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Post-ablative Head and Neck Reconstruction with Free Flaps

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ABSTRACT

Background: Tissue defects in the head and neck region have long been a challenge for reconstructive surgeons. The ability of free flaps to transfer a large panel of tissue containing skin, mucosa, muscle or well-vascularized bone has allowed considerable progress and refinement of this type of reconstruction, with a higher level of rehabilitation for head and neck cancer patients.

Patients and Methods: Prospective study conducted on 54 patients presenting with either oral cavity cancer or osseoradionecrosis secondary to radiotherapy treatment for head and neck cancer and all requiring bony, soft tissue reconstruction or both by using microvascular free flaps. Their age ranged at the time of operation from 32.8-85.7 years; 36 were men and 18 women. The initial disease leading to ablative surgery was a malignant tumour in 42 patients including 38 cases of squamous cell carcinoma (SCC) of the upper aerodigestive tract. The surgical defect involved different anatomical structures including mucosa, bone and skin. Various free flaps were used to repair these types of defects. Functional results were evaluated for the 38 patients with a SCC of the upper aerodigestive tract by the same clinician.

Results: The overall success rate of free flaps was 92.6%. There were 4 free flap failures (total flap necrosis), including 2 radial forearm flaps and 1 fibular flaps and 1 ALT flap. Surgical non-thrombogenic complications at the recipient site occurred in 13 patients, giving a local complication rate of 24.1%. At the donor site, postoperative complications occurred in 8 cases including 3 infections (fibular flap), 1 hematoma (radial forearm flap) and 4 split thickness skin graft partial losses (radial forearm flap). Thus, the overall donor site complication rate was 14.8%. Functional and aesthetic outcomes were evaluated for patients with a SCC of the upper aero-digestive tract. They were very satisfactory in group 1 (oral surgery without mandibulectomy). The results were worse in group 2 (oral surgery with mandibulectomy) than in group 1.

Conclusion: Free tissue transfers have proven to be very reliable to repair various types of defects in the head and neck area, with a low incidence of free flap failure and an acceptable level of complications.

INTRODUCTION

Tissue defects in the head and neck region have long been a challenge for reconstructive surgeons. The goals and principles are to achieve adequate function and aesthetics and thereby to improve the quality of life **[1]**. Free tissue transfer has become increasingly popular for head and neck reconstruction in the last 20 years. It greatly expands options for patients and surgeons, and does appear to result in improved patient outcomes compared with other reconstructive techniques applied to many head and neck sites **[2]**. The complexity of the anatomy and function of the head and neck region explains the disappointing functional and aesthetic results obtained with conventional myocutaneous flaps. The ability of free flaps to transfer a large panel of tissue containing skin, mucosa, muscle or well-vascularized bone has allowed considerable progress and refinement of this type of reconstruction, with a higher level of rehabilitation for head and neck cancer patients **[3]**.

This prospective study is a conjoined work between Plastic Surgery Department, Assiut University Hospital, Assiut, Egypt and Oral and Maxillofacial Department, Guy's hospital, King's College University, London, United Kingdom. In this work, we have tried the free flap reconstruction possibilities in many types of pathologies and defects in the head and neck region.

PATIENTS AND METHODS

This is a prospective study conducted on 54 patients, attending outpatient cancer clinic of Oral & Maxillofacial Department of Guy's Hospital, London, United Kingdom and presenting with either oral cavity cancer or osseoradionecrosis

secondary to radiotherapy treatment for head and neck cancer and all requiring bony, soft tissue reconstruction or both by using microvascular free flaps between April 2010 and December 2011.

Inclusion criteria: Any patient having soft tissue or bony reconstruction or both of the head and neck region by using microvascular free flaps.

Exclusion criteria: Nothing specified.

Informed written consent was signed by all patients under the study.

The age of the patients ranged at the time of operation from 32.8-85.7 years (mean age ± SD, 61.3±12.5 years); 36 were men (66.7%) and 18 women (33.3%). Immediate reconstruction was performed in 53 cases (98.1%) and secondary reconstruction in just one case (1.9%). For primary reconstructions, the initial disease leading to ablative surgery was a malignant tumour in 42 patients including 38 cases of squamous cell carcinoma (SCC) of the upper aerodigestive tract with a percentage of 71.7%. In these cases of primary reconstruction, the initial disease of the patients (n=53) is given in Table (1). Patients with SCC of the upper aerodigestive tract had a primary cancer (untreated tumor) in 34 cases (89.5%) and a recurrent cancer in 4 cases (10.5%). For the primary cancers, 26 patients (76.5%) had T3 or T4 disease and 18 patients (52.9%) had clinically positive lymph nodes (6 N1, 3 N2a, 8 N2b, and 1 N2c). The characteristics of the 54 patients included in this study are presented in Table (2).

