# FREE FLAPS FOR HEAD-AND-NECK RECONSTRUCTION: RETROSPECTIVE ANALYSIS OF A SINGLE-CENTRE EXPERIENCE

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**SUMMARY**

*Objectives*. We analysed the results of free-flap surgery in the head-and-neck area performed in a tertiary-care Italian hospital; we focus on the evolution of our approach toward bony reconstructions.
*Methods*. We retrospectively studied all patients who underwent free-flap reconstructive surgery in our institution from April 2010 to June 2018. Flap harvesting, disease aetiology, defect site, success and complication rates, demographic data, and comorbidities were analysed.
*Results*. A total of 134 free flaps was harvested in 127 patients. Fibular and radial forearm flaps were the most commonly used (45.5 and 26.1%, respectively). The overall free flap placement success rate was 96% and the complication rate was 16.4%.
*Conclusion*. Free tissue transfer has become a safe and reliable means of repairing soft tissue and bony defects of the head-and-neck region. Tailored surgery optimises outcomes and patient satisfaction.

**Key words:** microsurgery, head-and-neck cancer, free flap, CAD/CAM.



## Introduction

Free flap reconstruction in the head-and-neck region affords excellent success rates at a cost comparable to pedicled or transposition flap reconstruction (1). Free flap surgery is the gold standard of head-and-neck reconstruction, with a success rate of over 95% (2). For head-and-neck soft tissue reconstruction, the radial forearm free flap (RFFF), the anterolateral thigh flap (ALTF), and the latissimus dorsi free flap are preferred (3). The fibular free flap (FFF) is the first choice when treating segmental mandibular defects (4), and was the flap most frequently used by Authors for bony reconstruction; the deep circumflex iliac artery flap (DCIA), the scapula free flap, and the medial condyle femoral free flap were less frequently selected. We reviewed both our reconstructive outcomes and surgical evolution. For many years, we have sought to tailor head-and-neck reconstructive surgery to the individual patient and reduce postoperative morbidity (5). The traditional method of mandibular reconstruction, featuring segmental osteotomies of the fibula followed by hand-bent fixation, is being replaced by advances in computer-assisted surgery (CAS), especially computer-aided design/computer aided manufacturing (CAD/CAM), which allows detailed preoperative three-dimensional (3D) virtual surgical planning, and creation of customised implants, including plates, cutting guides and surgical hardware. These advances ensure reproducible and accurate results (6), reduce the surgical and ischaemic times (7), and improve facial symmetry and functional outcomes (8).

## Methods

We reviewed the records of all patients who underwent free-flap reconstructive surgery at "IRCCS Fondazione Ca' Granda Ospedale Maggiore Policlinico" of Milan between April 2010 and June 2018. Reconstructions were performed by various surgeons using a two-team approach. All microsurgical anastomoses were performed by the senior Author. Clinical data collected included age at surgery, pathology, site of reconstruction, flap type, previous radiotherapy, primary or secondary reconstruction status, flap survival, patient survival, complications and complication rates, use of anticoagulants, co-morbidities. Complications after free-flap surgery were divided into major and minor issues; major complications were those requiring revision surgery; minor complications were resolved conservatively (9, 10). Neither the preoperative nor postoperative protocols for soft tissue free flaps transfer changed significantly over the investigation period. For ALT flaps and the perforator skin islands of FFFs, pencil Doppler was used to indicate the perforator vessels. For RFFFs, the Allen test was performed to assess the adequacy of hand circulation via the ulnar artery. However, we introduced many innovations in bony reconstruction. In 2013, we introduced CAD/CAM to treat selected malignancies and all benign pathologies involving mandibular resection.CT scans affording 64-slice resolution of the head and lower extremities were obtained preoperatively. Concomitant leg angiography/CT was performed to rule out anatomical abnormalities. The Digital Imaging and Communications in Medicine (DICOM) data obtained were processed using ProPlan CMF software (Materialise, Leuven, Belgium; http://www.materialise.com) and, usually within 2-3 days, the DICOM files were employed for 3D virtual planning using the Web-based Synthes PROPLAN CMF service (GoToMeeting; Citrix Online, Santa Barbara, CA, USA) with the support of clinical engineers at Materialise in Belgium. The planning time was usually 1 h, but varied by case complexity. No specific hardware is needed; an on-line PC suffices. Segmentations of both the mandible and the fibular bone are simulated on 3D virtual models. Mirroring and superimposition of the non-affected side, assisted by surgical experience, facilitates shaping of the reconstructed mandible. After final validation, patient-specific mandibular and fibular surgical cutting guides are created using the previously determined osteotomy lines and angles. Finally, the 2.0-mm-thick plate is moulded to include at least three screw holes on either side of the osteotomy lines. Production requires up to 10 working days. For benign pathologies, CAD/CAM allows both mandibulectomy and fibular flap placement to be achieved using intraoral access only; a small cervical incision is required for anastomosis. At commencement of surgery, antibiotics (ampicillin/ sulbactam, as per our institutional protocol) were initially administered and continued for 10 days thereafter. An anticoagulant (intravenous heparin) was given during surgery, prior to anastomosis. The pedicle geometry was optimised and pressure on vessels minimised by correct patient positioning and avoiding placement of circular bandages around the neck (13). Postoperatively, the flap was clinically monitored every 2 h for the first 24 h via capillary refill, while in the absence of an island monitor, the pedicle was checked using percutaneous Doppler ultrasound. Patients received prophylactic low-molecular-weight heparin during the hospital stay and continued on antiplatelet therapy for 1 month after discharge.

