Original Article

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Versatility of radial artery fascio-cutaneous free flap for head and neck reconstruction

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ABSTRACT

Background: Reconstruction of the head and neck has made significant progress with the advent of microsurgery. The radial artery free flap is a workhorse flap in head and neck reconstruction due to its high-quality tissue that conforms to the complex and vital structures in this region. **Aim**: This study aims to assess the versatility and pliability of the radial artery free flap in the reconstruction of head and neck defects. **Methods**: A retrospective study was conducted over a six-year period (2017 to 2022) in Erbil, the capital of the Kurdistan region in Iraq, at Maryamana and PAR private hospitals. Twelve patients were included in the study, all of whom presented with large soft tissue losses and defects exposing vital structures in the head and neck The Allen test was performed bilaterally to assure perfusion. The operations were carried out under general anesthesia, and patients stayed in the hospital for seven days post-operation. Antiplatelet (aspirin) and anticoagulant (heparin) were administered. The patients were followed up for six months to several years after the operation. **Results**: Twelve patients were included in the study. The mean age (SD) was 49.2 (16.7%) years, with an age range of 22-78 years. The largest proportion (41.7%) of the sample were aged 40-49 years, and two thirds (66.7%) of the patients were female. The lip was affected in five patients out of eight (41.7%), and the tongue was affected in three patients (25%). Cancer was the cause of the defects in seven patients (58.3%), trauma in four patients (33.3%), and hemi-facial microsomia in one patient (8.3%). The success rate was 91.7%, with failure occurring in only one patient (8.3%). **Conclusion**: The radial artery free flap is versatile in the reconstruction of complex structures within the head and neck due to its high-quality fasciocutaneous properties, such as being thin, pliable, and having a long pedicle. This makes it particularly effective for lip and tongue reconstruction.

Keywords: radial artery free flap, microsurgery, Allen test, head and neck

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INTRODUCTION

Reconstruction methods for head and neck defects are varied. With the evolution of microsurgery, the decision to use free flap reconstruction depends on many factors, such as defect size, site, type, vessel status, and radiation, as most defects have an oncological background requiring wide surgical resection, with priority given to functional restoration before aesthetic appearance.[1–3]

The radial artery free flap was first described by Yang et al. in 1981.[3] Although many flaps have been described for head and neck reconstruction, the radial artery fasciocutaneous free flap remains one of the workhorse

flaps due to its numerous advantages: flexibility and thinness, long and sizable pedicle, the possibility of a two-team approach, reliability and ease of harvest, a wide surface area of up to 30*12 cm, the possibility of being raised as a chimeric flap with the incorporation of muscle, tendon, and bone, and the possibility of being a sensate flap with the inclusion of the lateral antebrachial cutaneous nerve.[2,4] The radial artery fasciocutaneous free flap relies on the radial artery perforators, which are mostly septocutaneous in the proximal forearm and direct cutaneous in the distal forearm. The flap can be based proximally or distally, allowing for the inclusion of a large surface area in both cases.[3]

That is why the potential applications of the radial artery free flap include the oral cavity, hypopharynx, oropharynx, facial, and craniofacial defects.[4]

Donor site morbidity is minimal but still a matter of debate due to reported complications such as hypertrophic scars, poor aesthetic appearance, cold intolerance, limitation of wrist motion, and decreased sensation in the area.[2]

To our knowledge, this research has not been conducted in the Kurdistan region or Iraq. The objective of this study was to assess the versatility and pliability of the radial artery free flap in the reconstruction of head and neck defects.

MATERIALS AND METHODS

A retrospective study was conducted from 2017 to 2022 in Erbil, the capital of the Kurdistan region in Iraq, at Maryamana and Par private hospitals. Twelve patients were included in the study, all of whom presented with large soft tissue losses and defects exposing vital structures in the head and neck. These patients required coverage with a flap as direct closure was not feasible, or they were anticipated to need future radiation therapy. Exclusion criteria encompassed patients with small or simple defects that could be managed using alternative methods of coverage or those with defects located at other body sites. All cases underwent preoperative assessment and preparation, focusing on site, size, and necessary investigations. Follow-up extended from six months to several years post-operation.

