

# Oral rehabilitation of oncology patients with dental implants after reconstruction surgery with autogenous flaps

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**Abstract. – OBJECTIVE:** Reconstruction after radical cancer surgery in terms of function and esthetics can be quite demanding. The aim of this study was to evaluate oral rehabilitation with autogenous flaps and dental implants for maxillofacial reconstruction in oncologic patients after implant insertions.

**MATERIALS AND METHODS:** The study consisted of 19 patients diagnosed with either squamous cell carcinoma, fusocellular carcinoma, or mucoepidermoid carcinoma. The reconstruction of the maxillofacial defects was done with autogenous flaps (free fibular flap, antero-lateral thigh flap, radial forearm flap, or rotational pedicled temporal muscle flap). Implants were inserted on the average 32.03±19.51 months after reconstructive operations. A total of 82 implants were inserted. Mean follow-up after maxillo-facial surgery was 7.2 years (mean 86.56±22.04 months). Mean follow-up after implant insertions was 4.5 years (mean 54.6±21.82). Primary outcome was implant survival. Secondary outcome was evaluation of post-surgical complications.

**RESULTS:** There were surgical revisions in seven patients after reconstructive surgery with flaps, mainly due to tumor relapse. Complications were seen in 11 patients. There was one implant failure. Overall implant survival rate was 98.8%. No relations were found between implant survival rate and gender, type of tumor, type of microvascular free flap, radiation therapy, chemotherapy, and prosthesis type.

**CONCLUSIONS:** According to the results of this study, oral rehabilitation with dental implants inserted in free flaps for maxillofacial reconstruction after ablative oncologic surgery can be considered as a safe treatment modality with successful outcomes.

## Key Words:

Oncologic patients, Maxillofacial reconstructive surgery, Autogenous flaps, Dental implants, Oral rehabilitation.

## Abbreviations

FFF: Free fibula flaps; RFF: Radial forearm flaps; ALT: Anterolateral free flaps; DCIA: Iliac crest bone flap using the deep circumflex iliac artery; FC: Fusocellular carcinoma; MEC: Mucoepidermoid carcinoma; SCC: Squamous cell carcinoma.

## Introduction

One of the main challenges of the maxillofacial reconstruction is the limited supply of well-suited local tissues, that are needed to approximate lost bone, muscle, nerves, skin, and mucosa. Since the late 1950s, the use of distant, regional and pedicled flaps has been a standard treatment method for maxillofacial reconstructions<sup>1</sup>. Currently, the reconstruction of large defects in the maxillofacial region with free autologous tissue transplants and microvascular anastomosis is accepted as the gold standard with well-established protocols<sup>2-4</sup>.

During the last decades different distant donor sites have been utilized in literature for reconstruction of large maxillofacial defects by free tissue transfer, and re-anastomosis of vessels for large complex tissue grafts<sup>4-6</sup>. These

composite free flaps can be harvested from the fibula, iliac crest, scapula, or radius, more recently, antero-lateral thigh flap (ALT) and the iliac crest bone flap using the deep circumflex iliac artery (DCIA) were introduced with successful results<sup>7-17</sup>. These options have permitted the surgeon to resect large tumors and to provide at least partly functional and aesthetic reconstruction and increase in the quality of life for the oncologic patient. Each flap has its unique features and no single kind of osseous or osteocutaneous flap is considered capable of resolving the wide variety of defects<sup>9</sup>.

Since its first introduction by Hidalgo et al<sup>10</sup> in 1989, free fibula flap (FFF) has become a preferred graft for oromandibular reconstructions<sup>9-10</sup>. The FFF is the primary choice for reconstruction of a large variety of mandibular defects due to its ability to incorporate a reliable skin paddle with bone flap, consistency in size, vascular pedicle length, vessel diameter<sup>11</sup>, and low donor site morbidity<sup>9</sup>. The long segment of bone, up to 25 cm in length, can tolerate multiple osteotomies without compromising its blood supply<sup>12-13</sup>. Reinnervation is also possible, using the lateral cutaneous sural nerve<sup>14</sup>. Another major advantage of FFF is the ability to use a two-team approach<sup>13</sup>.

ALT is a soft tissue perforator free flap, which was first described by Song et al<sup>15</sup> in 1984. The length of the soft tissue pedicle ranges from 8 to 16 cm and it runs in the intermuscular septum between the rectus femoralis and vastus lateralis muscles with a motor nerve supply from vastus lateralis<sup>11</sup>. Generally, minimal donor site morbidity is associated with ALT flaps<sup>11</sup>.

