International Journal of Research in Medical Sciences
Das PK et al. Int J Res Med Sci. 2017 Jun;5(6):2412-2418
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20172124

Original Research Article

Central arch mandibular reconstruction after surgery of oral carcinoma: an observational experience at MDACC, Houston, Texas, USA

Prafulla Kumar Das*[1], Geoffrey L. Robb[2]

[1]Department of Surgical Oncology, Acharya Harihar Regional Cancer Center, Mangalabag, Cuttack - 753007, India
[2]Department of Plastic Surgery, MD Anderson Cancer Center, Houston, Texas, USA

Received: 07 May 2017
Accepted: 12 May 2017

***Correspondence:**
Dr. Prafulla Kumar Das,
E-mail: pk_das1@yahoo.com

ABSTRACT

Background: Reconstruction of head and neck defects in general and oro-mandibular defects in particular, represents a challenge to the head and neck reconstructive surgeon. The most common indication of oro-mandibular reconstruction remains ablative surgery for neoplastic disease of the oral cavity and oropharynx. The principal purpose was evaluation of the various methods of such reconstruction done in order to achieve the best cosmetic and functional outcome in terms of adequate mouth opening, oral competence, deglutition of semisolid to solid foods, speech intelligibility, minimum donor site morbidity and complication.
Methods: The authors presented an observational work on the reconstruction of head and neck cancer after their curative excision, mostly oro-mandibular defects of various sizes ranging from 6cm to 12cm with special reference to the central arch during the first authors fellowship to MD Anderson Cancer Center (MDACC), Texas, where the second author was the supervisor.
Results: The authors reported 24 reconstructions including 10 bony reconstructions. The free flap was preferred to pedicle flap for the reason of better aesthetic and functional outcome. The free fibula was mostly preferred due to its characters akin to the native mandible. Seventy-five patients were also observed in the outpatient clinic and evaluated during the follow up period for aesthetic and functional aspects, donor site morbidity, and long term complications. The first auther also evaluated that the incidence of primary closure with residual cosmetic defect in his study had come down from 28.47% before MDACC visit to only 4.38% today owing to more number of free and pedicle flaps were used.
Conclusions: The free fibula was found to be the best option for mandible reconstruction overall. Observation within high volume centers however limited it may be, certainly upgraded the knowledge and working skills of the second author after he came back to his institution of Acharya Harihar Regional Cancer Center (AHRCC) in India.

Keywords: Central arch mandibulectomy, Free fibula flap, Microvascular technique, Oral cancer

INTRODUCTION

Reconstruction of head and neck defects in general and oro-mandibular defects in particular, represents a challenge to the head and neck reconstructive surgeon. The most common indication of oro-mandibular reconstruction remains ablative surgery for neoplastic disease of the oral cavity and oropharynx. Other causes of oro-mandibular defects include osteoradionecrosis, trauma and congenital deformities. After mandibular resection, particularly

following complex radical resection for advanced oropharyngeal carcinomas invading the different parts of the mandible including its central arch, the restoration of form and function is paramount for rehabilitation of such patients. Fibula bones, iliac crests, and clavicles had dimensions that best matches those of the mandible.[1] Out of those, the fibula is the bone that best matches the properties of the mandible. So, free fibular flaps have become the main tool of mandibular reconstruction, particularly its central part. Use of bridging plates is another option for lateral mandible reconstruction with no history of preoperative irradiation in order to avoid the risk of blood transfusion, but anterolateral defects and preoperative radiotherapy emerges as an independent negative factor for plate survival.[2]

This original research article focused mainly on analysis of the type of reconstruction of segmental mandibular defects particularly the central one, with or without loss of inner lining, soft tissue of the neck and the outer skin in various permutations and combinations of tissue volume. The aesthetic deformity and functional losses that occur with such defects will also be taken into consideration. In general, mandibular defect in the posterior body or ramus are better tolerated. As the defect extends to involve the symphysis or the anterior body of the mandible significant deformity and loss of function occurs. Mastication and deglutition are compromised as structural support for the tongue and larynx is lost. Airway compromise as a result of tongue prolapse can occur and necessitate tracheostomy. Even small defects in the posterior body or ramus of the mandible can lead to malocclusion over a period of time as the mandible shifts to the affected side. Mandibular reconstruction is undertaken to address these significant functional and esthetic deficits. So, the main aim was to evaluate best and optimum method of reconstruction of such central arch defect.

