ORIGINAL PAPER

Outcome of 1000 free flap head and neck reconstructions at a tertiary cancer care institute in India

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Abstract

Background Microvascular free flaps are ideal for reconstructing post-oncological surgery defects in the head and neck region. Free flaps provide ample tissue for reconstructing even large, complex defects, which gives oncosurgeons flexibility during tumor resections.

Methods We performed 1000 free flap head and neck reconstructions in 978 patients from June 2015 to September 2018. For reconstructing bone defects, our flap of choice was the free fibula. The surgical outcomes and complications according to flap were retrospectively reviewed and analyzed.

Results The overall flap success rate was 98.1%. A total of 45 cases required emergency surgical re-exploration for compromised flaps and 19 of these flaps could not be salvaged. Venous insufficiency was the most common cause of surgical re-exploration. Flaps with delayed arterial thrombosis and vascular compression could not be salvaged. Other complications were partial flap necrosis, orocutaneous fistula, and donor site complications. No statistically significant differences were noted for complications in elderly and post-radiotherapy patients.

Conclusions Free flap reconstruction is a robust and highly reliable option for head and neck defects, and two free flaps are a safe option for treating large defects. A second free flap should be the first choice in failed cases after the medical optimization of the patient. Free flap reconstruction is safe in elderly and post-radiotherapy patients.

Level of Evidence: Level IV, therapeutic study.

Keywords Free flap reconstruction · Head and neck reconstruction · Radial artery forearm flap · Anterolateral thigh flap · Free fibula flap

Introduction

Microvascular free flap reconstruction has become the preferred method for resolving post-oncologic surgical defects in the head and neck region [1–3]. Free flaps provide ample tissue to reconstruct any type of large complex defect, which, in turn, provides oncosurgeons with freedom and flexibility during tumor resections. Acceptable functional and esthetic outcomes have been achieved with free flap reconstruction. Better magnification and refined instrumentation have improved results with success rates up to 98% [4].

With advancements in free flap reconstruction, it has become a safe procedure for elderly patients as well [5, 6]. Free flap reconstruction is also safe in patients who have already undergone chemo or radiotherapy [7]. The radial artery forearm flap (RAFF) and anterolateral thigh (ALT) flap are ideal for soft-tissue defect reconstruction in the head and neck region. Free radial forearm flap reconstruction was first introduced by Yang et al. [8] in 1978 and has remained an ideal choice for certain situations that require a small, thin flap. Such situations include small tongue defects (Figs. 1, 2, and 3) where tongue mobility is more important, lip reconstruction, small mucosal defects, nose reconstruction, and palatal reconstruction. Song et al. [9] first described using the ALT flap in 1984, which replaced the radial forearm flap as the most common flap due to its high reliability and the availability of ample of tissue that can be harvested with

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less donor site morbidity (Figs. 4, 5, 6, and 7). In cases with bony defects of the mandible and maxilla, the free fibula has become the flap of choice. Bone stalk is also good for the placement of dental implants [10]. The free fibula can also be harvested as an osteocutaneous flap with either single or double skin paddles on different perforators (Figs. 8, 9, 10, 11, and 12).

In microvascular surgery, attentive monitoring is essential to identify any flap-related complication as early as possible and successfully salvage the flap. Maintaining a high flap reconstruction success rate and a low complication rate is challenging in a high-volume reconstruction unit. It requires a dedicated team of competent reconstructive surgeons, oncosurgeons, anesthesiologists, and nurses in both the ICU and general ward.

This study evaluates the outcomes of 1000 microvascular free flap reconstructions performed to treat head and neck defects from June 2015 to September 2018 at a tertiary cancer center.

Material and methods

In this retrospective study, the records of 978 consecutive patients were reviewed in which 1000 microvascular free flap reconstructions were performed between 2015 and 2018 to resolve defects in the head and neck region. A two-team approach was adopted to reduce the total surgical time for harvesting the flap and the oncologic resection.

After microsurgery, we recorded the major and minor complications. A major complication was defined as one that required additional surgical intervention whereas a minor complication could be managed conservatively.