Surgical Procedure:

The surgical procedure details were explained to the patients and their relatives. They were informed about potential donor and recipient site side effects, and verbal informed consent was obtained from them.

Before intubation, the Allen test was conducted to assess the reliability of both arteries (radial and ulnar) in both hands. The test has a sensitivity of 91.7% and specificity of 54.5%, although the specificity can now be increased by using pulse oximetry during each assessment.[1] Typically, the non-dominant hand is selected as the donor site. The procedure commenced under general anesthesia, with a two-team approach involving plastic surgeons and head, neck, ear, nose, and throat (ENT) surgeon for tumor cases. The patient was placed in a supine position and intubated with the arm abducted 90 degrees from the shoulder and the forearm in supination. Surface marking began by palpating or using a Doppler to locate the radial artery and marking its course from distal to proximal. Large superficial veins, especially the cephalic vein, were also marked for use as additional venous drainage. The defect size was measured, and the decision on whether to use a proximally or distally based donor flap was made, as both options were feasible. A tourniquet was applied without exsanguination. The margin of the flap was incised down to the fascia, which was included in the flap. The fascia and skin were sutured together to prevent shearing stress, followed by subfascial dissection while preserving the flexor tendon paratenon, sensory radial nerves, and including the cephalic vein in the flap. Next, the radial artery was identified, and a temporary vascular clamp was placed on it. The tourniquet was then opened briefly to ensure the patency of the palmar arch to prevent acute ischemic events in the hand after radial artery ligation. If perfusion was satisfactory, the surgeon proceeded with harvesting, ligating, and cutting the radial artery distally or proximally based on the skin paddle position and progress of pedicle dissection. The pedicle remained attached until the recipient site was well-prepared in terms of defect and vessels, before being transferred to the defect site.

Usually, the facial or superior thyroid artery and vein were prepared for anastomosis as recipient vessels. The donor site was managed with an unmeshed full-thickness skin graft and immobilized with a back slab. All patients received antibiotics and anticoagulants (heparin) intra-operatively (bolus of 60–80 unit/kg) and post-operatively (infusion of 18 units/kg/hour). After surgery, they were transferred to a special care unit and prescribed antiplatelet medication (aspirin 100 mg/day), while unfractionated heparin was replaced with low molecular weight heparin (clexane injection 1 mg/kg = 100 international unite/kg twice daily subcutaneous

injection) for two weeks. Patients were discharged approximately seven days post-operatively after receiving instructions on medications and follow-up procedures. Later, follow-up visits were scheduled and continued for up to three months to one year.

Statistical Analysis:

Data entry and analysis were performed using the Statistical Package for Social Sciences (SPSS, version 26). Means and standard deviations (SDs) were used to summarize numerical variables, while frequencies and percentages were calculated to present categorical variables.

RESULTS

In this study, 12 patients were included, with a mean age of 49.2 (SD = 16.7) years, a median age of 43 years, and an age range of 22 to 78 years. The largest proportion (41.7%) of the sample was in the 40–49 years age group, and two-thirds (66.7%) of the patients were female (Table 1).

The lip was affected in five out of eight patients (41.7%), and the tongue was affected in three patients (25%), with most cases presenting as subtotal defects in these areas. The etiology of the defects varied, with cancer accounting for (58.3%) of cases, trauma for (33.3%), and hemi-facial macrosomia for (8.3%). Further details are presented in Table 2.

The overall success rate of the procedure was 91.7%, with only one case (8.3%) experiencing failure. The primary complication noted at the donor site was scarring (91.7%). Skin grafting was the main method of donor site closure (91.7%). Two patients (16.7%) experienced recipient site complications, resulting in total loss (Table 3).

Table 1: Age and Gender Distribution

	No.	(%)
Age (year)		
< 40	3	(25.0)
40–59	5	(41.7)
≥ 60	4	(33.3)
Mean (SD)	49.2	(16.7)
Gender		
Male	4	(33.3)
Female	8	(66.7)
Total	12	(100.0)

