ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 06 | June - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

MANDIBULAR HARD TISSUE AUGMENTATION-AN OVERVIEW

Oral & Maxillofacial Surgery

Dr.Akshar Tareshkumar Patel* Consultant Oral And Maxillofacial Surgeon*Corresponding Author

ABSTRACT

Bone augmentation procedures in mandibular edentulous jaws are often necessary for placement of endosseous dental implants as, at times, available bone height is limited due to ridge resorption. Hence, different surgical techniques are currently being used to augment the maandible such as Inferior border augmentation,Pedicled and interpositional grafts,Alveolar distraction osteogenesis,Onlay grafts,Guided bone regeneration,Mandibular ridge split etc. In this article we will discuss about mandibular hard tissue augmentation using these surgical techniques.

KEYWORDS

INTRODUCTION

One of the most challenging procedures in reconstructive surgery remains the reconstruction of the severely atrophic mandible (Cawood and Howell Classes V and VI). Patients exhibiting these deficits are characteristically overclosed, which creates an aged appearance, are usually severely debilitated from a functional perspective, and often present with significant risk for pathologic fracture of the mandible. Because the ideal graft should be vascularized and eventually incorporated into the host bone through a combination of osteoconduction and induction, autogenous bone grafts consistently meet these requirements and offer the most advantages to the reconstructive plan. Unfortunately, graft resorption and unpredictable remodeling have complicated grafting procedures; however, rigid fixation and later incorporation of dental implants have allowed for the needed stability postoperatively with regard to resorption and have promoted beneficial stimulation to preserve existing graft volume. Initially, mandibular augmentation with autogenous rib and ileum enjoyed little long-term success. However, recent incorporation of rigid fixation, delayed implant placement 6 months after grafting (allowing for the initial stage of graft resorption), guided tissue regeneration, and BMP have all contributed to increased success rates in onlay augmentation of the mandible. (1-4)

Types of procedures performed in mandible augmentation are
1)Inferior border augmentation
2)Pedicled and interpositional grafts
3)Alveolar distraction osteogenesis
4)Onlay grafts
5)Guided bone regeneration
6)Mandibular ridge split

1)Inferior Border Augmentation

Inferior border augmentation has been demonstrated using autogenous rib or composite cadaveric mandibles combined with autogenous cancellous bone.5 The following describes our technique for inferior augmentation of the atrophic mandible using the latter method. Incisions are placed as inconspicuously as possible from one mandibular angle to the other and proceed circumferentially 3 to 4 mm below the inferior border of the mandible and anteriorly to the contralateral side. The superficial layer of the deep cervical fascia is sharply dissected. The fascia is then incorporated in the reflection; a nerve tester is used to perform a careful evaluation for the marginal mandibular branch of the facial nerve.(Figure 1)

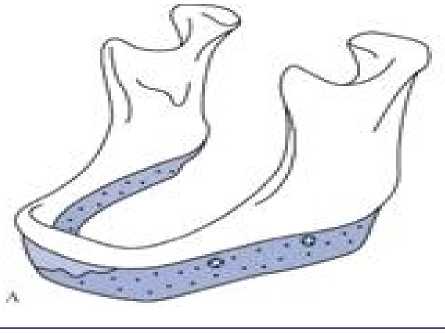


Figure 1: A.Cadaveric mandible tray rigidly fixed to an atrophic mandible with autogenous ncancellous bone sandwiched between native and cadaveric bone.Not that bur holes have been created for revascularization of the graft.

B.Cadaveric tray filled with autogenous bone before insetting
C.Graft and cadaveric tray insert for inferior border augmentation.

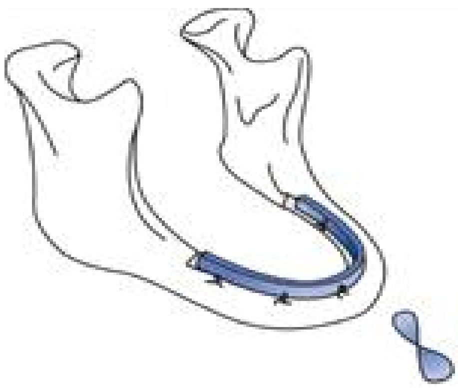
Reflection superficial to the capsule of the submandibular gland allows dissection to the inferior border. Facial blood vessels are located and managed with surgical ties accordingly. The inferior border is exposed in a subperiosteal dissection with great care to avoid intraoral exposure. Cadaveric mandibular adjustment involves relieving the condyles and superior rami, thinning the bone to a uniform thickness of approximately 2 to 3 mm, and creating a scalloped tray to incorporate the autogenous bone.Repeated try-ins are necessary to evaluate the overall adaptation to the native mandible. Osseous interfaces as well as form and symmetry as they relate to the overall maxillomandibular relationship are evaluated. Once appropriate dimensions have been reached, the atrophic mandible fits securely inside the cadaveric specimen without creating a Class III appearance, and flap closure is attainable, bur holes are drilled throughout the specimen to facilitate vascularization. Autogenous bone is then obtained from the ileum, morselized, and placed in the cadaveric specimen. BMP soaked in collagen is placed in the recipient bed as well as in a layered fashion over the autogenous graft. The entire specimen is fixed rigidly to the native mandible using screw fixation posterior to the area of future implant placement and in the mandibular midline, where implants are usually not placed. Postoperatively patients can function with their preexisting prosthesis and enjoy increased stabilization of the mandible. When combined with implant placement at 4 to 6 months, this procedure results in an overall resorption rate of < 5% and is associated with low rates of infection and dehiscence intraorally owing to the maintenance of mucosal barriers during reconstruction.