The other objective of this study was to evaluate the possible benefit of a cancer surgeon of a tertiary care cancer hospital of eastern India going to a high-volume center in USA to observe and value added to his surgical expertise in this field of reconstruction.

METHODS

The first author from Acharya Harihar Regional Cancer Center (AHRCC), Cuttack, India, in the department of Surgical Oncology, visited the MD Anderson Cancer Center, Houston, Texas, USA and the Department of Plastic Surgery, under UICC-ICRETT fellowship and under the supervision of Professor Geoffrey L. Robb, Chairman of Plastic Surgery, and made some important observations regarding various options of reconstructions in head and neck malignancies after their curative resections. During the period of the month of May 2006, 24 reconstructions of defects after curative resections for various head and neck malignancies were performed at the MD Anderson Cancer Center by autologous tissue transfers. Watchful observations were made regarding the age, sex, performance status of the patients, site distribution of the disease, preoperative radiation therapy status, types of defects left over after curative resections, size of the defects, nature of defects, whether through and through, type of reconstructions done, nature of reconstructions done, whether bridging plates used, and whether planned for osseo-integrated mandibular implants. Also, observations were made regarding total operation time and number of preoperative blood transfusions. Observations were made in the ICU and postoperative wards as to the routine protocol of management, any morbidity and the number of hospital days. During the whole month, 75 patients were also observed similarly in the out-patient clinics during the post-operative follow-up and evaluated for the short term and long term functional and cosmetic outcomes.

After coming back to home Institute, the first author with the help of local Plastic surgeon mentors has performed many such procedures of reconstruction with value added. A compilation of such data from the AHRCC records and records from outside private clinical practice of the first author until the month of March 2017 were done to assess the quantity and quality of such reconstructive work with value added. The possible benefits of such observational exposure from a higher center were evaluated.

RESULTS

The total number of patients observed in operation room was 24, the average age was 42 years.

Table 1: Site and irradiation status.

	Male	Female	Total
Oro-mandibular site R/B	4	2	6 (60%)
Oro-mandibular site CA^{H}/B	2	2	4 (40%)
Mucosa and soft tissue	9	5	14 (58.33%)
Pre-operative irradiation received	4	2	6 (25%)

Footnote: R=Ramus, B=Body, CA^{H} =Central Arch Hemi.

From Table 1, it was observed that 60% of mandibular defects resulted in body and ramus site where as 40% was in central arch which was a more challenging situation. Only mucosa and soft tissue defects were seen in 58.33%. There, was history of prior radiation in 25% of cases.

It was observed from Table 2 and 3 that the free fibula was planned for those 6 patients who needed only bone with or without mucosa. Whereas, the anterolateral thigh flap was selected for those 5 patients who needed mucosa and the bulk of soft tissue. There was only 1 patient in whom an antero-lateral thigh flap was planned in addition to free fibula osteo-cutaneous flap, it was found to be most

suitable for the patient as the soft tissue bulk could be achieved and simultaneous harvesting was possible along with the resection surgery, as well as that each of the three perforators were of equal size to the peroneal vessels. Three out of 13 patients with the requirement of mucosa and minimal soft tissue were opted for the radial forearm flap. None of the 6 preoperative irradiated patients underwent planning for osseo-integrated dental implants. It was noted that all 3 patients of the poor performance group were subjected to the procedure of bridging plate with muscle wrapping. Two out of these 3 patients, the wrapping of plate was with the muscle and the anterior rectus sheath from a vascularized free rectus abdominis myocutaneous flap; in the other patient, it was wrapped with a pedicled pectoralis major myocutaneous flap to minimize the operative time due to the lower physiologic status of the patient. Except in the patient of a mucosal defect where only a skin graft was placed, the operating time for all other free and pedicle flaps ranged from 6-9 hours. In none of the cases of bony reconstructions was the free scapula, ilium nor rib flap suitable. The evaluation of free iliac and scapular flaps in term of their results was left out as the number was too small to evaluate.