Results

The mean age of the patients was 49.8 years (range = 2.5–84 years). There were 185 patients above 65 years of age for which 185 free flap reconstructions were performed. There were more male ($n = 861$) than female ($n = 117$) patients. Medical records including details regarding the primary tumor site, flap type, outcome, and complications were analyzed. Buccal mucosa was the most common malignancy site followed by the tongue and the lower alveolus (Table 1). In 68 (7%) patients, reconstruction was done post-radiotherapy. In this clinical series, 978 patients were reconstructed with 1000 free flaps: 525 were anterolateral thigh flaps, 229 were fibula flaps, and 224 were radial forearm flaps (Fig. 13). The tensor fascia lata (TFL) flap, anteromedial thigh (AMT) flap, gracilis flap, and medial sural artery perforator (MSAP) flap were also used for reconstruction although less frequently. Two flaps were needed in 22 patients; double free flaps were required in 9 patients, 2 patients required free flaps for loss of

Fig. 1 Radial forearm flap harvest

the inner paddle of the fibula flap, and 11 free flaps were used as salvage flaps in free flap failures.

The most common artery used for anastomosis was the facial artery ($n = 728$) followed by the superior thyroid artery ($n = 242$). The lingual artery and end to side external carotid artery (ECA) were used for anastomosis in previously operated patients or in patients with neo-pharyngeal reconstructions where, due to salvage laryngectomy, other vessels were sacrificed (Table 2).

The most common veins used for anastomosis were the common facial vein ($n = 445$) and internal jugular vein ($n = 277$) but the superior thyroid vein and other innominate veins were also frequently employed (Table 3).
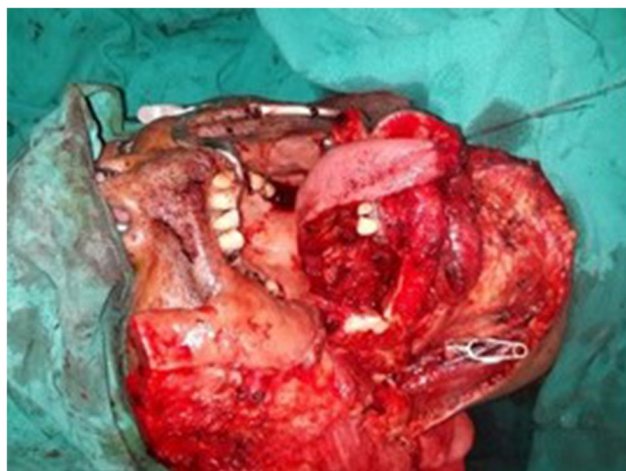

Fig. 2 A 48-year-old male patient who underwent surgery for carcinoma involving the right lateral border of the tongue

Fig. 3 Same patient as above after flap insetting. This patient required a flap because one third of his tongue and floor of mouth were removed along with a marginal mandibulectomy

Fig. 5 Same patient as above, 6 weeks after surgery

There were 76 major complications that required emergency re-exploration and 102 minor complications, which were managed conservatively (Table 4). Forty-five patients were examined for vascular compromise, and 31 were explored for bleeding only. Out of the 45 compromised flaps, 24 could be salvaged, and total flap loss was seen in 19 cases. In two patients with double paddle free fibula, inner skin paddle become completely ischemic due to compression over the perforator (Table 5).

Flap congestion was the major cause of compromised flaps in 33 cases in which venous thrombosis was the leading cause in two-thirds of the cases (Table 6). The flap salvage rate was 73% in this group.

Arterial thrombosis was observed in six cases; in two post-radiotherapy cases, where the arteries were thrombosed multiple times on the table, the pectoralis major myocutaneous

(PMMC) flap became the salvage flap. In the remaining four cases, flap ischemia was noted on the fifth to the seventh postoperative day and flap salvage was not possible due to this late presentation.

The vascular pedicle was compressed in four cases; the pedicle was pedicle was coming through the floor muscles and became compressed between the mandible and floor muscles. Both artery and vein were thrombosed so near to the skin paddle that re-anastomosis was not possible.

In the two double paddle cases, the free fibula inner paddle was lost due to compression of the perforator under the bone; the free ALT flap was used for lining.

Minor complications occurred in 102 cases (Table 4). Partial flap necrosis was seen in 26 cases and managed with debridement and re-suturing. Most of the orocutaneous fistulas were managed conservatively while a few required re-suturing. Donor site complications included seroma, partial graft loss, and scar hypertrophy.

Out of the 19 cases of free flap failure, a second free flap procedure was performed in 11 patients. The PMMC flap was used in six cases when undergoing a second prolonged anesthesia was life-threatening for the patients. In two small defects, one was managed with the nasolabial flap and the other one was managed conservatively (Table 7).