The radial forearm flap (RFF) was first reported by Yang et al<sup>16</sup> in 1981. The pedicle length in average ranges from 10 to 12 cm with good vessel diameter of 2.5 mm<sup>11-16</sup>. The sensory nerves also can be harvested with the flap to provide sensory reinnervation to the tongue<sup>11,17</sup>. Soutar et al<sup>18</sup> in 1983, reported ten cases of intraoral reconstruction using a radial forearm flap, including radial bone to replace segments of the mandible. Limitations on the use of RFF are based on two main considerations: adequate blood supply to the donor site hand and the high rate of fracture in the radius after harvesting<sup>9,11</sup>. Another problem is the bone thickness harvested from the radius, which is too small to endure stress in the mandible<sup>9,11</sup>.

The temporal arterial system provides a suitable donor site for head and neck reconstruction

and consists of the temporalis muscle (TM) flap and temporoparietal fascial (TPF) flap. These temporalis system flaps were first introduced in the late 1800s, and since their first presentation have developed gradually and gained popularity in the craniomaxillofacial region. Currently, they are considered as safe, versatile flaps with adequate bulk and flexibility to be mobilized to adjacent defects<sup>19-29</sup>. Especially in the field of maxillofacial surgery, the popularity of temporalis system flaps has increased over time due to the properties, such as, proximity to the recipient sites, low donor site morbidity and the versatility in flap design by enclosing different tissue types such as bone, muscle fascia, and skin<sup>11</sup>. They are suitable to be used in diversity of oral and maxillofacial defects, including ablative cancer surgery, facial reanimation, temporomandibular joint surgery, and congenital defects<sup>24-27</sup>. Furthermore, they are versatile to be used for reconstruction of defects in oral region (tongue, maxilla, palate, and mandible up to canine), temporomandibular joint, skull base, cheek, and orbit and eyelids<sup>24-27</sup>.

Various authors, in the literature, evaluated oral rehabilitation with dental implants placed in autologous bone grafts in head and neck oncology patients, reporting promising results<sup>30-32</sup>. Reconstruction of soft and hard tissues with the use of autogenous flaps might reestablish the aesthetics of the patient for the most part. However, due to the loss of alveolar tissues and teeth, the physiological function of the patient, such as, chewing and speech can represent a major problem after oncological ablative surgery<sup>11,33,34</sup>. Following surgical reconstruction for radical cancer surgery, patients can suffer from functional disabilities and esthetic deformity. The use of prostheses without dental implants may be compromised by changes in oral anatomy of the patients that underwent major oral and maxillofacial reconstructive surgery. The quality of life of the oral cancer patients can be dramatically improved by dental implant treatment; however, there are still limited reports in literature that assess the outcomes<sup>30-32,35-38</sup>.

The purpose of this retrospective study was to evaluate the outcomes and complications following reconstructive surgery with autogenous flaps and dental implants. The study population consisted of oncology patients that had received either microvascular free flaps or pedicled autogenous flaps and dental implants for oral rehabilitation.

## Materials and Methods

The study population consisted of oral oncology patients that had received microvascular free flaps and dental implants at Milano University in the department of Maxillofacial Surgery. The inclusion criterion was oncologic patients who needed maxillofacial reconstruction and oral rehabilitation with dental implants after resection and reconstructive surgery, with or without adjunctive radiation therapy. The patients that had no implant inserted or had dental implant inserted in other clinics after reconstructive surgery were not included. No other specific exclusion criterion was set. Nineteen patients (9 Male, 10 Female) were included. Patients were treated between January 2013 and May 2022 in the IRCCS Ca' Granda Ospedale Maggiore Policlinico unit at the Department of Oral Science and Maxillofacial surgery, University of Milan.

The pre/post-operative and surgical protocol was described in detail in the previous publications by the same team of authors<sup>35,36</sup>. In brief, the first stage maxillofacial operation was performed simultaneously by two teams. This included resection surgery in the head and neck region with simultaneous harvesting of autogenous flaps. Revision surgeries were applied whenever needed. Second stage implant placement surgeries were performed with interval period between two surgeries. None of the patients received immediate implant insertions and immediate loading of the dental implants.

In cases of postoperative radiation therapy, 66 or 60 Gy was delivered in fractions of 2 Gy given daily for 5 days each week. In patients with irra-

diated grafted residual bone, a minimum interval of 12 months elapsed between irradiation and implant placement. In cases of chemotherapy, Cisplatin (CDDP 30 mg/mEq) intra venous medication was administered when needed.