Table 2: Number of patients observed in the operation room taken for reconstruction (n=24).

Defects	No. of defects	Size of defects			Poor performanc status	Free fibula	Combined fibula	ALT	Radial fore-arm free flap	Gracilis
		<6cm	6-9cm	>9cm						
Bony mandibular only	1	1	-	-	-	1	-	-	-	-
Bone and mucosa lining	7	1	6	-	2	5	-	-	-	-
Bone, mucosa, soft tissue and skin	2	-	-	2	1	-	1	-	-	-
Mucosa only	1	1	-	-	-	-	-	-	-	-
Mucosa and soft tissue	13	-	13	-	-	-	-	5	3	3
Total	24	3	13	2	3	6	1	5	3	3

Defects	Bridging plates with muscle wrapping	Pec Major pedicle flap	Trapezius pedicle	Skin graft	Free scapula	Free Ilium	Free Rib	Plan for osseo integrated implant	# of Perioperative blood transfusion			Total hospital stay in days	Operation time in hours
									2 units	1 uni	Nil		
Bony mandibular only	-	-	-	-	-	-	-	1	-	-	-	7	9
Bone and mucosa lining	2	-	-	-	-	-	-	3	3	-	-	7	9
Bone, mucosa, soft tissue and skin	1	-	-	-	-	-	-	-	1	-	-	7	8
Mucosa only	-	-	-	1	-	-	-	-	-	-	-	5	5
Mucosa and soft tissue	-	1	1	-	-	-	-	-	2	4	-	6	9
Total	3	1	1	1	0	0	0	3	6	4	14		

Table 3: Number of patients observed in outpatient clinic (n=75).

Nature of reconstructions	No. of patients	Mouth opening acceptable	Speech intelligible	Deglutition to solids and or semisolids comfortable	Fair aesthetic appearance	Oral compe-tence	Donor site morbidity	Complications
Free iliac osteoseptocutaneous flap	1	1 (100%)	1 (100%)	1 (100%)	1 (100%)	1 (100%)	Nil	Nil
Free scapula osteo myocutaneous flap	1	1 (100%)	1 (100%)	1 (100%)	1 (100%)	1 (100%)	Nil	Nil
Free radial forearm flap-	11	10 (90%)	10 (90%)	9 (82%)	11 (100%)	11 (100%)	Nil	Nil
Free antero lateral thigh flap-single paddled	12	11 (92%)	11 (92%)	11 (92%)	12 (100%)	11 (92%)	Nil	Nil
Free antero lateral thigh flap-double paddled	5	4 (80%)	4 (80%)	4 (80%)	5 (100%)	4 (80%)	Nil	One partial flap necrosis
Combined Free fibula and rectus abdominis free flap	2	2 (100%)	2 (100%)	2 (100%)	2 (100%)	2 (100%)	Nil	One wound infection
Combined Free fibula and anterolateral thigh	6	5 (83%)	6 (100%)	6 (100%)	6 (100%)	6 (100%)	Nil	Nil
Free scapular osteocutaneous flap-	1	1 (100%)	1 (100%)	1 (100%)	1 (100%)	1 (100%)	Nil	Nil
Bridging plate and muscle	4	3 (75%)	3 (75%)	3 (75%)	3 (75%)	3 (75%)	2 (50%)	One plate extrusion
Transverse gracilis free flap for tongue reconstruction	6	5 (83%)	5 (83%)	5 (83%)	6 (100%)	5 (83%)	Nil	Nil
Pectoralis major pedicle flap	4	3 (75%)	1 (25%)	2 (50%)	1 (25%)	1 (25%)	3 (75%)	One wound infection
Trapezius pedicle flap	3	2 (66.7%)	Not applicable	2 (66.7%)	1 (67%)	2 (66.7%)	2 (66.7%)	One wound infection
Free fibula esteocutaneous flap	16	14 (87.5%)	15 (94%)	15 (94%)	16 (100%)	15 (94%)	Nil	Nil
Osseo integrated implants	3	3 (100%)	3 (100%)	3 (100%)	3 (100%)	3 (100%)		Nil
Total	75							