The complication rates in patients over 65 years of age are given in Table 8. Complete flap loss was noted in four patients (2.16%) compared with the younger population (1.63%),

Fig. 4 A 72-year-old male patient who underwent surgery for a basal cell carcinoma compromising his left cheek

Fig. 6 AALT flap harvest for a tongue defect after cancer resection

Fig. 7 A 32-year-old male patient with a carcinoma affecting the left lateral border of his tongue
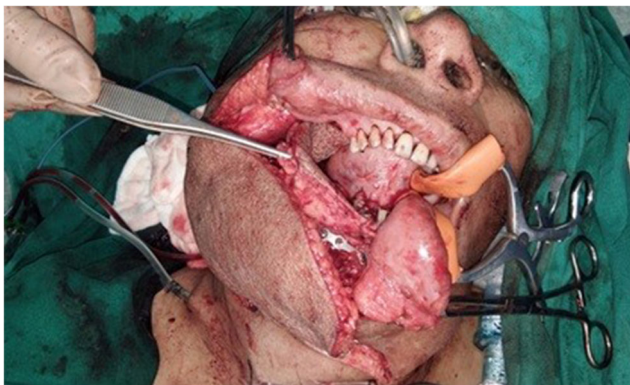

Fig. 8 Double skin paddle, free fibula reconstruction of the mandib. A 36-year-old male patient with a carcinoma affecting the right lower alveolus

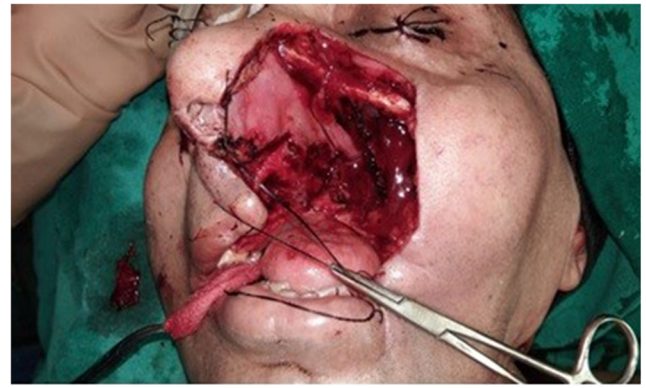**Fig. 9** Postoperative view at 3 months of the same patient with good lip seal.

Fig. 10 A 52-year-old male patient with a recurrent carcinoma of the left maxilla

Fig. 11 Same patient as above, after a reconstruction with a double paddle free fibula flap; anterior view at 3-weeks postoperative with the mouth open

which was statistically not significant ($p = 0.766$). The other complications were not statistically significant. We found more atherosclerotic changes in this population, especially in peroneal arteries. We found arterial thrombosis in the late postoperative period in two free fibula flaps, likely due to crushing the atheroma in the arterial wall by the double arterial clamp. Hence, going forward, we have taken two precautions: using the distal part of the artery for anastomosis with the least

Fig. 12 Same patient, anterior view with the mouth closed showing a good lip seal

Table 1 Site of malignancy

Site of malignancy	No. of patients	Percentage
BM	586	59.92
Tongue	182	18.61
LALV	136	13.91
Maxilla	33	3.37
Others	22	2.25
Larynx	19	1.94
Total	978	100.00

BM buccal mucosa, LALV lower alveolus

Table 2 Arteries for anastomosis

Artery	Number	Percentage
FA	728	72.8
STA	242	24.2
ECA	13	1.3
LA	17	1.7

FA facial artery, STA superior thyroid artery, ECA external carotid artery, LA lingual artery

atherosclerotic changes and anastomosis without applying clamps over the flap arteries. In this age group, we avoided adding a second free flap for fear of a second prolonged anesthesia. The PMMC flap was the subject in two cases, the nasolabial flap in one case, and a small tongue defect was managed conservatively in one case.

In post-radiotherapy patients, 68 free flaps were performed with primary free flap failure in two patients due to arterial thrombosis. Venous congestion was found in three cases, and all flaps were salvaged in this group. The flap failure rate was non-significant compared with the non-radiated group ($p = 0.375$). Vessel dissection in radiated neck tissue was challenging due to fibrosis in the region and the formation of tough capsules around the vessels. It was easier to follow the vessels from the lower, virgin part of the neck. Arteries showed more changes to their walls, especially the facial artery, and, therefore, we opted to use the superior thyroid and lingual arteries for anastomosis after two initial failures. Although the veins were also covered in a tough capsule, the walls were unaffected, in fact, along with capsule dissection the adventitia was removed automatically and the problem of drawing in the adventitia during anastomosis was reduced in our experience.