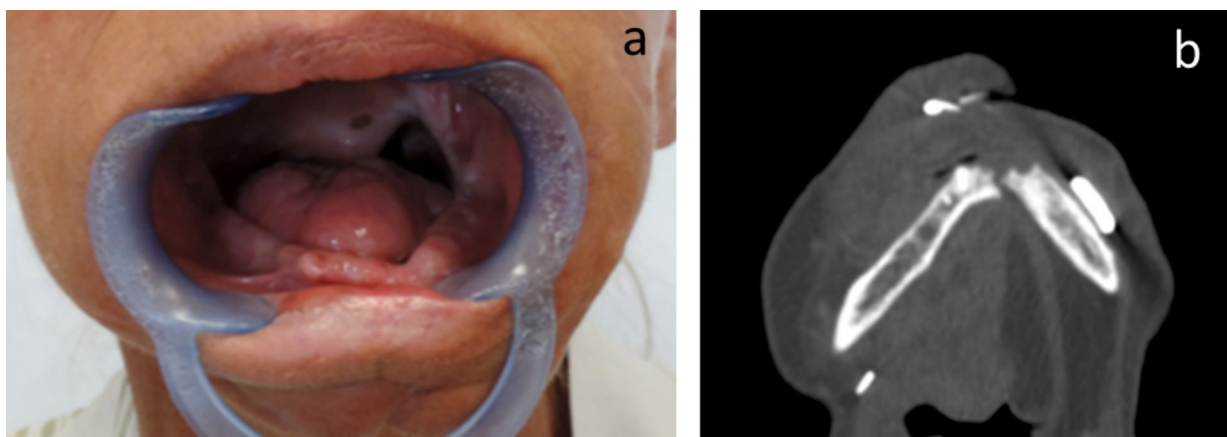
### Evaluation of Outcomes

Implant survival was the primary outcome of the study. Implant survival was evaluated as successful in the absence of following: spontaneous implant failure, implant mobility, peri-implant radiolucency, and infection at the implant site. The complications following reconstructive and implant surgeries were assessed as secondary outcomes. A complete clinical case is documented in Figures 1 to 5.

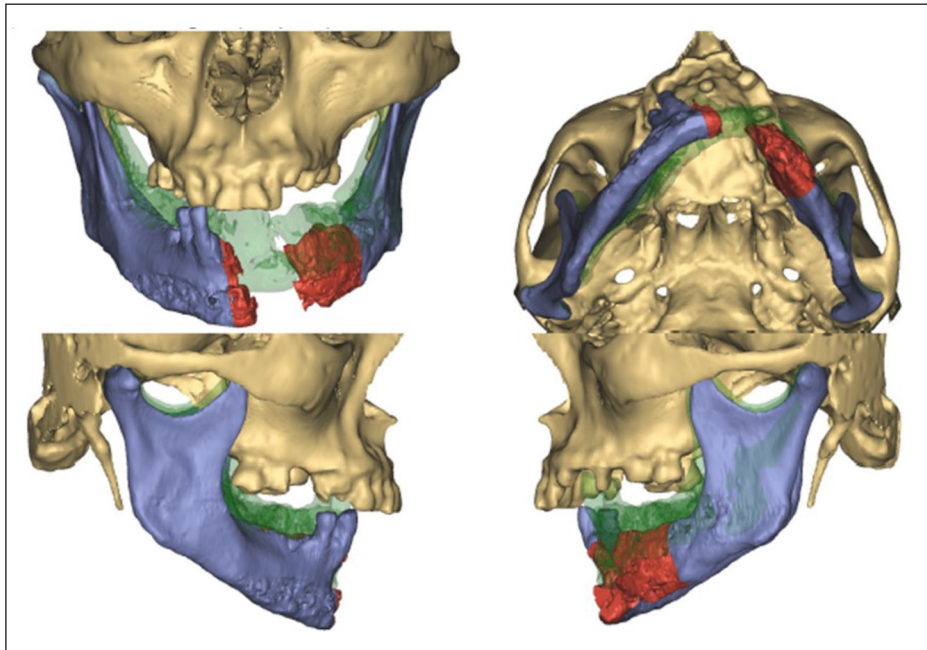
### Statistical Analysis

GraphPad Prism 5.03 (GraphPad Software, Inc., La Jolla, CA, USA) was used for statistical analysis.  $p=0.05$  was considered as the significance threshold.

Mean values and standard deviation (SD) data was used in calculations of descriptive statistics for quantitative variables normally distributed. The d'Agostino and Pearson omnibus test was used to evaluate normality of distributions. Both the patient and the implant were considered as the unit of analysis. The effect of each variable (gender, patients' condition, flap type, site, radiotherapy, chemotherapy, type of prosthesis, smoking habits) on implant survival was evaluated by using the Fisher's exact test given the low incidence of complications in each subgroup. In cases with more than two categories for a given variable, the generalized Fisher exact test was



**Figure 1.** Representative preoperative images of a 59 y-old female patient with SCC. (a) Intraoral view and (b) radiographic CBCT image.



**Figure 2.** The preoperative 3-Dimensional (3D) CAD/CAM images of the patient showing the location of the mandibular defect.