Table 2: Graft Details

	No.	(%)
Site		
Tongue	3	(25.0)
Lip	5	(41.7)
Skull base	1	(8.3)
Floor of the mouth	2	(16.7)
Cheek	1	(8.3)
Defect Area		
Total tongue	1	(8.3)
Subtotal tongue	2	(16.7)
Total lip	2	(16.7)
Subtotal lip	3	(25.0)
Skull base partial	1	(8.3)
Subtotal cheek	1	(8.3)
Partial floor of the mouth	2	(16.7)
Cause		
Cancer	7	(58.3)
Trauma	4	(33.3)
Hemi-facial microsomia	1	(8.3)
Total	12	(100.0)

Table 3: Outcomes

	No.	(%)
Survival		
Success	11	(91.7)
Failure	1	(8.3)
Donor Site Complication		
Scar	11	(91.7)
Cold intolerance	1	(8.3)
Donor Site Closure		
Skin graft	11	(91.7)
Direct repair	1	(8.3)
Recipient Site Complication		
Yes (total loss)	2	(16.7)
No	10	(83.3)
Total	12	(100.0)

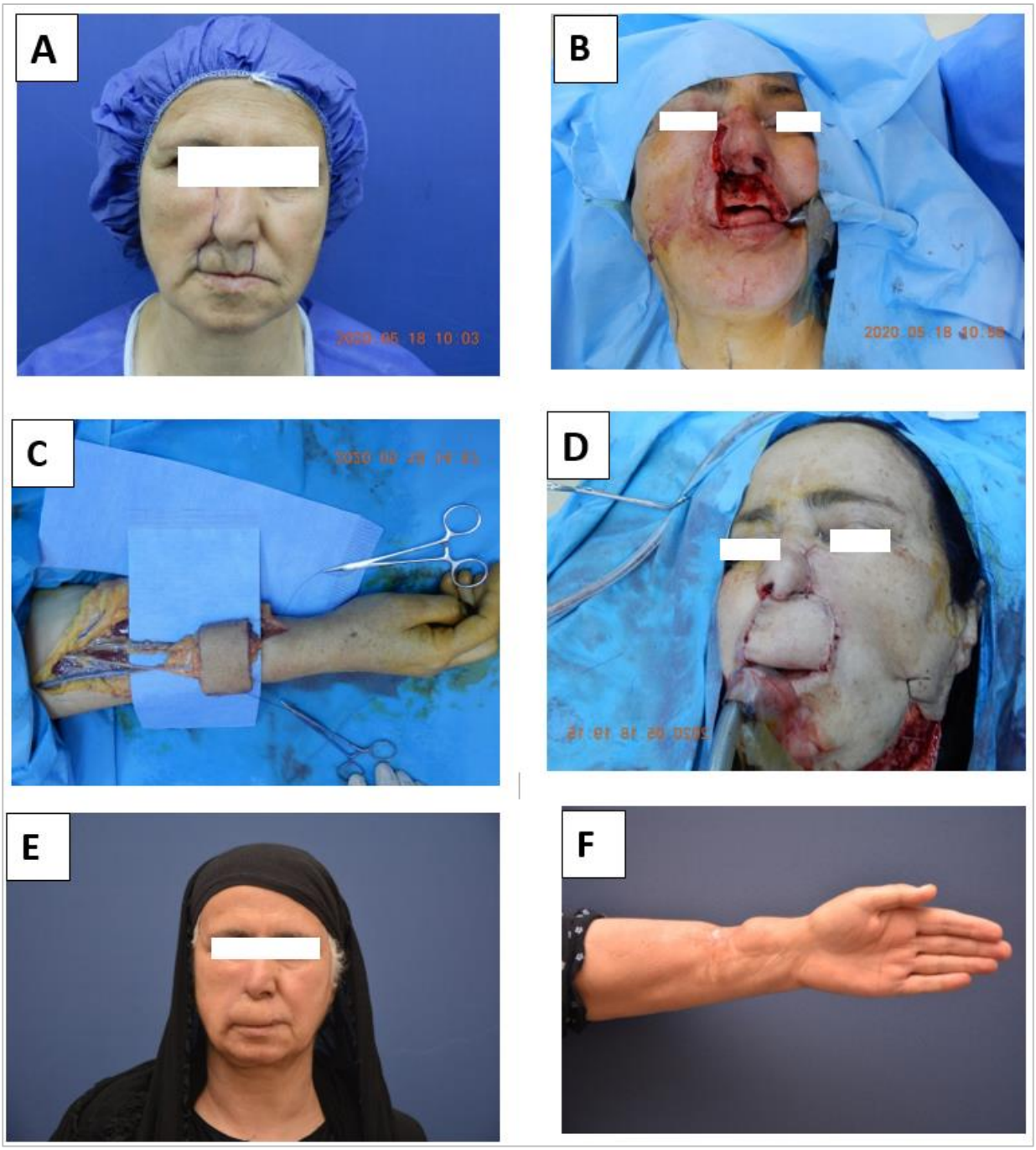

Figure 1: Case 1: A 58-year-old woman with dermatofibrosarcoma of the upper lip, planning for excision and reconstruction using a radial artery fasciocutaneous free flap. A: Pre-operative planning for upper lip removal. B: Full thickness subtotal excision of the upper lip. C: Fasciocutaneous radial artery free flap harvested before pedicle excision. D: Inset of the flap performed for the lip, with anastomoses of the vascular pedicle to the facial artery and vein. E: The final result after three months of follow-up. F: Forearm site of harvest showing a scar but maintaining full hand function.