## Results

A total of 127 patients (78 men and 49 women; mean age, 54.6 years; range: 18-87 years) met the inclusion criteria (Table 1). We excluded patients who underwent reconstructions employing locoregional flaps (temporalis, pectoralis major, or myomucosal flaps from the cheek mucosa)

(14). We harvested 134 free flaps: 61 FFFs (45.5%); 35 RFFFs (26.1%); 17 *latissimus dorsi* flaps (12.7%); 12 ATLFs (9%); 3 DCIA flaps (2.2%); 3 scapula flaps (2.2%); 2 medial femoral condyle flaps (1.5%); and 1 retroauricular free flap (0.7%) (15, 16) (Table 2). In 30 cases, we used CAD/CAM for resection, and FFF modelling and placement. Seven patients received more than one flap. Because of free flap failure (17), second primary tumor, SCC recurrence, osteoradionecrosis of the jaws following previous reconstruction and adjuvant radiotherapy. The most frequently reconstructed site was the mandible (40.3%), followed by the maxilla and orbita (17.2%), the tongue (13.4%), the trigonum (23%), the floor of the mouth (8.2%), the skin (4.5%), and the oropharynx (3%). Of the several diseases triggering a need for head-and-neck resection and reconstruction, the most frequent was SCC (70.8%) (18-23), followed by ameloblastoma (6.9%), osteoradionecrosis (3.9%), surgical sequelae (pseudoarthrosis, trismus; 3.9 %), a keratocyst (3.1%), fibromixoma (3.1%), severe jaw atrophy (2.3%) (24-26), mucoepidermoid carcinoma (1.5%), melanoma (0.8%) (27), sarcoma (0.8%) basocellular carcinoma (1.5%), basal salivary cell carcinoma (0.8%), and microcystic adnexal carcinoma (0.8%) (28) (Table 1). Twenty-one patients (16.5%) had already been treated for head-and-neck malignancies, both surgically and via irradiation. The free flap survival rate was 96%. Major complications occurred in 18 cases: bleeding or hematoma requiring surgical exploration (6.7%), or cervical fistulae requiring further procedures (such as pectoralis major flap) or hyperbaric oxygen therapy (3.7%), neck wound infection (1.5%), and partial scapular bone loss (1.5%). Minor donor site complications were found in four cases: skin graft loss (1.5%) and transient gait problems (1.5%) after FFF harvesting. No perioperative mortality was noted (Table 2).

**Table 1.** Patients enrolled in the study: demographic, etiopathological and reconstructive data.

| | Total (n = 127) N° (%) |
|---|---|
| **Age** (years) | |
| mean SD[a] | 54,6 |
| Min | 18 |
| Max | 87 |
| **Sex** | |
| M | 78 (61,5%) |
| F | 49 (38,5%) |
| **Pathology** | |
| SCC[b] | 89 (70,8%) |
| Ameloblastoma | 9 (6,9%) |
| ORN[c] | 5 (3,9%) |
| Surgical sequelae | 5 (3,9%) |
| Keratocyst | 4 (3,1%) |
| Fibromixoma | 4 (3,1%) |
| Severe jaws atrophy | 3 (2,3%) |
| Mucoepidermoid carcinoma | 2 (1,5%) |
| BCC[d] | 2 (1,5%) |
| Sarcoma | 1 (0,8%) |
| Melanoma | 1 (0,8%) |
| Basal salivary cells carcinoma | 1 (0,8%) |
| Microcystic adnexal carcinoma | 1 (0,8%) |
| **Reconstructive site** | |
| Mandible | 51 (40,3%) |
| Trigonum | 29 (23%) |
| Maxilla and orbita | 22 (17,2%) |
| Tongue | 17 (13,4%) |
| Floor of the mouth | 10 (8,2%) |
| Skin | 5 (4,5%) |
| Oropharynx | 4 (3%) |
| **Prior treatment** (surgery or radiotherapy) | |
| Yes | 21 (16,5%) |
| No | 106 (83,5%) |

[a] SD, standard deviation
[b] SCC, squamous cell carcinoma
[c] ORN, osteoradionecrosis
[d] BCC, basal cell carcinoma

## Discussion

Free tissue transfer has become the first choice for reconstruction of complex head-and-neck defects. Preservation of function (including speech and swallowing) and restoration of appearance are the goals of every reconstruction.

