ORIGINAL RESEARCH

Reconstruction of Oromandibular Defects by Vascularized Free Flaps: The Radial Forearm Free Flap and Fibular Free Flap as Major Donor Sites

[1]Virani J Shamsuddin, [2]Sanjeev Patni, [3]Shashikant Saini, [4]Kamal K Lakhera, [5]Gurdyal S Kalra

ABSTRACT

Restoration of good morphology and function are primary goals in the reconstruction of oral cavity defects. Several free flaps have been used in the reconstruction of bone and soft tissue defects in the oral cavity. We are reporting our experience in oromandibular defect reconstruction using radial forearm free flap (RFFF) and vascularized fibular free flap (VFFF). Of 228 total patients who had free flap reconstruction, 106 patients required reconstruction of oral soft tissue with an RFFF, and 122 patients required reconstruction of mandibular defects with a VFFF. Predictable results in terms of function and esthetics with minor donor site complications can be expected with the use of RFFF and VFFF for defects of the oral cavity.

Keywords: Fibular free flap, Free flaps, Oral cancer, Oromandibular defects, Plastic reconstruction, Radial forearm free flap.

INTRODUCTION

In today's era, restoring good morphology and function are primary goals in the reconstruction of oral cavity defects along with good oncologic outcome. Several free flaps have been used in the reconstruction of bone and soft tissues in the oral cavity, including the RFFF,[1,2] VFFF,[3] free deltoid flap,[4] scapular osteocutaneous flap,[5] brachioradialis forearm flap,[6] lateral arm free flap,[7] iliac crest free flap,[8] rectus abdominis musculocutaneous flap,[9] and anterolateral thigh flap.[10]

Although all of these flaps are of potential interest in covering defects within the oral cavity, the RFFF and VFFF are the preferred vascularized free flaps for intraoral soft and hard tissue reconstruction. Yang et al[1] first described the RFFF in 1981. It was described as an optimal method for intraoral reconstruction by Soutar et al.[11] The RFFF provides an excellent soft tissue covering because of its pliability and thickness. Moreover, multiple skin islands can be included, if needed, on a single pedicle. Various refinements, including the use of the palmaris longus tendon to confer oral continence in labial defects[12] and the creation of a sensate RFFF by means of the lateral antebrachial cutaneous nerve,[13] have been reported. Use of free osteocutaneous flaps becomes necessary for optimum cosmetic and functional outcome, when large mandibular defects are present. There are a range of osseous donor sites that can be used for the mandibular defects reconstruction. It may include the scapula, radius, iliac crest, and rib.[12-14] The VFFF is a more reliable reconstruction method after mandibular resection. It was first described in the literature by Taylor et al.[15] Several advantages of the VFFF have been reported, such as the possibility of several osteotomies, low donor site morbidity rate, possibility of combination with skin flaps, greater bone length, and suitability for osseointegrated dental implants.

In this article, we are reporting our experience in oromandibular defects reconstruction by using the RFFF and VFFF, after surgical ablation.

MATERIALS AND METHODS

Between January 2010 and May 2012, a total of 228 patients were treated in our department for oral cancer and underwent reconstruction of oral defects with microvascularized free flaps. The patients had reconstruction with either RFFF or free fibular flap based on the need for mandibular reconstruction. Demographic data, including gender, age, personal medical history, and habits, were obtained retrospectively from case files. The patients included 142 men and 86 women, with a mean age of 52 years (22–80 years). Surgical complications were

[1]DNB Student, [2]Head, [3,4]Consultant, [5]Plastic Surgeon

[1-4]Department of Surgical Oncology, Bhagwan Mahaveer Cancer Hospital & Research Centre, Jaipur, Rajasthan, India

[5]Department of Plastic Surgery, Sawai Man Singh Medical College, Jaipur, Rajasthan, India

Corresponding Author: Sanjeev Patni, Head, Department of Surgical Oncology, Bhagwan Mahaveer Cancer Hospital & Research Centre, Jaipur, Rajasthan, India, Phone: +919414078398 e-mail: sanjeevnidhi@yahoo.com

evaluated and classified as general complications (like infection and wound dehiscence), complications of the flap (need for reexploration due to either arterial or venous block, hemorrhage, etc.), donor site complications, or recipient site complications.

