ablation. (B) Buccal artery myomucosal island flap (BAMMIF) harvested from the left cheek. (C) The flap was transposed and sutured at the recipient site; the donor site was closed with a pedicled buccal fat pad flap. (D) Follow-up at 11 months.

Table 2. Results of sensitivity tests after 6 months of follow-up.

Patient No. Sex/age (years)	Soft touch	Tactile threshold (g/mm^2)		Two-point discrimination static/dynamic (mm)		Prick test	Pain threshold (g/mm^2)		Sharp/smooth discrimination	Hot/cold discrimination
		Flap	Contralateral/non-operated mucosa	Flap	Contralateral/non-operated mucosa		Flap	Contralateral/non-operated mucosa		
1 F/58 years	Yes	0.354	0.354	8/5	6/5	Yes	732.8	102.5	Yes	Yes
2 M/76 years	Yes	0.372	0.354	5/4	4/3	Yes	279.16	62.5	Yes	Yes
3 F/54 years	Yes	1.282	0.372	12/10	7/5	Yes	>732.8	104.6	Yes	Yes
4 M/67 years	Yes	0.354	0.354	8/5	4/3	Yes	289.89	61.8	Yes	Yes
5 M/50 years	Yes	0.372	0.354	7/5	5/4	Yes	279.16	61.8	Yes	Yes
6 M/59 years	Yes	0.372	NR	8/5	NR	Yes	279.16	NR	Yes	Yes
7 M/61 years	Yes	1.282	0.354	10/7	6/5	Yes	732.8	102.5	No	Yes
8 M/56 years	Yes	1.282	0.372	22/15	7/5	Yes	732.8	102.5	No	No
9 M/63 years	Yes	0.372	0.354	11/9	4/4	Yes	279.16	61.8	Yes	Yes
10 M/64 years	Yes	0.372	0.354	8/6	5/4	Yes	279.16	61.8	Yes	Yes
11 F/58 years	Yes	0.354	0.354	8/7	4/3	Yes	279.16	62.5	Yes	Yes
12 M/72 years	Yes	0.372	0.372	9/6	7/4	Yes	732.8	62.5	Yes	Yes
13 M/72 years	Yes	1.282	NR	7/7	NR	Yes	>732.8	NR	Yes	Yes
14 F/75 years	Yes	1.282	0.372	9/7	6/5	Yes	>732.8	102.5	Yes	Yes
15 M/54 years	Yes	0.354	0.354	10/8	7/5	Yes	279.16	102.5	Yes	Yes
16 M/62 years	Yes	1.282	1.282	21/15	18/9	Yes	>732.8	102.5	No	No
17 F/70 years	Yes	0.372	0.354	9/8	6/5	Yes	732.8	102.5	Yes	Yes
Total	100%	0.689 ± 0.451	0.42 ± 0.238	10.1 ± 4.6/ 7.5 ± 3.2	6.4 ± 3.4/ 4.6 ± 1.4	100%	519.95 ± 232.72	83.79 ± 21	82.3%	88.2%
Statistical analysis		Wilcoxon test $Z = -2.85$ $P = 0.004$		Wilcoxon test Static: $Z = -3.43$, $P = 0.001$ Dynamic: $Z = -3.31$, $P = 0.001$			Wilcoxon test $Z = -3.44$ $P = 0.001$			

F, female; M, male; NR, not reported (patients with defects involving the whole soft palate).

Table 3. Results of the deglutition assessment; the score ranges from 1 (severe complaints and unable to swallow) to 7 (no complaints)[24].

Patient number	Sex	Age, years	Deglutition score
1	F	58	6
2	M	76	7
3	F	54	5
4	M	67	7
5	M	50	6
6[a]	M	59	7
7	M	61	6
8	M	56	5
9	M	63	6
10	M	64	7
11	F	58	6
12	M	72	5
13	M	72	7
14	F	75	7
15	M	54	6
16	M	62	6
17	F	70	4
Total (mean ± SD)			6.1 ± 0.9

F, female; M, male; SD, standard deviation.
[a] See Supplementary Material, Video 1.

keeping an obturator still, so side effects such as mucositis and trismus may reduce patient compliance over time[18]. Furthermore, patients with soft palate obturators have shown reduced speech intelligibility in comparison with patients who have received a soft tissue reconstruction[4].

