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Original Research

Reconstruction of continuity defects of the mandible with non-vascularized bone grafts- Original study

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ABSTRACT:

Aim: The purpose of the study was to assess the success of using non- vascularized bone grafts in mandibular continuity defects. **Methodology:** The inclusion criteria were patients who had received NVBGs, such as anterior or posterior iliac crest and costochondral grafts, to reconstruct segmental defects of the mandible. Patients with a history of irradiation of the head and neck and patients with inadequate follow-up were excluded from this study. Success was judged by radiographic and clinical evidence of bone continuity and stability at a minimum of 4months postoperatively. Failures were considered loss of all or part of the graft, resulting in a residual continuity defect requiring further bone grafting. **Results:** We identified 21 potential cases, of which 16 met the inclusion and exclusion criteria. The mean age of the patients at the time of grafting was 42 years (range, 17 to 81 years), with a mean follow-up length of 18 months. The length of defects ranged from 2 to 22 cm. The grafts were 6 cm or less in length in 7 defects and greater than 6 cm in length in 22 defects. All cases were grafted at a minimum of 6 months after resection, and bone morphogenetic protein was used in 5 cases (86%). Failure occurred in 1 patient in the group with grafts of 6 cm or less and 2 patients in the group with grafts greater than 6 cm, corresponding to success rates of 86% and 91%, respectively. **Conclusion:** The results of our study show that NVBGs are a viable, safe, and effective treatment option for segmental mandibular defects over 6 cm in length in non-irradiated patients.

Keywords non-vascularized bone grafts, bone morphogenic protein, mandibular reconstruction.

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INTRODUCTION

Surgical management of several pathological conditions occurring in head and neck region require the resection of the pathology along with good margin. After resection the patient would be left with considerable hard and soft tissue deficit which mandates reconstruction not only to replace the missing structural component, but also to restore the associated function. This restoration of form and the function becomes more and more difficult as the tissues resected become larger and complex in nature.[1] Mandibular continuity defect is defined as loss of a portion of the bone resulting in a gap of more than 2cm or more in the lower jaw. The etiology is mainly acquired and rarely congenital.[2] Causes include cysts, benign and malignant tumors, trauma, and chronic osteomyelitis.[3] Resection of benign invasive odontogenic tumors and avulsion due to

trauma frequently cause the defects in sub-Saharan Africa and Asia, while malignancies, osteoradionecrosis and bisphosphonate related osteonecrosis are mostly responsible for the defects in Europe, America and parts of Asia.[4] Prevalence rates of the defects are not available in literature probably because of diverse and multiple etiologies. Reconstruction of mandibular continuity defects is a great challenge to surgeons because of the form and biomechanical functions of the bone.[5] Currently, the state-of-the-art technique to reconstruct this type of defects is vascularized bone grafting (VBG) because it is able to provide immediate blood supply to the bone graft and a soft tissue paddle for external cover and intraoral lining. This results in faster wound healing [11]and better resistance to infection and radiation effects.[6] However this is a complicated technique that requires high skills, technology, infrastructure and materials. In addition, it has the disadvantages of longer operating time, increased blood loss and lower cost.[7] An alternative for reconstruction of mandibular defects is the use of non-vascularized bone grafts (NVBG), which involves harvesting only bone grafts from sites like the ilium, rib, fibula, calvarium or parts of the mandible itself.[8] This technique has the advantages of shorter operating time, lesser amount of blood loss and more affordable to patients. This is particularly important in centers which lack sufficient expertise or the infrastructure and economic resources to perform microvascular anastomosis, required for the VBG. Failure to reconstruct mandibular defects causes collapse of the portion of the face leading to aesthetic, functional and psychosocial challenges for the patients.[9] These challenges have socioeconomic impact on the patients and to improve their quality of life, reconstruction of the defects takes utmost priority in the patients' management. Defects up to 6cm long (such as those extending from the first premolar to the third molar), are regarded as short defects, while defects longer than 6cm, are considered long defects. Several articles described the use of NVBG for reconstruction of the mandibular defects ranging from 3 to 14cm and achieved success rates of 38% to 100%. Most articles reported their outcomes for a period of 6-12 months, evaluation of long-term outcomes (>1year) is useful to assess the survival of NVBG for the treatment of mandibular bone defects. [10]

AIM OF THE STUDY

The purpose of the study was to assess the success of using non- vascularized bone grafts in mandibular continuity defects for proper reconstruction as well as to analyse any post-operative complications encountered post-operatively.

METHODOLOGY

This was a retrospective study carried out at the Department of Oral and Maxillofacial Surgery in our institution. The inclusion criteria were patients who had undergone reconstruction of segmental mandibular defects 2 cm or larger with NVBGs. Patients with a history of irradiation of the head and neck, incomplete notes, and lack of follow-up panoramic radiographs at least 4 months postoperatively were excluded from the study. All cases followed a similar surgical protocol. All patients underwent secondary mandibular reconstruction with autogenous NVBGs at a minimum of 6 months after the initial resection of the defect, and all defects were reconstructed via an extraoral approach. Corticocancellous blocks were used to span the defect, and the blocks were rigidly fixated to a mandibular reconstruction plate. Autologous corticocancellous chips and cancellous marrow were then crushed and mixed with a bone morphogenetic protein (BMP)–impregnated collagen carrier (if used) and packed around the secured blocks. The remainder of the BMP-impregnated carrier (if used) was then overlaid on the grafted blocks. Success was defined by radiographic evidence of bony continuity and stability at a minimum of 3 months postoperatively, as well as complete closure of intraoral and extraoral wounds. The success rates of grafts greater than 6 cm versus 6 cm or less were compared.