Initially, radial forearm flap was the most often used soft-tissue flap for reconstruction but as familiarity with ALT increased, it became the flap of choice. Free ALT was the most
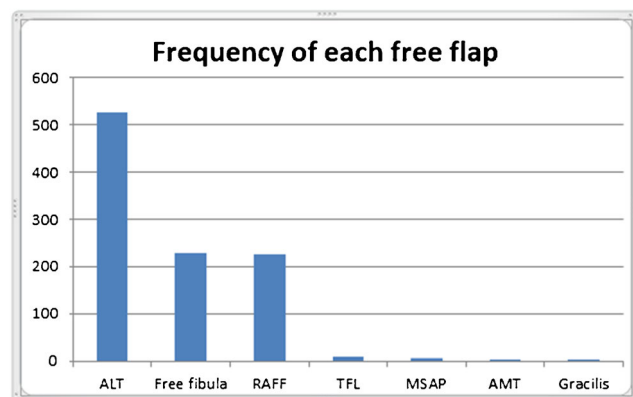
reliable and versatile soft-tissue flap with the least donor site complications. We did not use Doppler or angiography to identify the perforations preoperatively. When a good-sized perforator was not found in the lateral thigh, the flap was converted to an anteromedial thigh (AMT) flap [11]. We only encountered this situation on four occasions while harvesting 529 flaps (0.75%) (Fig. 14). Most of the time, if a typical perforator was not found coming from the descending branch of the lateral circumflex femoral artery, perforators coming from the transverse or oblique branches were saviors. We often found perforators coming through the posterior third muscle mass of the vastus lateralis instead of the anterior third. The average length of intensive care unit stay was around 48 h and the total hospital stay was 5 to 7 days. On the fifth day, oral liquids were allowed and Ryle's tube was removed between 10 and 14 days.

Discussion

At our institution, the ALT flap is a work-horse [12–14] flap for head and neck reconstruction though the free radial forearm flap remains an ideal choice for certain situations for which a small, thin flap is required [15]. Currently, we are replacing RAFF with supra-fascial or thinned ALT flaps or with medial sural artery perforator flap (MSAP), which negates poor donor site scarring over the forearm.

Free flaps have become the ideal choice for head and neck reconstruction. In high-volume centers, the global success rate of free flap survival is approaching 98%. At our center, the

Fig. 13 Frequency of each flap

Table 3 Veins for anastomosis

Vein	Frequency	Percentage
CFV	445	44.5
IJV	277	27.7
Innominate veins	264	26.4
STV	136	13.6

CFV common facial vein, IJV internal jugular vein, STV superior thyroid vein

Table 4 Major and minor complications

	Complications	Number
Major (76)	Venous congestion	33
	Arterial thrombosis	6
	Compression of vascular pedicle	4
	Skin paddle loss of fibula flap	2
	Bleeding	31
Minor (102)	Partial flap necrosis	26
	OCF	34
	Donor site complications	42

OCF orocutaneous fistula

overall success rate was found to be 98.1%, which is comparable to most centers worldwide [16–19].

Our data indicated an exploration rate of 4.5% for compromised flaps and compared favorably with available data in the literature reporting surgical re-exploration rates for compromised flaps between 3 and 20% [20–24]. Venous insufficiency was the most common cause of re-exploration. This finding is consistent with reports published in the literature [21, 23, 25, 26]. Because the venous wall is thinner and the pressure is much lower than arterial, they are more susceptible to mechanical compression. In head and neck reconstruction where watertight suturing is mandatory, flap edema itself exerts more pressure than other regions where loose suturing is an option. There are various reasons for vascular compression including narrow subcutaneous or submandibular tunnel, wound bed hematoma, excessive pedicle length leading to vessel kinks, improper positioning of the artery over the veins, tight dressing over the neck, acute neck flexion, and the body posture of the patient.

Venous insufficiency was the main cause of re-exploration in our study, but the flap salvage rate was quite high in this group in contrast to arterial insufficiency [27]. The overall flap salvage rate was 56% in this group, which is comparable to the salvage rates (30 to 70%) reported in the literature [18, 21–23, 28].

Compared with other flaps, free fibula flaps had higher complication rates. In two patients with double paddle free fibula, the inner paddle was lost due to compression of the perforator under the bone. Apart from this, venous congestion, bleeding, partial flap necrosis, and orocutaneous fistula formation were more common in free fibula cases. Other authors reported a similar trend of higher complication rates between

Table 5 Vascular complications

Vascular complications	45	Complete flap loss (19)
Venous congestion	33	9
Arterial thrombosis	6	6
Pedicle compression	4	4
Inner paddle loss of fibula	2	

Table 6 Causes of venous congestion

Venous congestion	33
Thrombosis	21
Venous kink/twist	6
Hematoma	5
Negative pressure	1

bone-containing free flaps compared with pure soft-tissue ones [29–31]. We used the fibula as a double paddle for lining and covering both based on different skin perforators. A few times, the proximal perforator did not come through the peroneal vessels and a separate anastomosis was performed.