Nowadays, soft tissue transfer is preferred to obturators for the management of most soft palate defects. Various local flaps, such as buccal fat pad, buccal mucosa, and palatal advancement flaps, have been utilized successfully for the restoration of small lateral defects of the soft palate[4–6].

Regional flaps such as the pectoralis major, latissimus dorsi, temporalis muscle, and temporal myocutaneous flap are necessary to deal with the larger defects[7–9]. These flaps provide a large amount of tissue, but they are affected by gravity due to their bulk. Furthermore, positioning is difficult because of their stiffness, and they lack sensation, resulting in speech and swallowing difficulties[27].

For these reasons, fasciocutaneous microsurgical free flaps represent the technique of choice for soft palate reconstruction. Free flaps have the advantages of reliable vascularization, simultaneous flap elevation with tumour resection, and wide versatility. The radial forearm flap is the first choice[11,13–15]. The thin, pliable nature of this fasciocutaneous flap is suited to replace the oropharyngeal mucosa, but it might shrink during healing, especially after postoperative radiotherapy, increasing the posterior oropharyngeal space and reducing soft palate mobility. These effects may result in velopharyngeal incompetence, nasal speech, and nasal regurgitation. To overcome these disadvantages, many efforts have been made to standardize the forearm flap design[13,14,28,29]. In 2013, Massarelli et al. described the double-layer restoration of a soft palate defect using a single 'folded' tunnelized facial artery myomucosal island flap (t-FAMMIF), which allows mucosal resurfacing of both the oral and the nasal lining[18] (Table 1, case 4).

Buccinator myomucosal flaps pedicled on branches of the dense vascular network between the facial artery and the internal maxillary artery conform to the 'like with like' reconstruction principle, because they contain thin, mobile, well-vascularized, and sensitive tissue, like that excised or lost. The pedicle length and tunnelling technique increase the versatility of the flap, which can be used to properly restore even contralateral or total soft palate defects (Fig. 3).

As local flaps, buccinator myomucosal flaps can be readily and quickly harvested from the same surgical field as the defect, reducing the operative time. They do not

Table 4. Results of the quality of life assessment: Functional Assessment of Cancer Therapy – Head and Neck questionnaire (FACT-H&N). For each domain, the overall score is given as the sum of the individual item scores; these range from 0 (severe deterioration of the item assessed) to 4 (no deterioration of the item assessed)[25].

Patient number	Sex	Age (years)	Physical well-being (range 0–28)	Social/family well-being (range 0–28)	Emotional well-being (range 0–24)	Functional well-being (range 0–28)	H&N cancer sub-scale (range 0–40)
1	F	58	27	28	21	26	40
2	M	76	28	25	21	25	40
3	F	54	23	10	8	18	34
4	M	67	27	28	24	28	40
5	M	50	28	28	24	27	38
6	M	59	26	28	24	27	40
7	M	61	15	18	16	22	33
8	M	56	20	26	18	20	34
9	M	63	26	25	21	25	39
10	M	64	25	27	23	26	38
11	F	58	24	27	23	27	38
12	M	72	26	28	22	26	38
13	M	72	27	28	23	28	40
14	F	75	27	28	21	26	39
15	M	54	26	25	15	27	33
16	M	62	23	25	11	24	34
17	F	70	20	21	9	17	35
Total (mean ± SD)			24.6 ± 3.5	25 ± 4.8	19.1 ± 5.4	24.6 ± 3.4	37.2 ± 2.3

F, female; M, male; SD, standard deviation.

Table 5. Donor site morbidity assessment (performed by two clinicians and the patient). For each parameter, the score ranges from 0 (severe donor site morbidity) to 3 (no donor site morbidity)[26].