Aesthetic and functional outcome was 100% in all free flaps but 25-75% in those with pedicle flaps and the case with a bridging plate reconstruction. Adequate mouth opening, speech intelligibility and oral competence were 83-100% in the free flap patients where as it ranged from 25-75% in the group of pedicle flaps and the bridging plate. Speech intelligibility, mouth opening and oral competency were not applicable to the trapezius pedicle flap patients as they were all extra oral head neck reconstruction. Speech intelligibility was 83% in gracilis group which was considered outstanding as all of those were reconstructions of tongue defects. The functional outcome in all 3 cases of osseo-integrated implants and prosthesis were excellent with regards to chewing quality and deglutition. Donor site morbidity was found in both pedicle flaps and the case of the bridging plate reconstruction as clinical or sub clinical muscle weakness. Fibula free flap harvest appeared to be associated with acceptable donor site morbidity and preservation of good

foot and ankle function in most individuals. There was one major long term complication in the one bridging plate reconstructed mandible after a period of 6 years and the stump of native mandible was visible and the patient was scheduled for a revision repair. The head and neck reconstructive operative work by the first author at AHRCC and outside clinical practice together from March 2001 to April 2006 were compared with the work after his visit to MDACC in May 2006 until March 2017.

Table 4: Comparison of number of surgeries done by first author before and after visit to MDACC.

	Before MDACC visit March 2001 to April 2006 (62 months) n=144	After MDACC visit June 2006 to March 2017 (130 months) n=411
Pedicled PMMC for lining	28 (19.44%)	107 (26.03%)
Pedicled PMMC for cover	16 (11.11%)	19 (4.62%)
Double paddle PMMC for both	09 (6.25%)	16 (3.89%)
DP flap 2 stage	05 (3.47%)	00 (0.00%)
DP flap single stage	04 (2.78%)	01 (0.24%)
Nasolabial flap	21 (14.58%)	42 (10.22%)
Tongue flap	12 (8.33%)	27 (6.57%)
Temporal flap	02 (1.39%)	03 (0.73%)
Bridging plate and muscle	06 (4.17%)	27 (6.57%)
Free radial forearm fasciocutaneous Flap (FRFF)	00 (0.00%)	97 (23.60%)
Free fibula	00 (0.00%)	29 (7.06%)
Free ALT flap	00 (0.00%)	16 (4.62%)
Free gracilis flap	00 (0.00%)	01 (0.24%)
Primary closure with cosmetic defect	41 (28.47%)	18 (4.38%)
Buccal mucosal flap	01 (0.69%)	08 (1.95%)

Table 4 shows the figures with percentages as individual variables. It is evident that before the author visited MDACC, primary closure of the buccal mucosa with resultant cosmetic defect and mandibular deviation with denture malocclusion was most commonly practiced closing the oral wound. Next in order was the pedicle PMMC flap for cover, lining or both, in which bulk were corrected, and the, mouth opening was adequate but no correction of mandibular deviation. The bridging plate and muscle were used to facilitate good dental alignment but only in 4.17% with a consistent fear of rejection due to potentially infection because of advanced stage and fungation with poor oral hygiene typical in this part of the country. Nasolabial and tongue flaps were used in 14.58% and 8.33% respectively to facilitate closure and prevention of leakage but compromising the mouth opening and tongue movement. There were no cases of free microvascular flaps. After exposure from MDACC, the author started doing more frequent free flaps like the radial forearm free flap, free fibula, and ALT in 23.60%, 7.06% and 4.62% in that order. The cosmetic results were much better. The cancer patients started seeing more and more such flaps and hence their acceptance to these reconstructions became better and better. Still PMMC pedicle flap is the workhorse for reconstruction now in 34.55% cases since it is the most reliable and cost effective which is a matter of concern in this part of India where a low socioeconomic economy prevails. The incidence of primary closure with residual cosmetic defect in my study has come down from 28.47% before MDACC to only 4.38% today.