Totally, in 106 patients, oral soft tissue reconstruction was done by using RFFF, and 122 patients required VFFF for mandibular defects reconstruction. The patients underwent resection as primary treatment for squamous cell carcinoma (n = 215), verrucous carcinoma (n = 11), and minor salivary gland tumor (n = 2). For the RFFF, nondominant arm was selected for harvesting the flap as described by Yang et al.[1] For the VFFF, all flaps were raised from left leg. Standard lateral approach, as described by Gilbert, was used for harvesting the VFFF. In this group, all patients had complex bone and soft tissue defects. The number of osteotomies ranged from 0 to 3 for better cosmetic and functional alignment. Reconstruction plates and bicortical screws were used in all cases for osteosynthesis. In both groups, facial artery was used for arterial anastomosis (end–end) in most cases (n = 218). Superior thyroid artery was used when adequate length of facial artery stump was not available (n = 10). For venous anastomosis, thyrolinguofacial trunk or one of its tributary was used with end-to-end anastomosis (n = 98). Internal jugular vein with end-to-side anastomosis was also used as frequently (n = 120), and less often external jugular vein was used (n = 10). Postoperatively, flaps were monitored by color change, temperature, and pin prick method 2 hourly for first 48 hours and then less frequently.

RESULTS

Of 228 total patients who had free flap reconstruction, 106 patients required reconstruction of oral soft tissue with an RFFF, and 122 patients required reconstruction of mandibular defects with a VFFF. Of 228 total patients, 108 patients had buccal mucosal lesion, 29 patients had retromolar trigone lesion, 63 had lower alveolus lesion, 17 had tongue/floor of mouth lesion, 4 patients had palate, and 7 patients had upper or lower lip lesion (Table 1). Of the total 228 patients, 117 patients had T4 tumor, 25 patients had T3 tumor, and 67 and 19 patients had T2 and T1 tumors respectively (Table 1).

Reexploration was done in 24 (10.5%) patients for various reasons. Hemorrhage (n = 5), venous thrombosis (n = 13), arterial thrombosis (n = 4), and vascular kink (n = 2) were the main reasons. Totally, 11 (73%) flaps were salvaged, out of 15 reexplorations which were done within 48 hours. Three cases of reexploration were done after 48 hours, but before 120 hours, of which 2 (66%) were salvaged. Six patients were reexplored after 5 days and only 1 (16%) was salvaged. Thus, of 24 reexplorations, 14 flaps

Table 1: Patient characteristics

	Radial free flap	Fibular free flap	Total no. of patients	%
Sex				
Male	66	76	142	62.3
Female	40	46	86	37.7
Site of lesion				
Buccal mucosa	72	36	108	47.3
Retromolar trigone	17	12	29	12.7
Lower alveolus	0	63	63	27.6
Tongue/floor of mouth	6	11	17	7.4
Palate	4	0	4	1.8
Lip	7	0	7	3.0
Stage of lesion				
T1	19	0	19	8.3
T2	48	19	67	29.3
T3	12	13	25	10.9
T4	27	90	117	51.3
Histological type				
Squamous cell carcinoma	95	120	215	94.2
Verrucous carcinoma	9	2	11	4.3
Minor salivary gland tumor	2	0	2	0.8

Table 2: Surgical outcome and complication of procedure

	Radial free flap	Fibular free flap
No. of reexplorations (%)	10 (9.4)	14 (11.4)
No. of salvage (%)	6	8
Success rate (%)	96.2%	95%
Wound dehiscence (%)	7 (6.6)	8 (7)
Wound infection (%)	8 (7.5)	9 (7.8)
Seroma (%)	9 (8.4)	10 (8.5)
Hematoma (%)	3 (2.8)	5 (4.1)
Donor site complication (%)	21 (19)	27 (22)

were salvaged, while 10 flaps underwent necrosis and further salvaged by pectoralis major flap. So, the overall success rate was 95.6% as 218 flaps survived (Table 2).

Of 106 radial free flaps, 10 (9.4%) patients underwent reexploration. Among them, 6 flaps were salvaged, while 4 flaps underwent necrosis. Thus, overall 102 flaps survived with a success rate of 96.2%. Complications in the recipient site occurred in 20 patients (18.8%); these ranged from wound infection to seroma formation. Wound dehiscence occurred in 7 patients (6.6%). Wound infection occurred in 8 patients (7.5%), and delayed hematoma occurred in 3 patients (2.8%). Seroma occurred in 9 patients (8.4%). Donor site complications occurred in 21 (19%) patients in the form of graft loss (Table 2).

Of 122 fibular free flaps, 14 (11.4%) patients underwent reexploration. In these 14 reexplorations, 8 flaps were salvaged while 6 flaps underwent necrosis and further salvaged by pectoralis major flap. Thus, overall 116 flaps survived with a success rate of 95%. Complications in the

recipient site occurred in 28 patients (22.9%) including wound dehiscence (7%), wound infection (7.8%), delayed hematoma (4.1%), and seroma (8.5%). Donor site complications occurred in 27 (22%) patients in the form of graft loss, infection, and hematoma. Delayed plate exposure occurred in three patients all requiring adjuvant radiotherapy and these required plate removal after an average 6 months postoperatively without any significant morbidity (Table 2).