The surgical defect involved different anatomical structures including mucosa, bone and skin. When these three types of tissue were included in the surgical defect, the defect was considered to be through and through. The bone defect was defined with the "HCL classification" as described by Jewer et al., [4]. The exact nature of the surgical defects is shown in Table (3).

Various free flaps were used during this period to repair different types of defects, including radial forearm fasciocutaneous or osseocutaneous flaps, fibular osteocutaneous flaps, scapular osteocutaneous flap, DCIA flaps, ALT flaps and VRAM flaps. Fibular flaps were used as osteocutaneous flaps in 18 cases and as osteomyocutanous flap in 2 cases. Scapular flaps were used as osseocutaneous flap in 1 case. The types of free flaps used in this study with their percentages are shown in Fig. (1).

Free flap harvest was performed at the time of the ablative procedure, employing a two-team approach, except for the scapular flap. All flaps were generally fixed in their definitive position before performing the microvascular anastomoses to prevent traction on the vascular pedicle. Microvascular anastomoses were performed with an operative microscope (Zeiss, Germany) and polypropylene sutures (Prolene 9.0, Ethicon, U.S.A.). The recipient vessels were identified and divided during cervical lymphadenectomy when indicated.

Functional results were evaluated for the 38 patients with a SCC of the upper aerodigestive tract by the same clinician. The following data were recorded for all patients: Quality of oral diet, speech intelligibility, mouth opening. Results were scored from 0 to 2, as follows:

Oral diet:

- 2 normal.
- 1 moderately impaired, restricted diet, soft diet.
- 0 severely impaired or impossible, requiring maintenance of an entral feeding tube.

Speech intelligibility:

- 2 normal, easily intelligible.
- 1 moderately altered, intelligible with effort.
- 0 severely altered or impossible, patient unintelligible for the listener.

Mouth opening:

- 2 normal, greater than two fingerbreadths.
- 1 moderately limited, between 1 and 2 fingerbreadths.
- 0 severely limited, less than one fingerbreadth (Table 4).

Table (1): Initial diseases leading to ablative surgery for primary (immediate) reconstructions.

Initial disease	Number of cases	Rate (%)
Malignant tumour	42	79.2
SCC of oral cavity	38	71.7
Adenocystic carcinoma	1	1.9
Mucoepidermoid carcinoma	1	1.9
Osteosarcoma	1	1.9
Odontogenic carcinoma	1	1.9
Non-malignant disease	11	20.8
Osseoradionecrosis	8	15.1
Ameloblastoma	3	5.6

Table (2): Characteristics of the 54 patients.

Patients' characteristics	Number of cases	Rate (%)
Sex:		
Male	36	66.7
Female	18	33.3
Previous radiotherapy: ☐		
No	36	94.7
Yes	2	5.3
Tumour status: ☐		
Primary	34	89.5
Secondary or recurrent	4	10.5
T stage: ☐		
T1 or T2	8	23.5
T3 or T4	26	76.5
N stage: ☐		
N0	16	47.1
N1, 2 or 3	18	52.9

☐ For the 38 patients with a SCC of the upper aerodigestive tract.
☐ For the 34 patients with a primary (untreated) SCC of the upper aerodigestive tract.

Table (3): Types of post-ablative surgical defects.

	Number of cases	Rate (%)
Defect type: ☐		
Mucosa alone	17	31.5
Bone + mucosa	36	66.7
Bone + mucosa + skin	1	1.8
Type of bone defect: ☐		
C	1	2.9
L	15	47.1
H	2	20.6
LC	8	20.6
LCL	2	5.8
HC	4	2.9

☐ For the 54 patients.
☐ For the 32 patients with a mandibular defect, classification of Jewer et al., 1989: Type C central defect, type L lateral defect, type H lateral defect including the condyle.

Table (4): Functional outcomes for the 38 patients with a SCC of the upper aerodigestive tract.