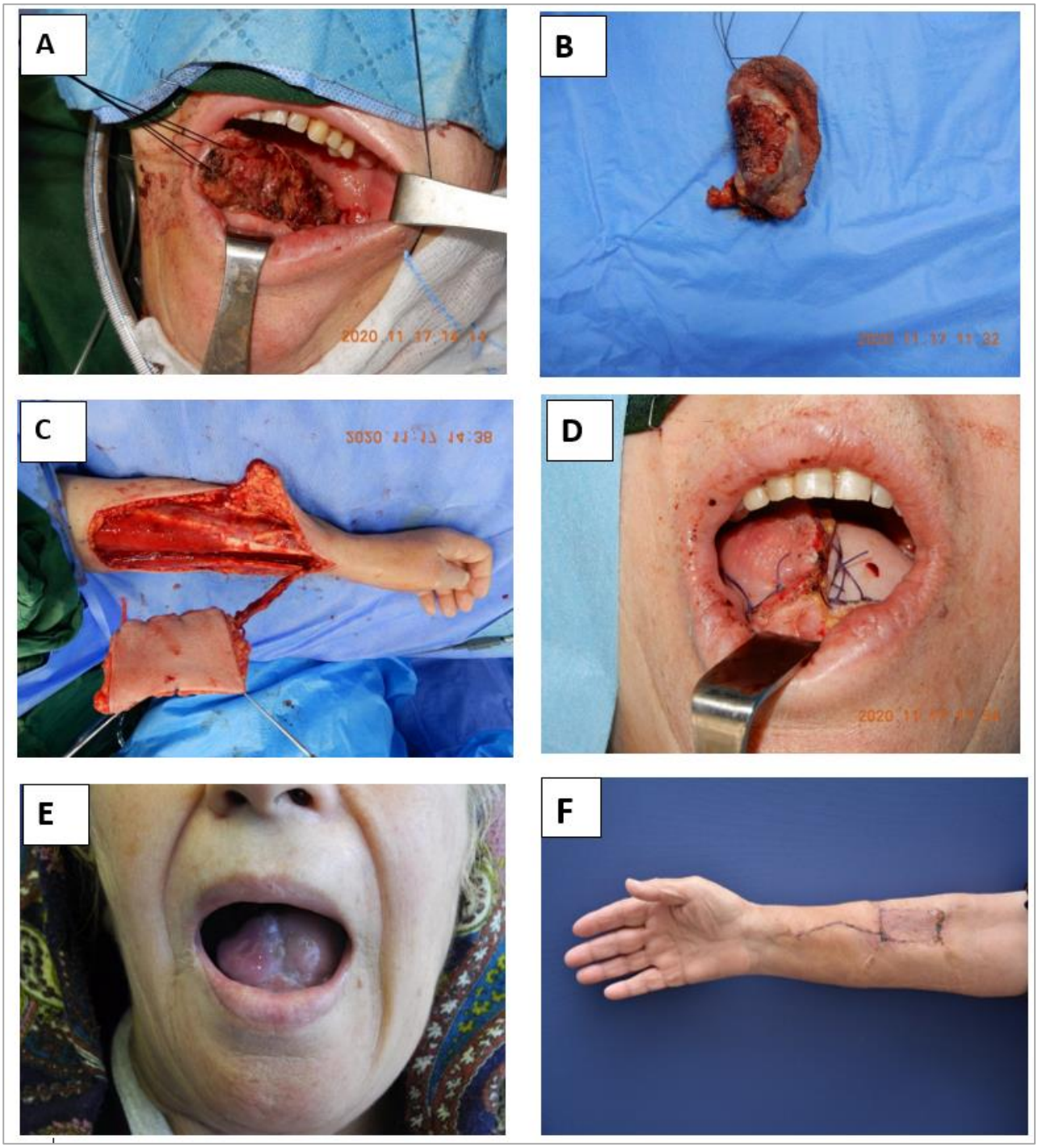

Figure 2: Case 2: A 60-year-old woman with squamous cell carcinoma of the tongue, planning for radial artery fasciocutaneous free flap reconstruction. A: Remnant of the tongue after hemiglossectomy. B: An excised portion of the tongue containing carcinoma with safe margin considerations. C: Proximally based radial artery fasciocutaneous free flap harvested with pedicle still attached. D: Inset of the radial artery free flap to the tongue defect with anastomosis to the facial artery and vein. E: The result of tongue reconstruction two months post-operation. F: The donor site of the right forearm covered by a skin graft.