DISCUSSION

Whenever there is substantial removal of tissue intraorally as well as the overlying skin following oral cavity cancer surgery, primary reconstruction seems to be mandatory in most of these cases. Several advantages provided by primary reconstruction can be expected, including the absence of fibrosis in the surgical bed in comparison to when it is left for secondary healing or skin grafting is used. The selection of the suitable flap depends on the ease of access to the donor arterial and venous vessels, and lack of significant functional disability at the donor site. The use of vascularized free flaps has become a routine practice in oncosurgery, with the advent of microsurgery. It avoided the need for regional pedicled flaps requiring multiple stages.

A wider spectrum for reconstruction is available with the use of different vascularized free flaps. Among these flaps, the RFFF and VFFF are two of the most popular for the reconstruction of oral soft tissue and oromandibular defects. A long adequate vascular pedicle could be obtained in most of our cases. The RFFF has proven to be a reliable option for reconstructing a range of oral cavity defects. It provides a very pliable tissue, which results in adequate mobility of the tongue and the floor of the mouth. Its suitable thickness is helpful for inner buccal mucosal covering and overlying cheek skin defect with folded flap. Total flap failure was observed in only 4/106 cases; our flap failure rate of 4% is in concordance with the rates reported for overall free flap reconstruction of the head and neck.[15-18] A very similar failure rate (4.9%) was obtained with use of the VFFF in our series. This is lower than the flap failure rates obtained with the use of other osseous free flaps.

The use of a simplified approach employing a small number of well-established flaps, which was popularized by Disa and Cordeiro,[19] can lead to more reliable surgical outcomes with lower complication rates. We advocate the use of a standard radial forearm fasciocutaneous flap in cases involving large amounts of mobile soft tissue, such as the tongue, floor of the mouth, or buccal mucosa. The advantage of a complete fasciocutaneous graft is to provide sufficient bulk and adequate mobility. Different reconstructive options, such as VFFF were used, in those cases where involvement of bone was present. Use of radius to repair mandibular defects is controversial because of the elevated number of donor site complications. The scapula has limited width and the radius has limited length for bone replacement. Due to flexibility in harvesting, the fibula is ideally suited for the reconstruction of all types of mandibular defects, including large defects.[20] Precision graft shaping can be possible in VFFF where the number and location of osteotomies are not restricted.[21] Those cases in which moderate-to-large bone defects were present underwent reconstruction with the VFFF, with overall good results.

The VFFF has several advantages over other osseous free flaps: (1) a sufficient amount of bone can be obtained; (2) it provides a uniform shape; (3) its blood supply favors performance of several osteotomies; (4) it has a convenient location, allowing a team-team approach; (5) adjacent soft tissue is available; (6) a reliable skin flap can be obtained in more than 90% of patients; (7) it is indicated for all anterior mandibular defects and most lateral defects; and (8) donor site morbidity is low. Our clinical experience indicates that a skin paddle can be safely transferred within the bone, and we have obtained good results using a skin paddle for covering mucosal defect. Low height of the bone is one of the main disadvantages of the flap. This could pose a problem, especially in dentulous patients, in whom nonatrophied mandibles may be encountered. However, as previously reported by Guerra et al,[22] this condition may be attenuated by using a partial double-barrel fibular flap or further vertical distraction of the fibula. However, we usually did not require any double-barrel flap without compromising functional or cosmetic outcome. This flap is considered easier to harvest and is associated with less morbidity than the ilium, radius, or scapula. In relation to vascular anastomoses, large-diameter vessels with adequate length are obtained using this technique, and vein grafts usually are not needed.[21] The cross-sectional dimensions of the fibula are adequate for implants,[23] and thus, adequate esthetic results can be obtained through dental rehabilitation. At the end of the follow-up period, no long-term functional complications in the lower leg were observed except for a few who developed chronic pain. To ensure adequate healing of the donor site, the skin graft should be secured using the tie over bolster technique for 1 week.

CONCLUSION

Due to adequate bulkiness and pliability of the skin, a long vascular pedicle with large diameters, relatively easy harvesting, and few donor site complications, the RFFF has become our preferred method for reconstructing soft tissue defects involving the oral cavity. The VFFF is a reliable method for reconstructing mandibular defects.

It has an acceptably low morbidity rate. Good results in relation to survival of the skin paddle have been obtained at the end of the follow-up period. Predictable results in terms of function and esthetics with minor donor site complications can be expected with use of the RFFF and VFFF for defects of the oral cavity.

REFERENCES

1. Yang GF, Chen PJ, Gao YZ, Liu XY, Li J, Jiang SX, He SP. Forearm free skin flap transplantation: a report of 56 cases, 1981. Br J Plast Surg 1997 Apr;50(3):162-165.