Score	All patients n = 38 (%)	Oral surgery without mandibulectomy n = 15 (%)	Oral surgery with mandibulectomy n = 23 (%)
Oral diet:			
2	20 (52.6)	11 (73.3)	9 (39.1)
1	11 (28.9)	3 (20)	8 (34.8)
0	7 (18.4)	1 (6.7)	6 (20.1)
Speech intelligibility:			
2	14 (36.8)	8 (53.3)	6 (26.1)
1	13 (34.2)	3 (20)	10 (43.5)
0	11 (28.9)	4 (26.7)	7 (30.4)
Mouth opening:			
2	22 (57.9)	12 (80)	10 (43.5)
1	8 (21.1)	1 (6.7)	7 (30.4)
0	8 (21.1)	2 (13.3)	6 (26.1)

RESULTS

Of the 54 free flaps performed for head and neck reconstruction, 50 were successful, with an overall success rate of 92.6%. There were 4 free flap failures (total flap necrosis), including 2 radial forearm flaps and 1 fibular flaps and 1 ALT flap. Hence, the free flap success rates for radial forearm flap, fibular flap, DCIA flap, scapular flap and VRAM flap, were, respectively, 92, 95.2,100, 100, 100%. The difference between the osseous and the non-osseous free flap success rates was not statistically significant (p=0.6).

Of the free flaps, 3 (5.4%) required a return to the operating theatre to control the patency of the vascular anastomoses, including 1 radial forearm flaps, 2 fibular flaps. A venous thrombosis in 2 flaps, an arteriovenous thrombosis in 1 flaps and good patency of the anastomoses in all the three flaps, giving an overall successful salvage rate of 100%. Among the radial forearm flaps, there were 4 cases (2.8%) of partial flap necrosis (<20% of the flap), which did not require another flap or another surgical procedure. Partial necrosis of the soft tissue component of the vascularised bone free flaps occurred in 3 cases (4.5%).

Surgical non-thrombogenic complications at the recipient site occurred in 13 patients, giving a local complication rate of 24.1%. The most common complication was infection, which occurred in 4 cases. Furthermore, there were 5 cases of neck wound dehiscence; 2 of them were due to infection, 4 cases of osteosynthesis failure and plate exposure; 2 of them were due to infection, 3 cases of trismus and 1 case of submandibular fistula.

At the donor site, postoperative complications occurred in 8 cases including 3 infections (fibular flap), 1 hematoma (radial forearm flap) and 4 split thickness skin graft partial losses (radial forearm flap). Thus, the overall donor site complication rate was 14.8%.

Medical complications occurred in 6 patients giving a general complication rate of 11.1%. Cerebrovascular complications were the most common, with three patients with cerebrovascular stroke. In addition, there were a case of myocardial infarction, 1 with pulmonary infection, and 1 case of pneumothoax.

3 patients died, 2 of them died within 1 month following surgery due to carotid blow out, giving a postoperative mortality rate of 3.7%. The other one died 8 month postoperative as he suffered from a concomitant chronic myeloid leukaemia.

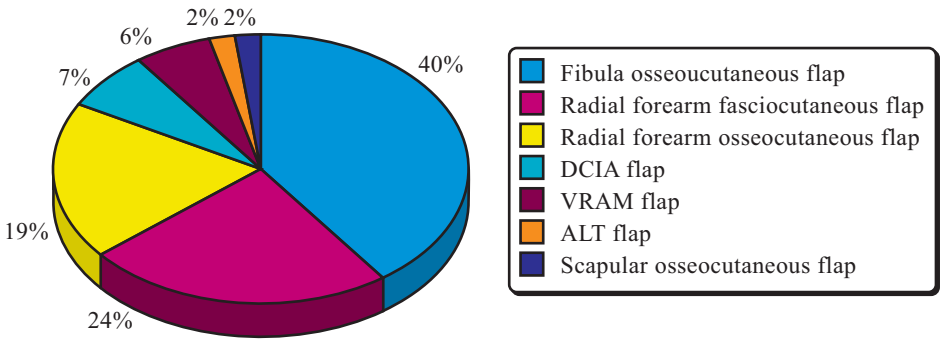

Fig. (1): Types of free vascualrized flaps used and their percentages.

Clinical Casees

Case [1]:

Fig. (2): 65y old patient with recurrent SCC of reconstructed mandible.

Fig. (3): Design of scapular and parascapular flap.