**Table 2.** Overview of raised flaps

| | Total (n = 134) N° (%) |
|---|---|
| Fibular | 61 (45,5%) |
| RFFF[a] | 35 (26,1%) |
| Latissimus dorsi | 17 (12,7%) |
| ALT[b] | 12 (9%) |
| DCIA[c] | 3 (2,2%) |
| Scapula | 3 (2,2%) |
| Medial femoral condyle | 2 (1,5%) |
| Retroauricolar flap | 1 (0,7%) |
| Major complications | |
| Yes | 18 (13,5%) |
| No | 116 (86,5%) |
| Minor complications | |
| Yes | 4 (3%) |
| No | 130 (97%) |

[a] RFFF, radial forearm free flap
[b] ALT, antero-lateral tight
[c] DCIA, deep circumflex iliac artery

Free-flap reconstructions are very successful, even in older patients, smokers, and those with a history of cardiovascular disease. Even patients who seem to be very fragile benefit greatly from microvascular reconstruction, especially in terms of the quality of life (10, 29). The success rates of free flap reconstruction now routinely exceed 95% (30, 31). In our cohort of 134 consecutive procedures, we observed a success rate of 96%, a relatively low complication rate, and no perioperative mortality. Complications developing during and after microvascular reconstruction are generally infrequent. Higher tumour stage and a need for pharyngoesophageal reconstruction are associated with more complications (32-34). The risk factors for total flap loss are often unclear (35). Historical or preoperative radiotherapy was reportedly associated with a higher risk of free flap failure and complications. Hypercoagulable status, external compression, and errors in flap harvesting and pedicle management can also cause flap loss. Age alone should not be considered as either a contraindication or an independent risk factor when considering free-tissue transfer (36). The management of total flap necrosis with a pedicled flap or a second free flap harvest remains controversial. Copelli et al. (37) reported a high success rate of second free flaps, and poor results (with higher local complication rates) of pedicled flaps were placed, suggesting that most patients would benefit from a re-attempt at microvascular reconstruction. We considered placing locoregional flaps, such as a pectoralis major flap, only when a second free flap was contraindicated (17). Overall flap placement success rates are increasing worldwide; it has thus become ever more important to improve the patient quality of life. We introduced CAD/CAM to treat selected malignancies and all benign pathologies involving mandibular resection; the technique is accurate and reliable (55). The virtual surgical planning, cutting guides, and patient-specific plates created via CAD/CAM reduce the need for a wide surgical field. The reduced incisional length, smaller surgical field, reduced rate of tissue dissection, and absence of any need for an aspiration drain facilitate healing and reduce the hospital stay. These advantages are particularly evident in patient with benign pathologies, where wide cervicotomic access is not justified because there is no need for neck dissection. We have always sought, during surgery and in our research, to optimise outcomes, and render them reliable and repeatable, and to use complementary procedures to improve both aesthetics and function (38-43). We established multidisciplinary relationships with the Dental Unit of our Institution, initially to promote earlier diagnosis of oral cancer (18-20, 44-47). We have also collaborated in studies of mesenchymal stem cells isolated and expanded from gingival papillae (GinPa-MSCs) in terms of their potential for oncological therapy (48-50). We have constantly updated and improved our surgical techniques, employing a variety of flap types for increasingly individualised reconstruction. We have refined FFF transfer and customised our approach to the needs of the patient, reducing postoperative morbidity (5, 51, 52). Patient outcomes after surgical reconstruction with FFFs were evaluated both by clinicians, and objectively based on actual measurements. The biomechanical characteristics of the temporomandibular joint (TMJ) and gait kinematic characteristics did not exhibit functional limitations (53, 54). Oral function and postoperative facial aesthetics greatly influence patient perceptions of outcomes after ablative surgery. Successful oral rehabilitation after reconstructive surgery often requires dental implants (56-58). In patients who undergo segmental mandibular resection, the FFF is the reconstructive option of choice; the fibular bone allows placement of osseointegrated dental implants (59, 60). However, dental rehabilitation is challenging even for multidisciplinary specialist teams because of prior irradiation, scarring, and soft tissue overlying the reconstructed mandible; dental rehabilitation is difficult. If corrective measures are not taken, hygiene around implants is generally poor; peri-implant tissue may become hyperplastic, infected, and/or develop abscesses that start as peri-implant marginal bone losses but eventually trigger implant loss and failure of dental rehabilitation (61). Additionally, when a single-barrel fibula is used, the height of the reconstructed mandible is much less than that of the native mandible. Dental and prosthodontic rehabilitation significantly improve patient quality-of-life, and must be meticulously planned.

## Conclusion

Head-and-neck reconstructive surgery is a dynamic field, with a high success rate. It has become ever more important to improve patient quality of life; to this end, CAD/CAM represents a great innovation in mandibular reconstruction, affording excellent morphological and functional results.

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The English in this document has been checked by at least two professional editors, both native speakers of English. For a certificate, please see: http://www.textcheck.com/certificate/vvBWav.

## Conflict of interest

The Authors declare that they have no a conflict of interest.

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