2)Pedicled and Interpositional Grafts

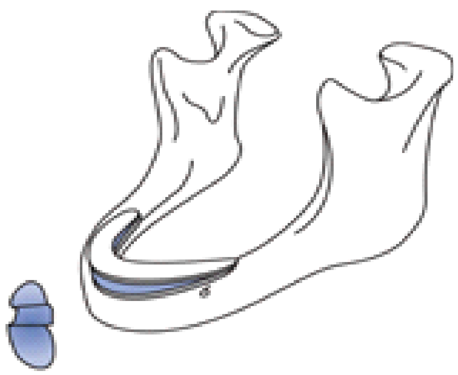
Placement of pedicled or interpositional grafts in the mandible is based on the maintenance of the lingual periosteum. The lingual periosteum maintains ridge form and its presence results in minimal resorption of the transpositioned basalar bone, as described by Stoelinga.28 Peterson and Slade as well as Harle described the visor osteotomy in the late 1970s.6,7

Unfortunately, labial bone grafting of the superiorly repositioned lingual segment was necessary to reproduce alveolar dimensions that were compatible with prosthesis use. Schettler and Holtermann and then Stoelinga and Tideman described a horizontal osteotomy with interpositional grafts to augment mandibular height, with repositioning of the inferior alveolar neurovascular bundle.8,9

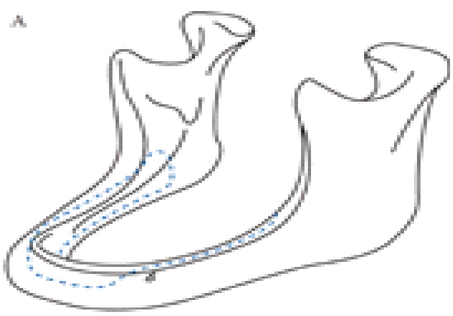
Unfortunately, neurosensory complications and collapse of the lingual segment became significant disadvantages to this technique. With the incorporation of mandibular implants and the success of full mandibular prostheses that are supported by four or five anterior implants between mental foramina, many of these pedicled and interpositional procedures are in decline today. (2,3,4)



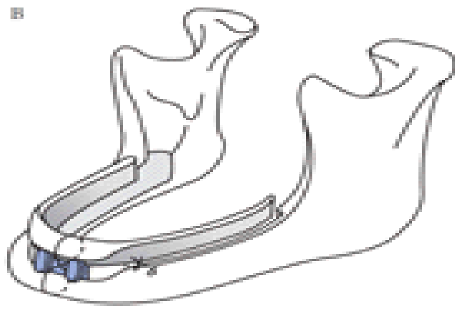
2: Visor osteotomy devised by Harle F. Adapted from Frank Moloney,Stoelinga PJW and Harle F.



3: Sandwich osteotomy designed by Schettler and Holtermann. Adapted from Frank Moloney,Stoelinga PJW and Schettler D and Holtermann W



4. Sandwich-visor osteotomy according to Moloney, Stoelinga and Tideman (9). A, Bone cut is outlined (dotted line).



Sandwich-visor osteotomy according to Moloney, Stoelinga and Tideman. (9)

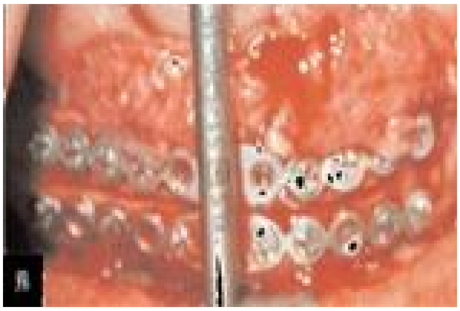
B, Cranial fragment is lifted, supported by bone struts, and secured by a wire tied in a figure of eight. Adapted from Stoelinga PJW and Schettler D and Holtermann W