DISCUSSION

The current state of mandibular reconstruction is the result of an evolution in techniques within the past 60 years. Refinements in micro vascular techniques, biomedical advances in plating technology and instrumentation, and an understanding of donor site vascular anatomy have made reliable mandibular reconstruction a reality. Over the past twenty years, however, the use of vascularized bone grafts has become the state of the art for mandibular reconstruction. The most common donor sites for osseous free tissue transfer include the fibula, scapula, iliac crest and radius.[3,4] The use of reconstruction plates also remains an option in the appropriately selected patient population.[5] Use of mandibular reconstruction plates is typically indicated in patients with poor physiologic status or in cases in which the soft tissue defect in the oral cavity or oropharynx is more extensive than the bony mandibular defect.[6] In patients in whom mandibular continuity is restored with a reconstruction plate, wrapping the plate with muscle and the anterior rectus sheath from a vascularized free rectus abdominis myocutaneous flap can be also used to prevent plate exposure and extrusion.[7]

However, microvascular free flap remains the preferred technique for mandibular reconstruction. This type of reconstruction also requires rigid internal fixation with plates and screws at osteotomy sites. The latest innovation in the screw and plate technology is the development of self-drilling, self-tapping screws and locking miniplates. The main advantage of primary oromandibular reconstruction using free vascularized bone flaps is improved oral function from maintenance of mandibular and soft tissue architecture and dental rehabilitation through osseo-integrated implants. Fibula bones, iliac crests, and clavicles had dimensions that best matched those of the mandible.[1] The fibula is the bone that best matches the properties of the mandible.

The fibula has multiple advantages, including bone length and thickness, and donor site location permitting flap harvest simultaneously with tumor resection, with minimal donor site morbidity.[8] The fibula is the workhorse of modern day mandibular reconstruction. The fibula can be used to reconstruct bony defects as long as 30 cm in length. The fibula allows placement of osseo-integrated dental implants and can be easily contoured. Fibular bone allows planned osteotomies in relation to the orientation of the bone and its vascular pedicle. Thick cortical bone readily accepts plates and screws for a secure interosseous fixation and osseo-integrated implants can be placed in this bone safely. Correct surgical planning reduces surgical timing, minimizes the chance of failure during the reconstruction, and simultaneously increases treatment efficacy and the best functional and aesthetic results.[9] Fibula free flap harvest appears to be associated with acceptable donor site morbidity and preservation of good foot and ankle function in most individuals.[10] Sliding mandibulectomy is another simple method of mandibular reconstruction. This surgical technique is indicated for repairing short mandibular defects up to 9 cm in overall length, including the mandibular arch for which extra vertical osteotomies is needed to bend the segment.

Moreover, it has its value in patients with poor prognosis and poor general conditions in whom longer and complicated mandible reconstruction procedures with free vascularized bone flaps are not advisable.[11] Radiation therapy has been considered a contraindication to implant surgery. Although mostly used as a secondary procedure, a one-stage procedure combining the free vascularized fibula transfer with simultaneous placement of osseo-integrated implants is feasible.[12] For through and through large oromandibular defects which may require a large skin flap in addition to the bone and mucosal lining repair, the anterolateral thigh flap seems to be best for many reasons.[13]

Alternatively the radial forearm flap and the rectus abdominis myocutaneous flap can be used but they have some disadvantages that restrict their use for this purpose. The forearm flap is usually too thin to cover the fibular bone and reconstruction plate and the rectus abdominis myocutaneous flap can cause a sub-clinical reduction in abdominal strength. Both of the above flaps are difficult to harvest during tumor excision. Vascularized bone grafts have become the preferred method of mandible reconstruction, the technique is thought to increase both operating time and blood loss, and may be associated with increased morbidity and mortality. Distraction osteogenesis is a technique originally developed for lengthening long bones, has recently been applied to lengthening of the reconstructed mandible.[14] Oromandibular reconstruction although a challenge for the head and neck reconstructive surgeon, is now more reliable and highly successful with excellent long term functional and aesthetic outcomes.[15]

CONCLUSION

Vascularized osseous free tissue transfer is the preferred reconstructive modality today for oromandibular reconstruction especially central arch mandible defects after curative surgery for head and neck malignancy. The free fibula with or without other flap combinations has shown excellent long term aesthetic and functional outcomes. The anterolateral myocutaneous flap can offer adequate skin and mucosal lining as well as soft tissue for reconstruction. The gracilis myo-cutaneous neurovascular flap repair can give a good functional tongue. However, for patients with compromised health, the bridging plate wrapped with muscle reconstruction can be an effective alternative option. Refinements in technique and development of new directions in tissue engineering within the field of osseo-integrated implants and prostheses can offer a near normal native mandible function and excellent cosmetic outlook in addition to an oncologic cure.

