ORIGINAL ARTICLE

RECONSTRUCTION OF MANDIBULAR DEFECTS WITH AUTOGENOUS BONE GRAFTS: A REVIEW OF 30 CASES

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Background: Multitudes of options are available for reconstruction of functional and cosmetic defects of the mandible, caused by various ailments. At the present time, autogenous bone grafting is the gold standard by which all other techniques of reconstruction of the mandible can be judged. The purpose of this study was to evaluate the outcome of different osseous reconstruction options using autogenous bone grafts for mandibular reconstruction. **Methods:** This Interventional study was conducted at Department of Oral and Maxillofacial Surgery, King Edward Medical University/Mayo Hospital Lahore, from January 2008 to July 2009 including one year follow-up. The study was carried out on thirty patients having bony mandibular defects. They were reconstructed with the autogenous bone grafts from different graft donor sites. On post-operative visits they were evaluated for outcome variables. **Results:** Success rate of autogenous bone grafts in this study was 90%. Only 10% of the cases showed poor results regarding infection, resorption and graft failure. **Conclusion:** Autogenous bone grafts, non-vascularised or vascularised, are a reliable treatment modality for the reconstruction of the bony mandibular defects with predictable functional and aesthetic outcome.

Keywords: Mandibular reconstruction, maxillofacial reconstruction, Autogenous bone grafts, mandibular defects

INTRODUCTION

Defects in mandible may be functional, cosmetic or both and can be caused by many ailments such as congenital, pathologic, and iatrogenic; as a result of tumour excision, infections or post radiation necrosis. Apart from Motor vehicle injuries, diverse injuries like gunshot injuries, interpersonal assaults, burns, electrical flashes and splashes also contribute their part to damage the soft and hard tissues of the whole body in general and maxillofacial region in particular.[1–3]

The aesthetic deformity and functional losses that occur with mandibular defects depend on the size and location of the segmental mandibular defect. Mandibular defects, in general, are better tolerated in the posterior body or ramus. When the defect extends to involve the symphysis or the anterior body of the mandible, significant deformity and loss of function occurs. Mastication and deglutition is compromised as structural support for the tongue and larynx is lost. Even small defects in the posterior body or ramus of the mandible can lead to malocclusion over time as the mandible shifts to the affected side. Mandibular reconstruction is undertaken to address these significant functional and aesthetic deficits.[4]

There are many options available for the reconstruction of the mandibular osseous defects. Alloplastic materials like, organic calcium salts or synthetic materials such as methylmethacylate, proplast and Teflon and larger reconstruction plates, have all been used for reconstruction with varying degree of success.[5–7]

At present, autogenous bone grafting, is the gold standard and mainstay for mandibular bony reconstruction.[8] Non-vascularised autogenous bone grafts can be harvested from local and/or distant sites. If the defect size is small, local or intra-oral donor sites may be sufficient. For larger defects and when a moderate amount of bone is required, distant or extra-oral sites are preferably employed.[9,10] All other reconstruction options could be worth mentioning only in terms of simplicity, lack of the requirement for elaborate equipment, technical capability and longer operating room time and resources. Simplicity does not, however, always bring desirable outcome, particularly as mandibular defects become more centrally placed. Then, these conservative endeavours bring more unpredictable results and often greater or more protracted complications.[11]

Free bone grafts have been used frequently for mandibular reconstruction. Autogenous bone grafts from the calvarium, rib, ilium, tibia, fibula, scapula, and radius have been used.[4] New novel developments and techniques are tested to eliminate need for bone harvesting from a donor site; these include transport disc distraction osteogenesis (TDDO), tissue-engineering and modular endoprosthesis for mandibular reconstruction.[1,12,13] Over the past two decades, however, the use of vascularised bone grafts has become 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.[14,15] With the advent of vascularised osseous free flaps over

the past thirty years, reliable mandibular reconstruction with remarkable success rates is possible.[14–17]

PATIENTS AND METHODS

The study sample consisted of thirty patients with mandibular defects who were reconstructed with various autogenous bone grafts, in the Department of Oral and Maxillofacial Surgery, from January 2008 to July 2009.