Patient number	Sex	Age (years)	Mouth opening (range 0–9)	Commissure symmetry (range 0–9)	Inner vestibule (range 0–9)	Cheek lining (range 0–9)	Aesthetics (range 0–9)
1	F	58	9	9	9	9	9
2	M	76	9	9	9	9	9
3	F	54	6	7	8	9	8
4	M	67	9	7	9	9	9
5	M	50	9	9	9	9	9
6	M	59	9	8	9	9	9
7	M	61	6	5	6	7	6
8	M	56	6	8	8	7	5
9	M	63	9	9	8	8	9
10	M	64	9	8	9	8	9
11	F	58	9	9	8	8	8
12	M	72	9	9	9	8	9
13	M	72	9	9	8	9	9
14	F	75	6	7	8	7	7
15	M	54	9	8	8	8	8
16	M	62	6	7	9	7	8
17	F	70	6	8	8	8	8
Total (mean ± SD)			7.9 ± 1.5	8 ± 1.1	8.3 ± 0.8	8.2 ± 0.8	8.2 ± 1.2

F, female; M, male; SD, standard deviation.

require two surgical teams, they entail shorter operating times, and they cause less donor site morbidity, with no evident scar[16–19]. Trismus may occur due to the donor site scar, but it can be avoided with postoperative massages of the area and using the advancement of a buccal fat pad during donor site closure.

Moreover, satisfactory functional and aesthetic results were reported for these myomucosal flaps (Tables 2–5). All patients experienced good recovery of flap sensitivity (Table 2). These excellent results, even better than those reported for fasciocutaneous reinnervated free flap reconstructions[30,31], may be related to the low fibrotic retraction of the buccinator muscle, which favours nerve sprouting from the surrounding tissues.

All patients started speech rehabilitation therapy after nasogastric tube removal, achieving satisfactory recovery of speech (Supplementary Material, Video 1) and swallowing (Table 3). The restoration of these oropharyngeal functions led the patients to report a satisfactory perception of their QoL (Table 4).

In conclusion, the buccinator myomucosal island flap appears to be a versatile and useful reconstructive method because of its intrinsic characteristics, and merits consideration with regard to reconstructive surgery for extensive soft palate defects. Obviously, this study presents some limitations due to its retrospective nature, the small number of patients assessed, and the lack of a control group reconstructed with other techniques (e.g., forearm free flaps). It is planned to perform further prospective studies to compare the functional outcomes of different types of soft palate reconstruction in homogeneous groups of patients, either by tumour characteristics, or in terms of treatment modalities.

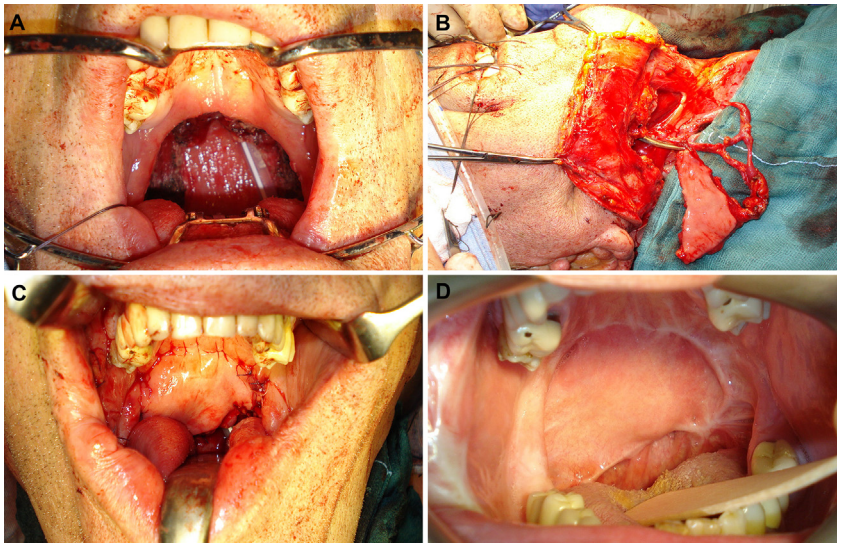

Fig. 3. Case 6, a 59-year-old male patient. (A) Total soft palate defect following tumour ablation. (B) A tunnelized facial artery myomucosal island flap (t-FAMMIF) was harvested from the right cheek. (C) The flap was sutured at the recipient site to reconstruct the soft palate and the two tonsillar lodges. (D) Follow-up at 16 months.

Funding

None.

Competing interests

None.

Ethical approval

Ethical approval was given by the Ethics Committee of the University of Sassari (Ref. No. 69/2016).

Patient consent

Written consent was obtained to publish the clinical photographs.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.ijom.2017.11.012.

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