Observation within high volume centers however limited it may be, is going to certainly upgrade the knowledge and working skills among the cancer care clinicians of a developing country like India. Such knowledge can then be readily translated into the actual work within the home institution for better care of the cancer patients in the community.

Funding: This work has been supported by a UICC International Cancer Technology Transfer Fellowship funded by the American Society of Clinical Oncology for the year 2006
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Seikaly H, Chau J, Li F, Driscoll B, Seikaly D. Bone that matches the properties of the mandible. J Otolaryngol. 2003;32(4):262-5.
2. Okura M, Isomura ET, Lida S, Kogo M. Long term outcome and factors influencing bridging plates for mandibular reconstruction. Oral Oncol. 2005;41:791-8.

3. Urken ML, Buchbinder D, Costantino PD, Sinha U, Okay D, Lawson W, et al. Oromandibular reconstruction using microvascular composite free flaps. Arch Otolalyngol Head Neck Surg. 1991;117:733-44.
4. Genden E, Haughey BH. Mandibular reconstruction by vascularized free tissue transfer. Am J Otolaryngol. 1996;17:219-27.
5. Koch WM, Yoo GH, Goodstein ML, Eisele DW, Richtsmeier WJ, Price JC. Advantages of mandibular reconstruction with the Titanium Hollow Screw Osseointegrating Reconstruction plate (THROP). Laryngoscope. 1994;104:545-52.
6. Poli T, Ferrari S, Biancha B, Sessena E. Primary oromandibular reconstruction using free flaps and THORP plates in cancer patients: a 5-year experience. Head Neck. 2003;15-23.
7. Yokoo S, Komori T, Furudoi S, Shibuya Y, Umeda M, Ichinose A, et al. Indications for vascularised free rectus abdominis musculocutaneous flap in oromandibular region in terms of efficiency of anterion rectis sheath. Microsurg. 2003;23:96-102.
8. Dissa JJ, Cordeir PG. Mandible reconstruction with microvascular surgery. Semin Surg Oncol. 2000;19(3):226-34.
9. Valentini V, Agrillo A, Batisti A, Gennaro P, Calabrse l, Ianetti G. Surgical planning in reconstruction of mandibular defect with fibula free flap; 15 patients. J Craniofac Surg. 2005;16(4):601-7.
10. Alan G, Yadranko D, Raghu SA, Travis M, Brian C. Evaluation of fibula free flap donor site morbidity. Am J Otolaryngol. 2006;27(1):29-32.
11. Bhathena HM. Mandibular reconstruction with local live vascularized bone transfer. Acta Chir Plast. 2004;46376-80.
12. Santamaria E, Wei FC, Chen HC. Fibula osteoseptocutaneous flap for reconstruction of osteoradionecrosis of the mandible. Plast Reconstruct Surg. 1998;101:921.
13. Koshima I, Hosoda S, Inagawa K, Urushibara K, Moriguchi T. Free combined anterolateral thigh flap and vascularised fibula for wide, through and through oromandibular defects. J Reconstr Microsurg. 1998;14(8):529-34.
14. Kessler P, Schultze MS. Lengthening of Reconstructed mandible with pre-fabricated osseous free flaps: A three years experience with 23 patients. Plast Reconstr Surg. 2003;111:1400-6.
15. Mehta RP, Deschler DG. Mandibular reconstruction in 2004: An analysis of various techniques. Curr Opinion Otolaryngol Head Neck Surg. 2004;12(4):288-93.

Cite this article as: Das PK, Robb GL. Central arch mandibular reconstruction after surgery of oral carcinoma: an observational experience at MDACC, Houston, Texas, USA. Int J Res Med Sci 2017;5:2412-8.