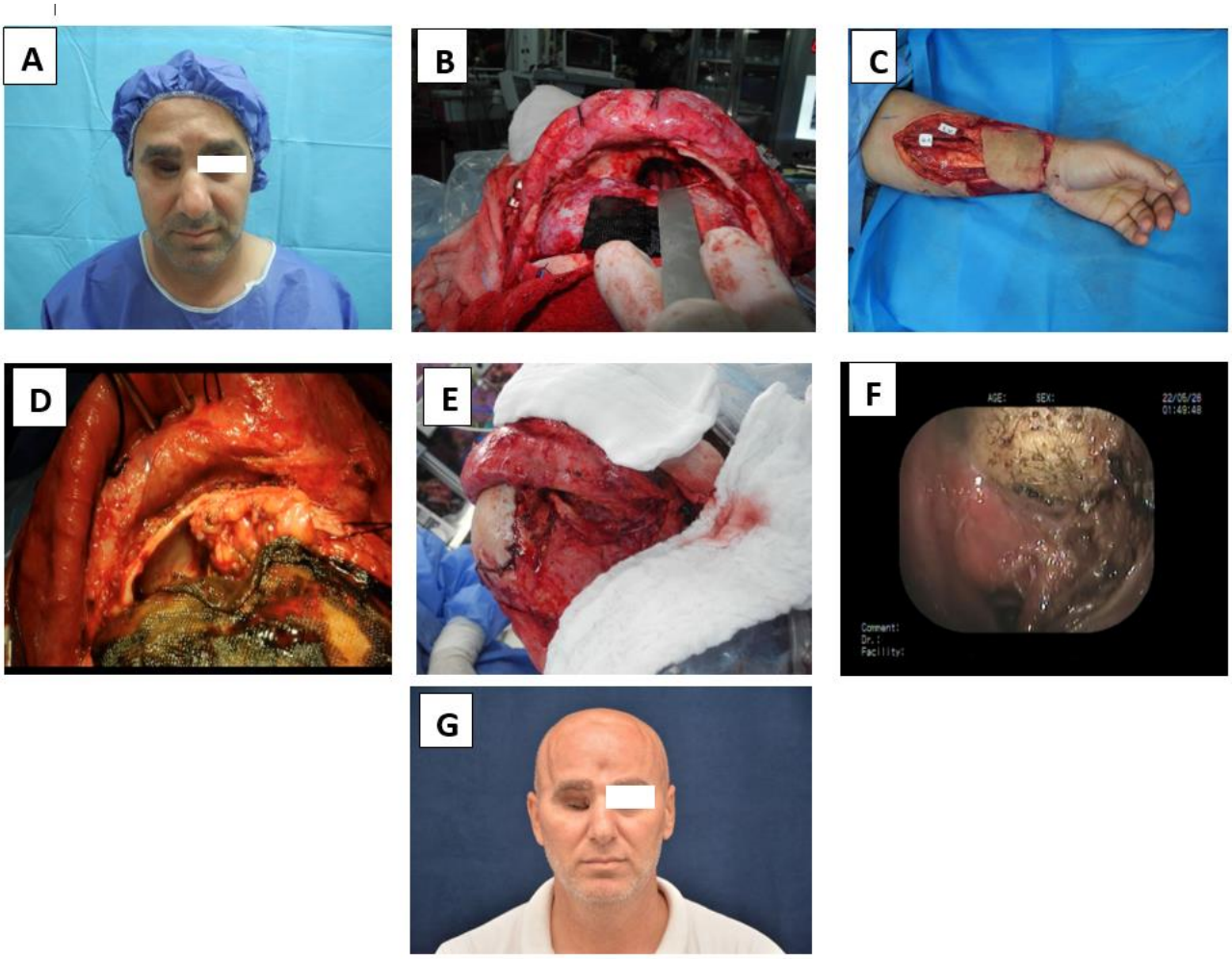

Figure 3: Case 3: A 40-year-old man with a recurrent malignant intra-orbital tumor involving the skull base, planning for skull base reconstruction with a radial artery fasciocutaneous free flap. A: Pre-operative preparation for surgery. B: Skull base defect cleared of the tumor. C: Distally based radial artery fasciocutaneous free flap harvested. D, E: Inset of the flap to the skull base defect, obliterating the defect and pedicle anastomosed with the superficial temporal artery and vein, with bone repositioning. F: Intra-nasal endoscopic view showing the well-positioned flap, completely separating the intra-cranial and intra-nasal cavities three months post-operation. G: Patient three months post-surgery with satisfactory results.