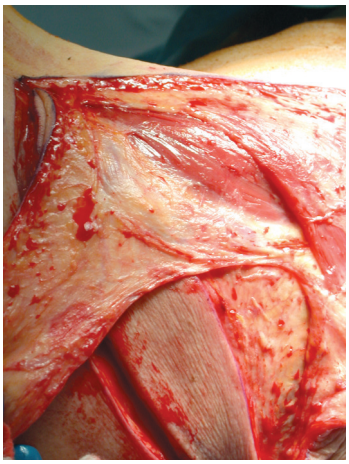

Fig. (4): Elevation of the flap.

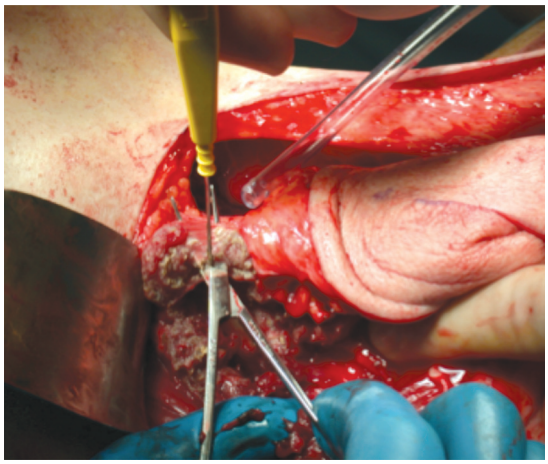

Fig. (5): Identification of the pedicle.

Fig. (6):Post-operative intraoral view of skin paddle.

Fig. (7): Post-operative extraoral view.

Case [2]

Fig. (8): 54y old with osseoradionecrosis of left side of mandible secondary to radiotherapy of S.C.C. tongue.

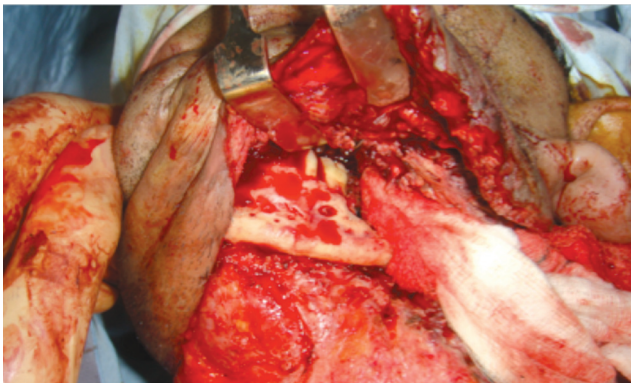

Fig. (9): Intra-operative view after bone excision.

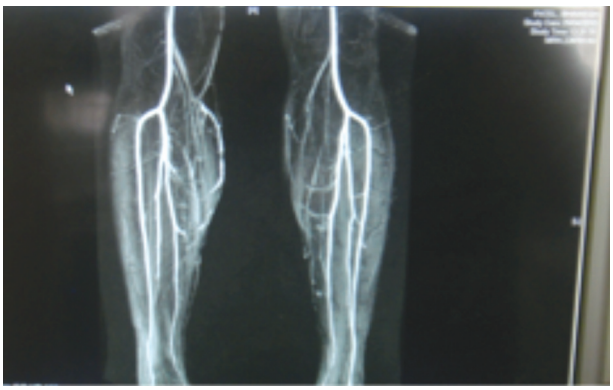

Fig. (10): MR angiography of both lower limbs demonstrating patent leg arteries.

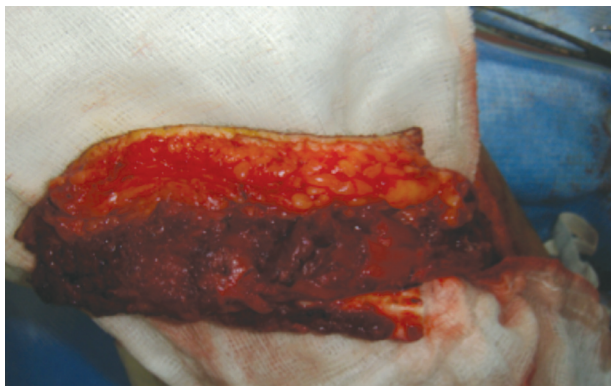

Fig. (11): Fibula osseocutaneous flap elevated but still attached to the pedicle.