Patients with mandibular defects fulfilling the inclusion criteria were selected. Patients with systemic bone pathology, craniofacial deformities, with previous failed mandibular reconstruction were excluded. An informed consent was obtained from them or their parents/ guardian for including in either surgical procedure or for using their data in research. An approval of the study was taken from the hospital ethical committee. All reconstructions were carried out under general anaesthesia (GA) with nasotracheal intubations. Out of thirty patients 18 were those in whom oncological resection was undertaken and a segmental resection was carried out in 11 patients, and they were having continuity mandibular defects. To restore the continuity of the mandible we also applied the reconstruction plates with bone grafts at the recipient sites. We also employed intraoperative maxillomandibular fixation (MMF/IMF) in these patients to achieve the occlusion and kept it for 4 to 6 days postoperatively. In the remaining 19 patients the continuity of the mandible was maintained obviating the need for the application of any reconstruction plate or need for the MMF/IMF. In all 30 patients, fixation of the bone grafts was achieved either with the miniplates or with the intraosseous wiring. In 11 patients we used the extraoral approach and in 19 patients an intraoral approach was used. In 21 patients we carried out the primary/immediate reconstruction in a singl-stage operation while in 9 patients secondary/delayed reconstruction was undertaken after the primary surgical procedure. In 3 patients we also needed the soft tissue cover and secondary closure was done while harvesting the pectoralis major myeocutaneous flaps.

Before intervention, patients' records were entered on the performa and patients were prepared for GA. Postoperative outcomes; infection, radio-density, resorption and failure of bone grafts were checked clinically and radiographically on serial Orthopantomogram (OPG). Patients were checked postoperatively on 7th day, 3rd month, 6th month and 1 year respectively for outcome variables.

RESULTS

Amongst a total of 30 patients, 19 (63.34%) were males and 11 (26.66%) females; age ranged from 15–65 years with an average of 38 years at the time of presentation. Eighteen (60%) patients had defects secondary to oncological resections, 5 (16.67%) were having post-temporomanibular joint ankylosis defects; 5 (16.67%) patients had post-traumatic defects and 2 (6.66%) patients presented with the Ostoeomyelitis of the mandible. Out of 18 patients with post-oncological resection defects, 4 were with the Ameloblastoma, 3 had Squamous Cell Carcinoma invading the mandible, 3 patients with Dentigerous cyst, 3 patients had Keratocystic Odontogenic Tumor, 2 patients with Central Giant Cell Granuloma, 1 patient with Adenomatoid Odontogenic Tumor, 1 patient with Pindborg tumour and 1 patient had Odontogenic Myxoma of the mandible. Five patients who had posttraumatic defects included 3 with infected malunion of fracture sites, 1 patient had the firearm injury and one patient presented with the comminuted mandible fracture due to road traffic accident.

In 15 (50%) patients, reconstruction was undertaken with the iliac crest bone grafts. In 8 (26.67%) patients, rib grafts were harvested, while 2 (6.67%) patients received calvarial bone grafts for reconstruction; 4 (13.33%) patients were reconstructed with the free fibula flap. In 1 (3.33%) patient reconstruction was undertaken with bone graft from the sternum.