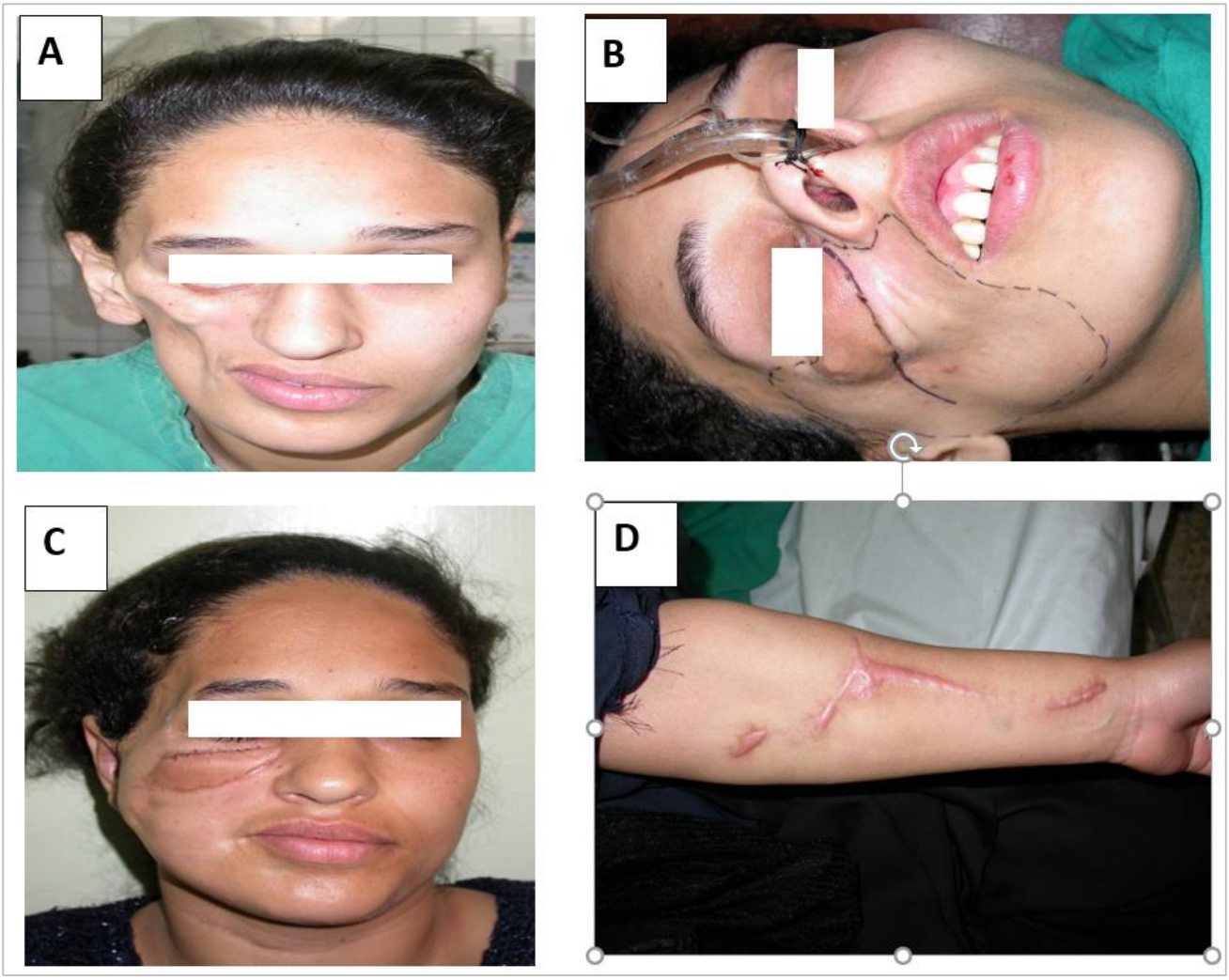

Figure 4: Case 4: A 34-year-old woman with hemifacial microsomia on her right side, planning for cheek reconstruction using a radial artery free flap. A, B: Pre-operative planning with the area to be filled marked for the radial artery free flap. C: Result after three weeks post-operation showing a well-filled cheek. D: Well-healed donor site, closed primarily.

DISCUSSION

Reconstructing head and neck defects is challenging due to the presence of various vital structures. Options for reconstruction include primary closure, secondary closure, skin grafts, local flaps, regional flaps, and free flaps.[5]

The advent of microsurgery and the free flap concept has significantly improved the functional and aesthetic outcomes of these reconstructions.[2] Among the many workhorse free flaps described for head and neck reconstruction, the radial artery free flap, discovery by Yang et al. 1981 in China and known as the "Chinese flap," has become particularly popular for oral and maxillofacial surgeries and soft tissue defect coverage.[5–7]

The choice of flap depends on several factors, including the site, size, type of tissue loss, vessel status, and radiation exposure.[2] The radial artery free flap is particularly desirable due to its reliable anatomy, ease of harvest, and the thin, flexible tissue it provides, which can be easily folded. This flexibility is crucial for intra-oral reconstructions, especially for the tongue, as it allows for free movement and hypertrophy of the remaining basal tongue muscle for compensation, which may be restricted by bulkier flaps.[3,8] Additionally, the flap can also be sensate by incorporating the lateral antebrachial cutaneous nerve or chimeric by including the distal radial bone (length: 10–12 cm, width: 40% of radial circumference).