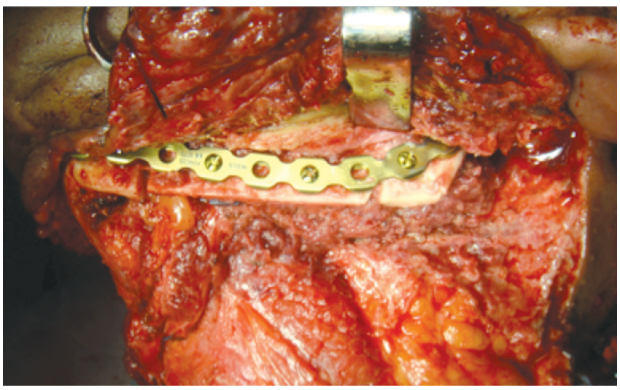

Fig. (12): Intra-operative fixation of the osteotomized bony flap with a 2.5 mm reconstruction plate.

Fig. (13): Intra-operative view after suturing of skin paddle and completing the anastomosis.

Case [3]

Fig. (14): 55y old male patient with SCC of the alveolar ridge.

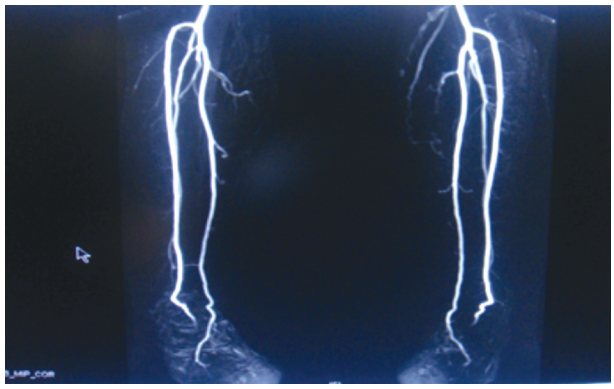

Fig. (15): MR angiography of lower limb vessels detecting complete patency.

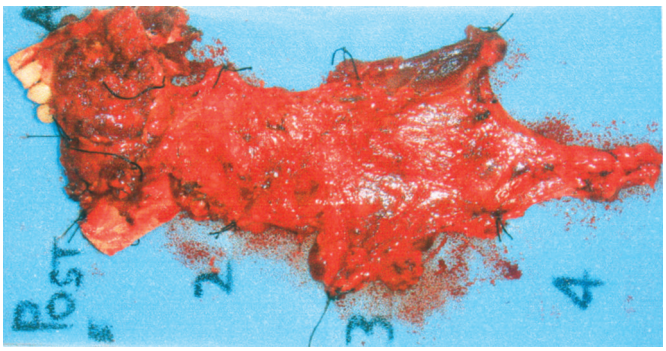

Fig. (16): Intra-operative view of the excised specimen (segmental mandibulectomy + selective neck dissection levels I-IV).

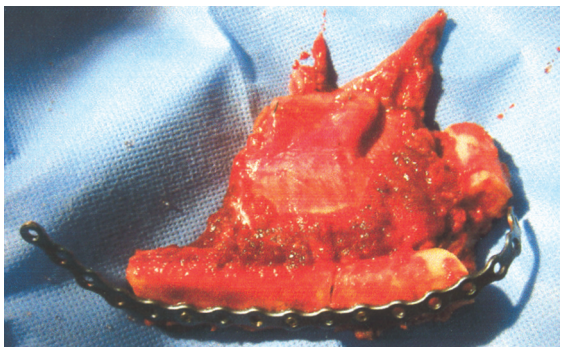

Fig. (17): Fibula free flap being osteotomized and fixed to the pre-contoured 2.3 mm plate just separated and ready for transfer.

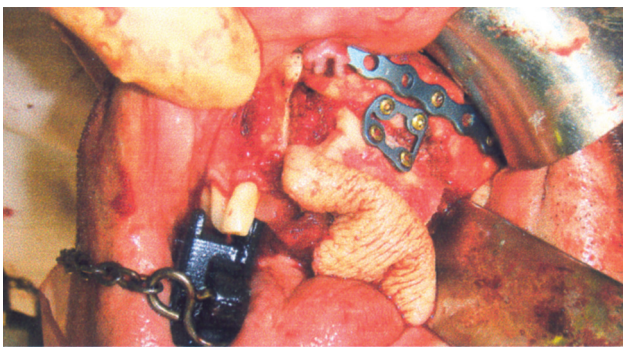

Fig. (18): Intra-oral view of the fibula osseocutaneous flap being fixed to the resection margins.