2. Soutar DS, McGregor IA. The radial forearm flap in intraoral reconstruction: experience of 60 consecutive cases. Plast Reconstr Surg 1986 Jul;78(1):1-8.

3. Muñoz-Guerra MF, Gías LN, Rodríguez-Campo FJ, Díaz González FJ. Vascularized free fibular flap for mandibular reconstruction: a report of 26 cases. J Oral Maxillofac Surg 2001 Feb;59(2):140-144.

4. Wang Z, Sano K, Inokuchi T, Li J, Lan X, Sekine J, Ikeda H. The free deltoid flap: Microscopic anatomy studies and clinical application to oral cavity reconstruction. Plast Reconstr Surg 2003 Aug;112(2):404-411.

5. Bidros RS, Metzinger SE, Guerra AB. The thoracodorsal artery perforator-scapular osteocutaneous (TDAP-SOC) flap for reconstruction of palatal and maxillary defects. Ann Plast Surg 2005 Jan;54(1):59-65.

6. Sanger JR, Ye Z, Yousif NJ, Matloub HS. The brachioradialis forearm flap: anatomy and clinical application. Plast Reconstr Surg 1994 Oct;94(5):667-674.

7. Wenig BL. The lateral arm free flap for head and neck reconstruction. Otolaryngol Head Neck Surg 1993 Jul;109(1):116-119.

8. Moscoso JF, Urken ML. The iliac crest composite flap for oromandibular reconstruction. Otolaryngol Clin North Am 1994 Dec;27(6):1097-1117.

9. Butler CE, Lewin JS. Reconstruction of large composite oromandibulomaxillary defects with free vertical rectus abdominis myocutaneous flaps. Plast Reconstr Surg 2004 Feb;113(2):499-507.

10. Song YG, Chen GZ, Song YL. The free thigh flap: a new free flap concept based on the septocutaneous artery. Br J Plast Surg 1984 Apr;37(2):149-159.

11. Soutar DS, Scheker LR, Tanner NSB, McGregor IA. The radial forearm flap: a versatile method for intra-oral reconstruction. Br J Plast Surg 1983 Jan;36(1):1-8.

12. Serafin D, Villareal-Ríos A, Georgiade NG. A rib-containing free flap to reconstruct mandibular defects. Br J Plast Surg 1977 Oct;30(4):263-266.

13. Taylor GI. Reconstruction of the mandible with free composite iliac bone grafts. Ann Plast Surg 1982 Nov;9(5):361-376.

14. Schwartz WM, Banis J, Newton E, Ramasastry SS, Jones NF, Acland R. The osteocutaneous scapular flap for mandibular and maxillary reconstruction. Plast Reconstr Surg 1986 Apr;77(4):533-545.

15. Taylor GI, Miller GDH, Ham FJ. The free vascularized bone graft. Plast Reconstr Surg 1975 May;55(5):533-544.

16. Vaughan ED. The radial forearm free flap in orofacial reconstruction: personal experience in 120 consecutive cases. J Craniomaxillofac Surg 1990 Jan;18(1):2-7.

17. Urken ML, Weinberg H, Buchbinder D, Moscoso JF, Lawson W, Catalano PJ, Biller HF. Microvascular free flaps in head and neck reconstruction: report of 200 cases and review of complications. Arch Otolaryngol Head Neck Surg 1994 Jun;120(6):633-640.

18. González-García R, Naval-Gías L, Rodríguez-Campo FJ, Román-Romero L. Reconstruction of oromandibular defects by vascularized free flaps: the radial forearm free flap and fibular free flap as major donor sites. J Oral Maxillofac Surg 2009 Jul;67(7):1473-1477.

19. Disa JJ, Cordeiro PG. Mandibular reconstruction with microvascular surgery. Semin Surg Oncol 2000 Oct-Nov;19(3):226-234.

20. Disa JJ, Winters RM, Hidalgo DA. Long-term evaluation of bone mass in free fibula flap mandible reconstruction. Am J Surg 1997 Nov;174(5):503-506.

21. Hidalgo DA, Rekow A. A review of 60 consecutive fibula free flap mandibule reconstructions. Plast Reconstr Surg 1995 Sep;96(3):585-596.

22. Guerra MF, Gías LN, Campo FJ, Pérez JS, de Artiñano FO, González FJ. The partial double-barrel free vascularized fibular graft: a solution for long mandibular defects. Plast Reconstr Surg 2000 Apr;105(5):1902-1903.

23. Frodel JL Jr, Funk GF, Capper DT, Fridrich KL, Blumer JR, Haller JR, Hoffman HT. Osteointegrated implants: a comparative study of bone thickness in four vascularized bone flaps. Plast Reconstr Surg 1993 Sep;92(3):449-455.