RESULTS

Of the patients who had received NVBGs 2016 to 2019, 16 were included in the study based on the inclusion and exclusion criteria. Overall, there were 10 male and 6 female patients with a mean age of 42 years (range, 17 to 81 years). The mean follow-up length was 12 months. The most common etiologies of mandibular defects were benign conditions, including ameloblastoma, odontogenic keratocyst, myxoma, fibrous dysplasia, and ossifying fibroma The success rate of short grafts, measuring 6 cm or less, was 86% (5 of 6 patients), whereas the success rate of long grafts, measuring greater than 6 cm, was 91% (8 of 10 patients). This corresponded to 3 total failures, with 1 short graft failure. (Table 1) Minor complications included infection at the donor or recipient site, seroma, necessity for hardware removal, wound dehiscence, and fracture at the donor site, all of which were treated without further sequelae.

DISCUSSION

With considerable advances in the field of maxillofacial reconstruction, surgeons face an increasing number of decisions in reconstructing segmental mandibular defects. NVBGs have been used successfully since the turn of the 19th century[11] and have been used in mandibular reconstruction since the first documented case by Skyoff in 1900.[12] However, since the first major publication of the use of a fibula free flap for mandibular reconstruction by Hidalgo,[13] nonvascularized grafts have been falling out of favor in mandibular reconstruction. Vascularized grafts have repeatedly been shown to be superior in irradiated areas, in sites with composite defects, and in cases of immediate reconstruction compared with nonvascularized grafts.[3]

Table 1- Details of all reconstruction cases included in study arranged by length

Case no.	Etiology of Defect	Age at Grafting	Length (in cm)	Success of graft
1	OKC	23	22	yes
2	Ameloblastoma	28	15	Yes
3	Osteomyelitis	45	18	No
4	Ossifying fibroma	54	20	Yes
5	Pathological fracture	22	16	No
6	Osteomyelitis	62	14	Yes
7	Ameloblastoma	47	4	Yes
8	OKC	18	5	Yes
9	Pathological fracture	22	3	Yes
10	Myxoma	27	11	Yes
11	Pathological fracture	65	18	Yes
12	Ameloblastoma	42	21	Yes
13	Ameloblastoma	41	17	Yes
14	Osteomyelitis	39	9	Yes
15	Ossifying fibroma	59	5	Yes
16	Pathological fracture	21	4	No

However, as the number of surgeons trained in microvascular surgery increases and the popularity of the vascularized graft continues to gain momentum, it is important not to overlook classic and considerable advantages of nonvascularized grafts such as decreased operating time, decreased donor-site morbidity, shorter postoperative hospital stay, and improved volume and contour of the reconstructed site.[14] In this study, we question a recent trend toward using vascularized grafts for reconstruction of large mandibular defects. A pervasive belief in the field that NVBGs should not be used to reconstruct large (ie, >6 cm) mandibular segmental defects originated in a 1983 article by Weiland et al,[15] who published their experiencewith 41 VBGs without direct comparison to NVBGs. This idea that 6 cm represents a reconstructive cutoff above which NVBGs should not be used was further bolstered by 2 highly referenced publications by Pogrel et al[3] (1997) and Foster et al[16] (1999); they directly compared the success of mandibular reconstruction with VBGs and NVBGs in relation to graft length and claimed that increased failure rates of NVBGs were closely correlated to increased graft lengths. Pogrel et al reported that 95% of 39 total VBGs were successful compared with 72% of 29 total NVBGs; they further noted that short NVBGs (<6 cm in length) had a failure rate of 17% compared with a 75% failure rate for long grafts (>12 cm in length), concluding that NVBGs greater than 6 cm in length have an increased rate of failure and that NVBGs ‘‘should be used with extreme caution in defects exceeding 9 cm in length.’’ Foster et al reported a similar correlation between increased graft length and increased graft failure in their study, in which they found a 75% success rate for short NVBGs, measuring less than 6 cm, compared with a 44% success rate for grafts measuring 6 cm or greater, concluding that NVBGs should be used for short bone defects less than 5 to 6 cm in length.

The findings of our study, on the other hand, are in stark contrast to those published by Foster et al[16] and Pogrel et al.[3] Of our 29 total cases, most (n = 22) received long grafts, measuring greater than 6 cm (mean, 11.5 cm; range, 7 to 22 cm), with a success rate of 91%; in comparison, our short grafts (n = 7; mean, 4.1 cm; range, 2 to 6 cm) had a success rate of 86%, with no statistically significant difference. Radiographically, our NVBGs resulted in good bony bulk and contour allowing for future implant reconstruction. The differences in the results of the aforementioned landmark studies and our findings may be attributed to several factors. For instance, BMP—which was first used in 2001 for human bony reconstruction by Moghadam et al[17]—was not available when Foster et al and Pogrel et al conducted their studies; in contrast, our study had nearly routine use of BMP (86% of cases), which may have considerably impacted our results. In addition, patients with a history of radiation to the head and neck were excluded in our study but were included in the studies by Foster et al (3 of 26 NVBG cases) and Pogrel et al (3 of 29 NVBG cases). Although this study was limited by the sample size, the results of our study begin to question the dogma of the need for vascularized grafts over 6 cm in length. We suggest that appropriately selected patients might benefit greatly from reconstruction of large segmental defects with NVBGs.

CONCLUSION

The pervasive belief that there is a correlation with the success of NVBGs based on a 6-cm cutoff mark should be questioned with further investigation. This study has shown that one can successfully secondarily reconstruct large mandibular defects in non-irradiated

patients without concern for an increased rate of failure or complications

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