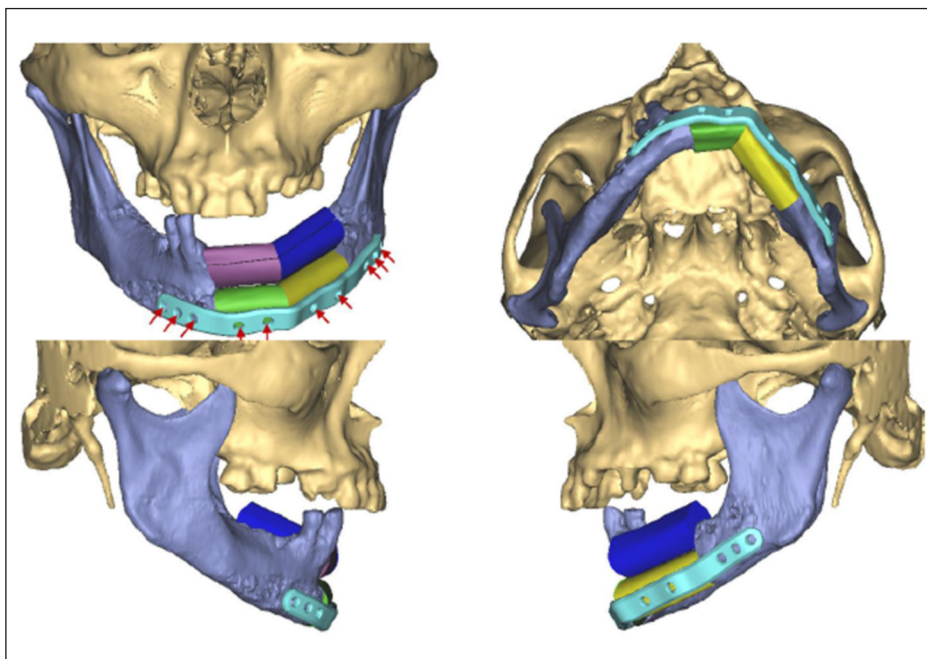
applied using the online free package SISA (Simple Interactive Statistical Analysis-<http://www.quantitativeskills.com/sisa/>).

### Results

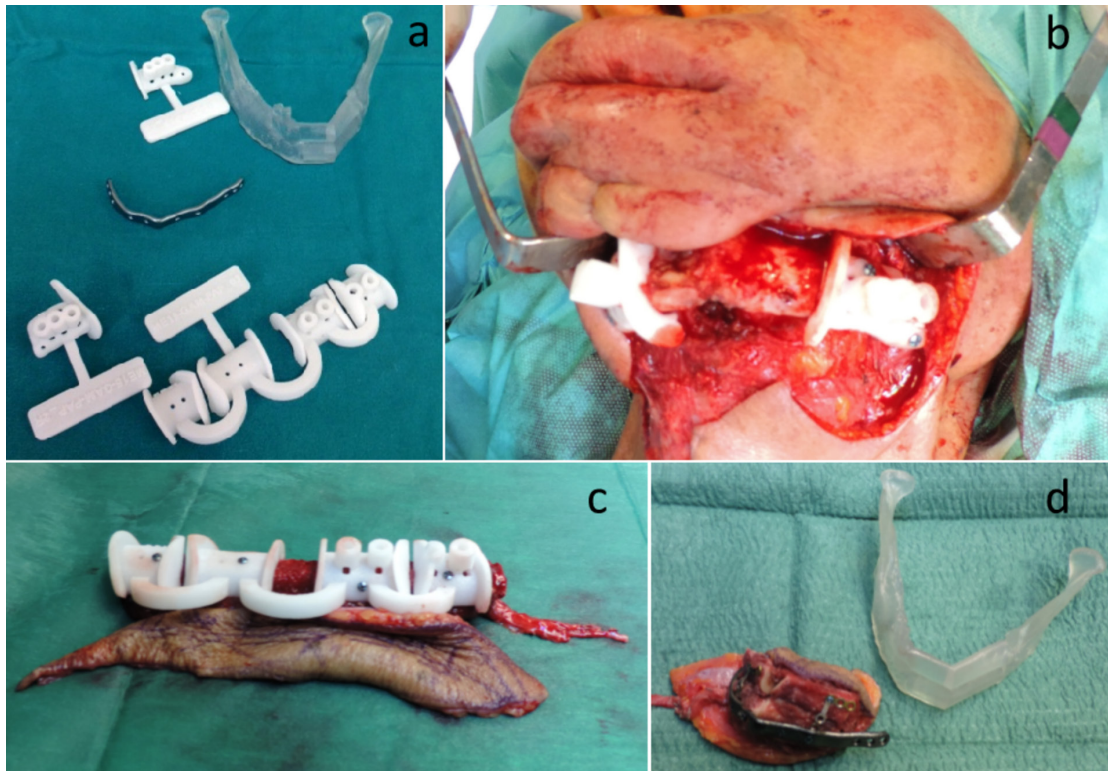
The study group consisted of 19 patients that received autogenous flap maxillofacial reconstructions (9 FFF, 5 RFF, 1 rotational pedicled

temporal muscle flap, and 4 ALT). A total of 82 dental implants were inserted (44 dental implants in free flaps and 38 in native bone).