Infection in bone grafts was checked clinically. (Table-1) On 7th day postoperatively, only 3 (10%) patients developed mild infection. On 3rd months visit, 5 (16.67%) patients showed infection with pus discharge. On 6th month follow up, there was improvement in the infection rate and 3 (10%) patients had infection. On final, 1 year follow up visits, only 2 (6.66%) patients were noted with infection (Chi-Square=1.639; p=0.6506). Radio-density of the bone grafts was assessed on Orthopantomogram (OPG) as good, partial or lucent (Table-2). On one year follow up, radio-density was 'good' for 21 (70%) bone grafts, 'partial' for 6 (20%) and 'lucent' for the bone grafts of 3 (10%) patients only. (Chi-Square=16.35; p=0.01200). Resorption of bone grafts was assessed on Orthopantomogram (OPG) as mild, moderate or severe.(Table-3). Bone grafts of 24 (80%) patients showed only 'mild' resorption; 3 (10%) with 'moderate' resorption and only 3 (10%) patients' bone grafts showed 'severe' resorption after one year.(Chi-Square=4.28; p=0.3693) Failure of bone grafts was assessed based on overall infection, radio-density and resorption of the harvested bone grafts (Table-4). Failure was noted only in 3 (10%), while in rest of 27 (90%) patients bone grafting was successful after one year. (Chi-Square=3.509; p=0.319).

The collected data was analysed by SPSS 11.0, the statistical test for this study was Chi-Square and $p<0.05$ was taken as significant.

Table-1: Infection (n=30)

Infection in Bone Grafts	At 7th day follow-up		At 3 month follow-up		At 6 months follow-up		At 1 year follow-up	
	Patients	%	Patients	%	Patient	%	Patients	%
Present	3	10.0	5	16.67	3	10.0	2	6.67
Absent	27	90	25	83.33	27	90	28	93.33
Total	30	100.0	30	100.0	30	100.0	30	100.0

Table-2: Radio-density of Bone Grafts (n=30)

Radio-density of Bone Grafts	At 7th day follow-up		At 3 month follow-up		At 6 months follow-up		At 1 year follow-up	
	Patients	%	Patients	%	Patients	%	Patients	%
Good	30	100	29	96.67	23	76.67	21	70
Partial	0	0	1	3.33	5	16.66	6	20
Lucent	0	0	0	0	2	6.66	3	10
Total	30	100.0	30	100.0	30	100.0	30	100

Table-3: Resorption of Bone Grafts (n =30)

Resorption of Bone Grafts	At 7th day follow-up		At 3 month follow-up		At 6 months follow-up		At 1 year follow-up	
	Patients	%	Patients	%	Patients	%	Patients	%
Mild	0	0	29	96.67	26	86.67	24	80
Moderate	0	0	1	3.33	2	6.66	3	10
Severe	0	0	0	0	2	6.66	3	10
Total	30	100.0	30	100.0	30	100.0	30	100

Table-4: Failure of Bone Grafts (n =30)

Failure of Bone Grafts	At 7th day follow-up		At 3 month follow-up		At 6 months follow-up		At 1 year follow-up	
	No. of pts.	%	No. of pts.	%	No. of pts.	%	No. of pts.	%
Yes	0	0	1	3.33	2	6.66	3	10%
No	30	100	29	96.67	28	93.34	27	90%
Total	30	100.0	30	100.0	30	100.0	30	100

DISCUSSION

Reconstruction of mandibular defects represents a challenge to head and neck reconstructive surgeon. Maxillofacial region of the body is the most important one regarding function and cosmesis. The defects in the specific anatomic sites of mandible have unique problems aesthetically and functionally and should be reconstructed with the most appropriate reconstructive option to meet the individual needs of a patient.

Indications for reconstruction depend upon aetiology of mandibular defects that can be caused by many ailments like congenital, pathologic, and iatrogenic; as a result of tumour excision, infections or post-radiation necrosis; motor vehicle injuries, diverse injuries like gunshot injuries, interpersonal assaults, burns, electrical flashes and splashes.[2,3] The most common indication for reconstruction in our study remained the oncological resection secondary to benign or malignant disease of the mandible followed by postsurgical defects secondary to temporomandibular joint ankylosis; post-traumatic defects, and the osteomyelitis of the mandible. Szpindor E in a similar study reported the most common indication for reconstruction of the mandibular defects as oncological resection, followed by resections secondary to osteodystrophy, osteoradionecrosis and facial trauma.[18]