Managing complex defects with double free flap reconstruction

Simultaneous multiple free tissue transfer is a challenging undertaking typically in patients with locally advanced disease and composite tissue defects. Most double free flap procedures consist of a combination of osteocutaneous and soft-tissue flaps [32–34]. This combination provides good functional and esthetic results in large oro-mandibular defects [35]. Free osteocutaneous fibula flaps were used for bony defect and inner lining whereas the chimeric ALT flap was used to fill the cavity of the maxillary sinus and infratemporal fossa and to provide an outer cover [36]. In two cases, the free radial forearm flap was combined with the fibula flap when lip reconstruction was required along with the bony defect. Although, theoretically, the risk of complication is higher in double free flap reconstructions, we were lucky to not have any single flap loss. Due to an abundance of tissue, fistula, infection, and post-radiation plate exposure rates were also lower [37].

Management after flap failure

The ideal choice for reconstruction in failed free flap cases is a matter of debate. Initially, we would use the PMMC as a salvage flap but we were forced to use another free flap when the defect was too large and complex to be reconstructed with the PMMC. After patient optimization and excluding preventable causes, the results were promising. To date, we have not lost any second free flaps. Currently, we use the PMMC flap

Table 7 Secondary procedures in patients of flap loss

Total no. of flap loss	19
Free flap	11
PMMC	6
NLB	1
Conservative	1

NLB nasolabial flap

Table 8 Incidence rate of complications in ≥ 65 and below 65 years of age

	Complications	≥ 65 years (185 free flaps in 185 patients) no. (%)	< 65 years (815 free flaps in 793 patients) no. (%)
Major	Venous congestion	6 (3.24)	27 (3.4)
	Arterial thrombosis	2 (1.08)	4 (0.5)
	Pedicle compression	1 (0.54)	3 (0.38)
	Skin paddle loss of fibula flap	0 (0)	2 (0.25)
	Bleeding	8 (4.32)	23 (2.9)
Minor	Partial flap necrosis	7 (3.78)	19 (2.4)
	Orocutaneous fistula	6 (3.24)	23 (2.9)
	Donor site complications	9 (4.86)	33 (4.16)

Fig. 14 Anteromedial thigh flap; as savior when no lateral perforators were found
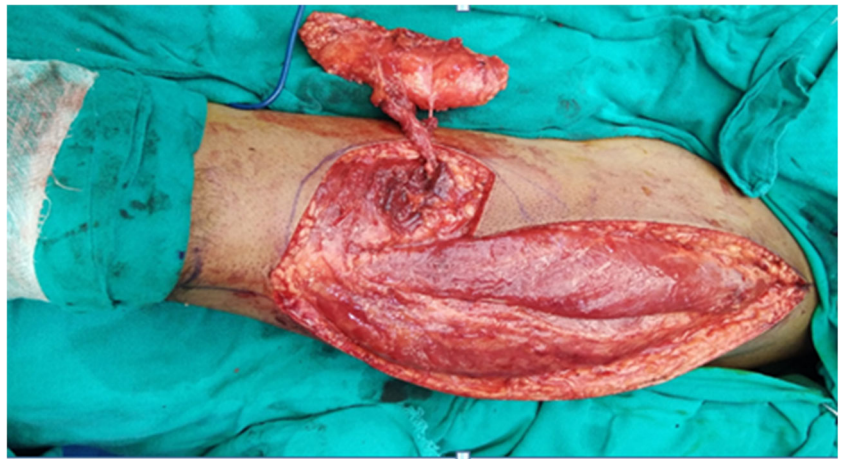
when the patient is too high-risk for a second prolonged anesthesia.

Conclusions

In our experience with 1000 free flaps for head and neck reconstruction, it is a highly reliable technique with the ability to reconstruct any complex bony or soft-tissue defect. Even two free flaps are safe for large defects in experienced hands. A second free flap should be the first choice in failed cases after the medical optimization of the patient. The ALT flap is becoming the first choice for reconstruction of soft-tissue defects except for small tongue defects in obese patients where RAFF is the flap of choice. The fibula flap carries the additional risk of complications due to the complexity of fabrication and fixation. Flap failures are unavoidable but the success rate is promising with an experienced team, good instruments, and solid infrastructure.

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