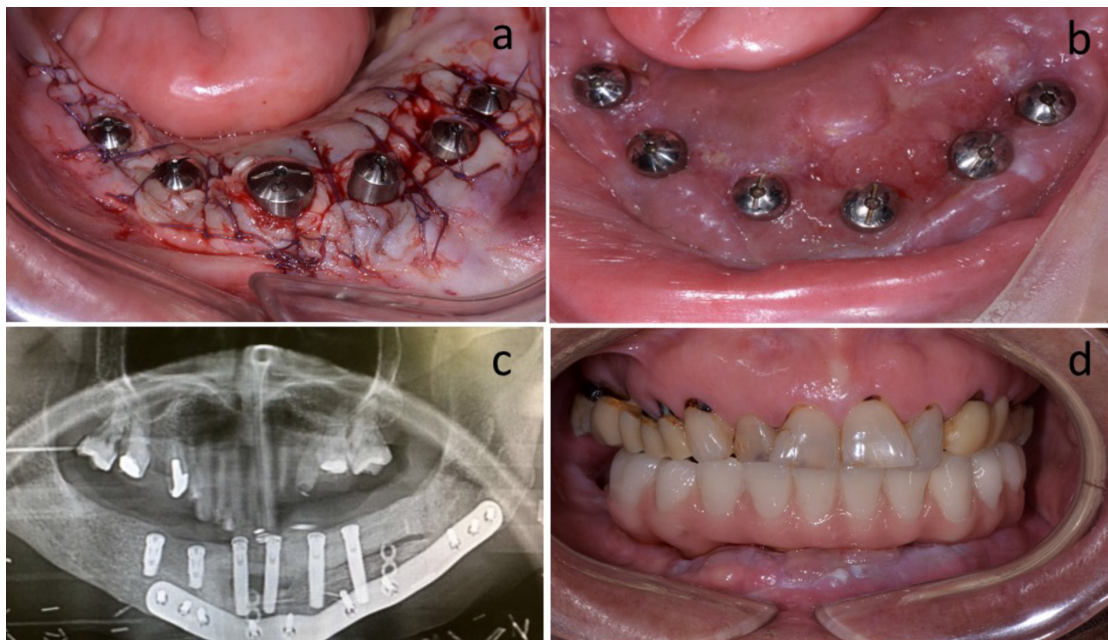
- 50 Biomet 3i<sup>®</sup> implants (Zimmer Biomet, Biomed SpA, Vicenza, Italy)
- 21 Megagen Anyone<sup>®</sup> implants (Megagen Italia Srl, Merone, Italy)
- 3 Intra-Lock Blossom<sup>®</sup> implants (Intra-Lock System Europa SpA, Salerno, Italy)



**Figure 3.** The preoperative 3D CAD/CAM surgical planning images of the patient, showing the planned positioning of the flap and fixation plate.



**Figure 4.** Intraoperative images (a) Patient specific guides, reconstructive 3D titanium plate and 3D anatomical model of the mandible; (b) patient with cutting guides for resection; (c) custom made reconstruction guides with the harvested flap in position; (d) 3D anatomical model and patient specific reconstructive 3D titanium plate with the harvested free fibular flap in position.



**Figure 5.** Images of the patient after implant surgery (24 months after reconstructive surgery with microvascular free fibular flap). (a) postoperative intraoral image of the patient on the day of the insertion of the implants; (b) intraoral image of the patient after suture removal, ten days after implant placement; (c) panoramic x-ray of the patient at 6-month follow-up before prosthetic rehabilitation; (d) intraoral view of the patient after the delivery of the prosthesis.

- 4 IDI evolution<sup>®</sup> implants (IDI evolution Srl, Concorezzo, Italy)
- 4 NORIS<sup>®</sup> implants (Noris Medical Ltd., Israel).

Second stage implant placement surgeries were performed with a mean interval period between two surgeries as: 32.03±19.51 months (min 4.7-max 78.2 months).

In the study population there were one fusocellular carcinoma (FC), one mucoepidermoid carcinoma (MEC), one low grade salivary gland carcinoma and 16 squamous cell carcinoma (SCC) patients.

The mean age of the patients at the time of surgery was 63.33 years [Standard Deviation (SD) 14.28] ranging from 41 to 82 years.

Implants were inserted on the average 32.03±19.51 months after reconstructive operations. A total of 82 implants were inserted. Mean follow-up after maxillo-facial surgery was 7.2 years (mean 86.56±22.04 months). Mean follow up after implant insertions was 4.5 years (mean 54.6±21.82).