[4] However, using the radial bone is often avoided due to insufficient bone quantity for facial reconstruction and the risk of radius fracture. Including the palmaris longus is beneficial for lip reconstruction, providing bulk and helping regain oral sphincter function.[4,8] The long and sizable pedicles, which can extend up to 10 cm, facilitate anastomosis away from the

defect by passing the irradiated vessels into nearby defects and sometimes use contralateral vessels for anastomosis.[8] In our study, the most commonly used vessels were the facial artery and vein, the superior thyroid artery and vein, and, in one case, the superficial temporal artery and vein. We experienced one failure, resulting in a success rate of 90%, which is comparable to the result reported by Song et al. (greater than 90%).[9]

The reason for the failure in this case was a late ischemic event on the eighth day post-operation. This phenomenon was also reported by Jelenav-Jermir et al. who experienced a similar case of late ischemia.[7] Various factors could explain this, including vasospasm, endothelial edema, stagnation, hypotension, local acidosis, microthrombi formation, changes in fibrinolysis, and endothelial cell damage, all of which enhance platelet aggregation and fibrin deposition.[7,10,11]

CONCLUSIONS

The radial artery free flap is versatile in the reconstruction of complex structures within the head and neck due to its high-quality fasciocutaneous flap, which is thin, pliable, and has a long pedicle. This makes it especially suitable for lip and tongue reconstructions. Additionally, the flap's straightforward dissection process further enhances its utility.

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