Success rate of reconstruction with autogenous bone grafts remained 90% in our study and graft failure was noted only in 10%. Szpindor E reported the positive results or success rate of bone grafts of 84%, although his study sample (n=64) was larger than that of ours, our success rate remained slightly higher than that of Szpindor's study. We noted failure of bone grafts in 10%, while other factors also attributed to graft failure. In a 61 year old male patient, the failure of the iliac crest bone graft was due recurrence of squamous cell carcinoma that also got secondarily infected. We had to remove the bone graft with local excision of the recurrent lesion at 3rd month visit. In a 55 year old male, there was intraoral extrusion of the bone graft with associated dehiscence of the sutures and the pus discharge noted on 6th month visit. A marginal resection of the mandible to bleeding bone and iliac crest grafting was undertaken in this patient to treat the osteomyelitis of mandible, which did not resolve in spite of giving antibiotic cover and continuous wound care. The contributing factors in failure of bone graft in this case may be the longstanding chronic osteomyelitis of mandible, and advanced age of the patient. Another failure was in a 57 years old diabetic patient, who developed infection with an orocutaneous fistula. This patient had history of firearm injury with comminuted fracture of the mandibular body region and was reconstructed with a rib graft, the underlying immunocompromised host defence with longstanding infection might have led to rib graft failure, noted on one year follow up. Keeping in view the failure of two iliac crest and one rib grafts, it is assumed that phase-II osteogenesis was not successful in these free non-vascularised grafts. Chiapasco M *et al*[19] in their study on similar lines, demonstrated no total graft failure, while partial loss of graft was observed in one patient. Cumulative survival and success rates were 96.7% and 93.3% respectively. The success rate is very near to that of our study.

In our study calvarial bone graft showed the highest bone density followed by iliac crest, clavicle, fibula and rib. Myoung H *et al*[20] also described almost the same radio-density rating of bone grafts; they showed

rib as more radio-dense than the fibula, but we observed fibula more radio-dense than rib grafts.

Many factors potentially influence bone mass preservation or rate of resorption after bony mandibular reconstruction; these include, site of reconstruction, age of the patient, length of follow-up, adjuvant radiotherapy, and delayed placement of osseo-integrated dental implants. To elucidate the long-term effects of free flap mandibular reconstruction on bone mass, maintenance or reduction in bone height over time was used as an indirect measure of preservation or loss in bone mass by Dissa JJ, *et al*. They reported no loss, as examined by serial panorex radiographs, in bone height in mandibular body reconstruction with ileum free flap; and fibula free flaps did not significantly lose bone height when evaluated with respect to age, follow-up, radiation therapy, or placement of dental implant. Retention in bone height, demonstrated in this study, suggests that bone mass is preserved after osseous free flap reconstruction of mandible.[21]

Szpindor E[13] showed that in the patients with immediate reconstruction, more than 50% of the bone grafts resorbed. In our study the cumulative 'moderate' and 'severe' resorption was 6 (20%) while in the 24 (80%) of the grafts, 'mild' resorption was noted. Out of 3 bone grafts which showed severe resorption, 2 were iliac crest and 1 rib graft, while 2 other iliac crest grafts and 1 free fibula bone flap showed 'moderate' resorption but these remained viable and taken up successfully, showing the successful phase-I and phase-II osteogenesis. Two iliac crest grafts and one rib graft which showed severe resorption, were the bone grafts which ended up in failure. The grafts with moderate and severe resorption also showed partial and lucent radio-density on radiographs. Lenzen C, *et al*[22] showed lower resorption with calvarial bone grafts than when using iliac bone grafting. We also noted the same observations regarding the calvarial and iliac crest bone grafts.

CONCLUSION

Reconstruction of mandibular defects is challenging but the use of autogenous bone grafting, non-vascularised or vascularised, produce the most successful and predictable results when selected from the available reconstruction options for the mandibular bony defects.

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