Mean follow-up after maxillofacial surgery was 7.2 years (mean 86.56±22.04 months, range 16.03 to 114 months). Mean follow-up after implant insertions was 4.5 years (mean 54.6±21.82, range 1.5 to 77.3 months). Implant survival rates and patient demographics, such as, age, gender, oncologic condition, radiotherapy, chemotherapy, smoking, flap type, implant site and type of prosthetic denture are listed on Table I. Maxillofacial surgery resection sites (2 maxillary, 17 mandibular sites) and flap types are listed on Table II.

18 the patients received prosthesis (8 Toronto, 1 removable prosthesis, 3 fixed dental bridge restorations, and 6 temporary prosthesis). No relations were found between implant failure and gender, type of tumor, type of microvascular free flap, radiation therapy, chemotherapy, and prosthesis type. There was no correlation between any variable and success.

According to the results, overall implant survival rate was 98.8%. There was one implant

**Table I.** Patient demographics and implant survival.

Patient	Characteristics	Patients with failure/Total no of patients	p-value	Failed implants/Total no of Implants	p-value
Gender	Male	0/9	0.55	0/35	0.58
	Female	1/10		1/47	
Site	Mandible	1/17	0.90	1/76	0.93
	Maxilla	0/2		0/6	
Type of prosthesis	Temporary	0/6	0.21	0/16	0.14
	Toronto	0/8		0/50	
	Removable	0/1		0/4	
	Bridge	1/3		1/10	
Smoking habits	smoker	0/2	0.90	0/8	0.90
	No smoker (9 ex-smokers)	1/17		1/74	
Age	⇒ 65	1/14	0.75	1/60	0.73
	< 65	0/5		0/22	
Radiotherapy	yes	0/10	0.50	0/38	0.54
	no	1/9		1/44	
Chemotherapy	yes	0/3	0.85	0/14	0.83
	no	1/16		1/68	
Oncologic condition	SCC	1/16	0.85	1/71	0.87
	FC	0/1		0/3	
	MEC	0/1		0/4	
	Low grade salivary gland carcinoma	0/1		0/4	
Flap type	FFF	1/9	0.50	1/40	0.49
	RFF	0/5		0/22	
	ALT	0/4		0/16	
	Rotational Pedicled Temporal	0/1		0/4	
	Muscle Flap				
Total		1/19 (94.7%)		1/82 (98.8%)	-

SCC = Squamous cell carcinoma, FC = Fusocellular carcinoma, MEC = Mucoepidermoid carcinoma, FFF = Free fibular flap, ALT = Antero-lateral thigh flap, RFF = Radial forearm flap.

**Table II.** Maxillofacial surgery resection sites and flap types.

Maxillofacial surgery resection sites (1 Maxillary, 16 Mandibular sites)	Flap type
Mandibular trigone, soft palate, anterior tonsillar pillar	ALT
Right mandible from trigone till mental foramen, mandible right from 45 to 48	ALT
Half-base of the tongue and oral floor (right) removal	ALT
Upper maxilla from 13 till pterygoid process	ALT
Oral floor and tongue right, bone baguette	RFF
Oral floor and tongue left, bone baguette	RFF
Mandibular trigone, cheek, bone baguette	RFF
Mandibula left and cheek mucosa	RFF
Oral floor and half tongue left	RFF
Mandible left from 41 till 35	FFF
Mandible left and oral pelvis+ tongue left	FFF
Left mandible	FFF
Mandibular trigone left	FFF
Right mandible body	FFF
Right mandible including angle	FFF
Right mandible	FFF
Left mandible from 33 till the angle	FFF
Oral pelvis, tongue base, submandibular left gland, mandible body	FFF
Hemi-maxillectomy left	Rotational Pedicled Temporal Muscle Flap left

FFF: Free fibula flaps; RFF: Radial forearm flaps; ALT: Anterolateral free flaps.

failure (inserted in FFF) in a female patient due to SCC relapse. As treatment, the implant was removed at a surgical revision appointment. There were no implant failures in native bone.

Six of the patients had additional health conditions as follows, 1 breast cancer, 1 ovarian and uterus cancer, 1 colorectal polyp, 1 mucopidermoid cancer and 1 patient with hypertension that had heart stroke and has pace-maker and stent.

There were post-operative maxillofacial complications in eight patients. Two of these patients had additional complications after implant insertion operations, and one of these patients lost one implant because of SCC relapse in the same region.

Post-operative complications and treatments modalities for flap reconstructions are listed in Table III. Three of the patients had minor complications after delivery of dental prosthesis and in each case, prosthesis was adjusted without any additional problems (One patient with oral mucositis, and two patients with chipping of dental prosthetics).

Ten patients received radiotherapy and two of them developed osteoradionecrosis. Nine patients did not receive any radiation therapy. Detailed information about radiotherapy dose, modality and complications associated with radiotherapy for each patient are listed on Table IV.