DISCUSSION

The free flap success rate of 92.8% in this study confirms the reliability of these complex reconstruction procedures in the head and neck area. Over the last 15 years, the free flap success rate has increased from 80% in the first studies to 95% in the most recent publications **[5,6]**.

All free flap failures occurred in the group of patients with SCC of the upper aerodigestive tract. In this group, the failure rate of osseous free flaps was higher than in soft tissue free flaps (15 and 5.5%, respectively), although this difference was not statistically significant. Several studies confirm the higher risk of free flap failure in mandibular reconstruction compared to soft tissue reconstruction **[7,8]**.

The rate of surgical re-exploration to check microvascular anastomoses was 5.4% in this study. It is interesting to note that all cases requiring verification led to a successful free flap outcome. Identical results are given in the literature. This highlights the importance of early surveillance focused on the viability of the flap and on checking, at the least suspicion, the patency of the vascular anastomoses **[6]**.

In the context of composite osteocutaneous free flaps, vascularization of the skin paddle does not totally reflect vascularization of the osseous component of the flap. For the fibular flaps, good vascularization of the skin paddle habitually reflects good vascularization of the bone, but ischemia of the skin paddle does not necessarily correlate to defective perfusion of the bone **[9]**. Thus, in our study, all cases of necrosis of the bone component

of fibular flaps were accompanied by necrosis of the skin paddle, while in three cases; complete necrosis of the skin paddle arose despite good viability of the bone component.

In this study, partial free flap necrosis in the form of partial or complete necrosis of the flap skin paddle without necrosis of the bone component occurred in six cases including one case of radial forearm flap, four cases of fibular flaps, one case of scapular flap. Partial free flap necrosis is a relatively rare event (11.1% of cases in this series), confirming the findings reported in the literature. In recent studies, the rates of free flap and pedicle flap failures are comparable, while partial necrosis is significantly more frequent with regional pedicle flaps **[7]**.

The radial forearm free flap is considered as the flap of choice for oral soft-tissue reconstruction. Our study confirms the excellent outcomes habitually reported after free flap reconstruction of oral mucosal defects. The radial forearm flap provides a thin and pliable skin paddle and a long vascular pedicle, which is very appreciated in this type of reconstruction **[10,11]**.

Free, vascularized bone-containing flaps have become the method of choice for reconstructing segmental defects of the mandible and the mucosal lining. In our series, this flap was the method of choice in most cases requiring bony reconstruction especially when the native bony height is reasonable, extensive bony defects and small to moderate soft tissue defects, and when complex reshaping of the reconstructed mandible is required with multiple osteotomies reaching up to 4 osteotomies in our study.

The level of non-thrombogenic complications at the recipient site in our series was 24.1% (excluding free flap failures) and similar levels are often reported in published series. For us, the most frequent local complications were infections at the recipient site (7.4% of cases), which can be favoured by other local complications (loss of free flap, fistulas and hematoma) **[7,12]**.

Functional and aesthetic outcomes were evaluated for patients with a SCC of the upper aerodigestive tract. They were very satisfactory in group 1 (oral surgery without mandibulectomy). The main complaint in this group concerned elocution and intelligibility of speech. This could be explained by the importance of tongue and velopalatal resection **[13,14]**. The results were worse in group 2 (oral surgery with mandibulectomy) than in group 1 because group 2 patients presented more extensive defects. However, the outcomes of group 2 patients were encouraging as their values were not far behind group 1 and most patients in this group fell in the category of either 2 or 1 regarding oral diet, mouth opening, and speech intelligibility. This could be explained by the quality of mandible reconstruction. Similar results are commonly reported in the literature **[11,15]**.

Conclusion:

Free tissue transfers have proven to be very reliable to repair various types of defects in the head and neck area, with a low incidence of free flap failure and an acceptable level of complications. Careful preoperative assessment, particularly concerning patient co-morbidity and history of surgery or radiotherapy, can help to identify patients with a high risk of postoperative complications. Radial forearm free flap and fibular flap were the most used flaps for soft tissue and mandible reconstruction, with a percentage of 76.5% and 59.5% respectively.

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