## Discussion

Microvascular surgery currently represents one of the most preferred methods for maxilla-mandibular reconstruction. Whenever possible, immediate reconstruction at the time of segmental resection provides the best functional and aesthetic result<sup>6</sup>. Although routine, these procedures are limited by the available suitable donor tissue size, shape, and function<sup>6</sup>. There are various flap options, and the quality of each type of bone and accompanying soft tissue is different and no single kind of osseous or osteocutaneous flap can be considered capable of resolving the wide variety of mandibular defects. A suitable flap should be selected with caution according to the type of bone and soft-tissue defect and patient condition<sup>9</sup>.

Oral rehabilitation with implant supported prosthesis after reconstruction of the lost tissues with autogenous flaps can improve the quality life of the patients significantly, in terms of speech, deglutition and aesthetics<sup>30-32</sup>. Oral rehabilitation success might decrease because of the insufficient retention and stability of the prosthesis. Survival rates of free flaps and subsequent implants were reported by various authors with promising results<sup>31,32,35-38</sup>.

The bicortical bone of FFF has a perfect ability to accept oral implants with promising survival

**Table III.** Flap complications and treatment modalities.

<b>Complications after ALT flaps</b>
<ul style="list-style-type: none"> <li>• SCC relapse in oral pelvis. Treatment: surgical removal</li> <li>• Cutaneous fistula. Treatment: surgical revision.</li> <li>• Osteoradionecrosis and pseudarthrosis at 8 months in the right mandible. Treatment: FFF right reconstruction after partial mandibulectomy</li> <li>• Trismus. Treatment: scar debridement with forearm reconstruction</li> </ul>
<b>Complications after RFF flaps</b>
<ul style="list-style-type: none"> <li>• Cutaneous fistula. Treatment: pectoralis flap reconstruction</li> <li>• Intraoral small dehiscence of sutures and spinal nerve suffering with paresthesia of hand's first finger. Treatment: controls, solved by the time</li> <li>• Following implant insertion: White lesion in posterior left tongue with biopsy that reveal hyperkeratosis. Treatment: Prosthetic adjustments and controls.</li> <li>• Mandibular pseudarthrosis and osteoradionecrosis. Treatment: Reconstructive surgery with FFF. 11 months after reconstruction a tumor relapse located in left tongue and oral floor. SCC surgically removed and reconstructed with soft tissues from forearm flap.</li> </ul>
<b>Complications after FFF flaps</b>
<ul style="list-style-type: none"> <li>• Painful neuropathy of the lower face 3<sup>rd</sup> (left mandible). Treatment: Clinical follow up controls and pain therapy.</li> <li>• Tumor relapse of SCC after 10 months in inferior right mandibular crest. Treatment: surgical revision and removal of 1 implant.</li> </ul>

FFF: Free fibula flaps; RFF: Radial forearm flaps; ALT: Anterolateral free flaps.

**Table IV.** Radiotherapy and complications after radiotherapy

<b>Patient number and radiotherapy</b>	<b>Complications</b>
1. No	Cutaneous fistula during osteodistraction SCC relapse 3 years after MX surgery
2. No	None
3. No	None
4. No	Oral mucositis
5. No	SCC relapse 4 years after MX surgery
6. Yes (66Gy Total)	Cutaneous fistula after 2 months and osteoradionecrosis after 10 months
7. Yes (66Gy Total; 59Gy N+; 54 Gy N-) ended in 20/03/2017	Intraoral small dehiscence of sutures after one month, hyperkeratosis after 2 years
8. No	None
9. Yes 66Gy Total; barrage 2Gy (40 Gy surgical area; 36Gy high risk areas: N+; 34Gy low risk areas: N-)	None
10. Yes but interrupted because of mucositis	Oral mucositis
11. No	Neurophatic pain at the lower face 3rd left side SCC tumor relapse 4 years after MX surgery and one implant failure
12. Yes (66Gy T; 56Gy N)	Cutaneous fistula after 2 months
13. Yes (60Gy)	None
14. No	None
15. Yes (60Gy Total)	Mandibular pseudoarthrosis and osteoradionecrosis after 6 months SCC tumor relapse located in left tongue and oral floor after 4 years
16. Yes (66Gy surgical area; 59,4 Gy high risk areas; 51,6 Gy low risk areas)	Trismus after 2.5 years
17. Yes (66GY T; 56Gy N)	None
18. Yes (66GY T; 56Gy N)	None
19. No	None

MX: Maxillofacial, SCC: Squamous cell carcinoma.



rates reported in literature<sup>32</sup>. In this study FFF was the most applied type of free flap (9 out of 19 patient) due to several advantages it offers, such as available bone length and thickness, low donor site morbidity. According to the results, there was one implant failure in a patient who received FFF for reconstruction. However, the reason of this failure was the recurrence of the tumor, and it was not related to the success of the FFF that was applied.

In our clinic, radial forearm flap (RFF) was selected when a soft tissue graft (with small amount of bone) is needed in regions such as, tongue, oral floor, cheek, and a smaller bone baguette. Main concern about RFF is that bone graft obtained is too small and weak to manage the stress of the mandible and fractures might occur more when compared to FFF<sup>9,11</sup>. In this study, radial forearm flap (RFF) was the second most applied free flap (5 out of 17 patients). There were no implant failures in RFF flaps, however there were post-operative complications in three patients. In two of the patients, additional reconstructive surgeries were performed with success. The other patient had minor prosthetic adjustments due to hyperkeratosis lesion and showed no additional complications.

According to the results of this study with ALT flaps, post-operative complications were seen in three patients with no implant failures. All these patients received additional surgical interventions (1 FFF, 1 RFF reconstruction and 1 surgical removal of SCC). In cases of larger soft tissue defects ALT flaps were chosen, since it offers many advantages as a soft tissue graft. ALT can be raised as fasciocutaneous or myocutaneous and it can be custom designed to fit almost any tissue defect in the head and neck<sup>39,40</sup>.

The only pedicled flap that is evaluated in this report was a rotational temporal muscle flap in a hemi-maxillectomy reconstruction. This patient received the dental implants after 13 months of first surgery and still has temporary prosthesis as oral rehabilitation and showed no intra- or post-operative complications.

A great advantage of all these three grafts (FFF, ALT, RFF) is that the two-team surgery (one team performing resection of the tumor site, the other performing harvesting of the graft) can be easily performed simultaneously without the need for patient repositioning. While the main advantage of a pedicled temporalis muscle flap is the proximity of the oral and maxilla-facial area with good blood supply. In the present work, al-

though there were complications associated with microvascular free flaps, none of these were related to success or failure of the procedure applied. As a rule, for a proper flap selection, the defect and patient health condition are considered first. The complications were mostly due to patient specific factors, mostly dependent on health condition of the patient.

There are opposing arguments in literature about the timing of radiotherapy and negative effect of radiotherapy on bone regeneration<sup>41,42</sup>. According to the results of this present study there was no difference between irradiated and non-irradiated patients in terms of implant failure, just one patient that received radiation therapy had an implant failure due to SCC relapse, not because of irradiation. However, 50% of the patients that received radiation had complications, such as osteoradionecrosis and cutaneous fistula, trismus, and mucositis. In non-irradiated patients one cutaneous fistula was seen (one out of nine). Post-operative irradiation can have negative effects on bone healing in terms of incorporation of the graft and implants.

In this work, no prosthetic superstructure was found to be particularly favorable in terms of implant survival mostly due to the diverse individual variability regarding the location and dimension of the maxillofacial defect. All the patients had received temporary prostheses, and none of them had immediate loading of the implants. Decision for prosthesis type and time of delivery of the final prosthesis was dependent on many factors such as health condition of the patient and dimensions of the defects and the flaps. The limited number of patients included in the evaluation and retrospective design of this study can be considered as major limitations. Future studies should focus on longer follow up periods with at least 10-year outcomes of these rehabilitations with evaluation and comparison of guided CAD/CAM surgery and reconstruction.

## Conclusions

Oral rehabilitation with implant-supported prosthesis following maxillo-mandibular reconstruction with autogenous flap after ablative oncologic surgery can be considered as a safe procedure with promising survival rate and successful aesthetic and functional outcomes, which can dramatically increase the quality of life of such patients.

### Conflict of Interest

The authors declare no potential conflicts of interest with respect to the authorship and/or publication of this article.

### Acknowledgements

None.

### Ethical Permission

The protocol of this study was approved by the Ethics Committee of Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Regione Lombardia with date 21/02/2017 (Ethics Committee of Milano Area B Act 478/2017). All patients were treated in agreement with the principles laid down in the Declaration of Helsinki on medical protocol and ethics. A signed informed consent form was obtained from all subjects for the medical and surgical procedure and for the use of data in the research.

### Availability of Data

Data is available upon request.

### Funding Statement

The authors received no specific funding for this work.

### Authors' Contribution

F.G., and M.D.F. conceived and designed the analysis. Databases were searched and data was collected by F.G., A.R.B., P.B. and M.D.F. Maxillofacial surgical interventions were performed by A.R.B., A.B., G.B., and A.B.G. Oral implant rehabilitations were done by F.G., G.B., C.M. and M.R.D.P. All the authors contributed on analysis and interpretation of data for the work. F.G. drafted the work and wrote the manuscript with input from all authors. A.B., A.R.B., C.M., G.B., A.R., D.S.R., M.R.D.P., M.D.F., C.M., A.B.G. revised the work critically for intellectual content. Integrity of the work was appropriately investigated and resolved by all authors. All authors contributed and approved equally to the final version of the manuscript.

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