3)Alveolar Distraction Osteogenesis

Growing bone via the application of tension or stress has been shown to be a viable solution to defects of the long bone, mandible, and midface. Application to alveolar bone has been limited only by technologic advancement in appliances—the principles are still the same. Alveolar distraction offers some distinct advantages over traditional bone grafting techniques. No donor site morbidity is involved, and the actual distraction process from the latency period through active distraction and consolidation is actually shorter than Phase I and Phase II bone remodeling and maturation. The quality of the bone grown in response to this tension/stress application is ideal for implant placement. The vascularity and cellularity of the bone promote osseointegration of dental implants. The greatest successes are related to the achievement of vertical graft stability. One of the biggest problems in alveolar bone grafting historically has been maintaining vertical augmentation of bone graft sites. When distraction is used, the transported alveolar segment does not undergo any significant resorptive process because it maintains its own viability through an intact periosteal blood supply. The intermediate regenerate quickly transforms into immature woven bone and matures through the normal processes of active bone remodeling. The sequencing of events is crucial to maintaining the newly augmented bone and is definitely applicable in cases in which the alternatives are limited. Diagnosis and treatment planning of a typical case for alveolar distraction osteogenesis involves good clinical and radiographic examinations, primarily using panoramic radiographs.

Anatomic structures such as adjacent teeth, the sinus floor, the nasal floor, and the inferior alveolar canal are all easily identifiable in these situations. It is rare that CT or other more sophisticated imaging studies are required. The prosthetic work-up for these cases is also important. The ideal placement of the new alveolar crest both vertically and buccolingually determines the success of the distraction. The final position of the alveolus determines the exact alignment of the transport device and how it should be positioned in the bone. The shape of the residual alveolar bone is also important to identify. Often vertical bone defects are accompanied by a significant horizontal bone loss. This bone loss must be dealt with either by further reduction of the vertical height to achieve adequate horizontal width or by some type of pre- or postdistraction bone graft augmentation to achieve an adequate width. Although the success rates with alveolar distraction are very high when cases are properly planned, there are surgical pitfalls to be avoided to ensure that alveolar distraction succeeds. First and foremost is maintenance of the blood supply of the distracted or transported segment.Many times this is difficult when access to the osteotomies is limited. Although there is no minimum height or width for the transport segment, it should not exceed the distance across which the segment is being transported. Mistakes are often made related to the application of the distraction appliances. In the posterior mandible, the appliances are often inclined too far lingually for implant reconstruction. Similarly, in the anterior maxilla, an adequate labial projection of bone is difficult to achieve unless the appliance is proclined to transport the alveolus inferiorly and labially. Additionally, care must be taken when handling soft tissues at alveolar ridge distraction sites. Mucosal flaps maintained with a substantial vascular supply are necessary to achieve predictable wound healing. In addition, we recommend both periosteal and mucosal closure to prevent segmental dehiscence during the distraction process. There are both intraosseous and extraosseous devices that have been designed for alveolar distraction.The Lead R System device designed by Chin is a simple one consisting of two bone plates and a distraction rod.(10)

Figure 5:A.Atrophic mandible in preparation for alveolar ridge distraction



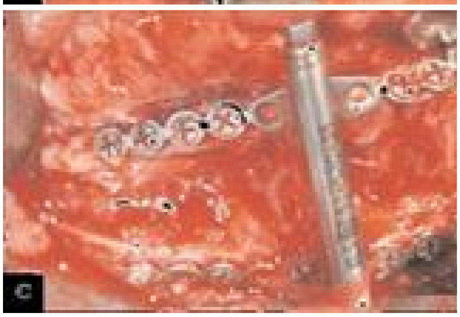


Figure 5:B.Distraction device in place

Figure 5:C.Bony regenerate at the distraction site is visible at the time of device removal

A horizontal osteotomy is created, and the distraction rod is inserted from a crestal direction. The transport bone plate is then engaged and positioned on the transport section with a bone screw; the basal bone plate is engaged and likewise supported on the bone with a screw. There are some limitations with this device because the distraction rod may limit its use in areas where the vertical dimension of occlusion is compromised.

The rod is also visible anteriorly, which may be an esthetic issue. Finally, the rod may interfere with future implant placement unless the implant can be placed directly into the site vacated by the rod. The Robinson Inter-Oss alveolar device was designed to be used in a onestage procedure in which the transport appliance actually becomes the implant when the regenerate has matured. Anatomic limitations require a fairly significant crestal bone height and width for use. A similar device, the ACE distraction dental implant system, allows for a distractor that can be placed and then replaced with a dental implant once the distraction has been completed. Again, this is a simple and easy implant to be placed, but anatomic constraints limit its use to certain situations. Both the ACE device and the Robinson Inter-Oss device have limitations in that they must be externally directed or the distraction may veer off course. Other devices available commercially that are similar to those above are the DISSIS distraction implant and the Veriplant. The Lead device mentioned above provides relatively rigid stabilization of the transport segment, but these other devices may violate one of the prime requirements of successful alveolar distraction, namely, rigid fixation of the transport segments. Extraosseous devices are much more successful and practical for distraction and rigid fixation of the segments. The Track Plus System manufactured by KLS Martin and the bone plate device manufactured by Walter Lorenz Surgical are two devices that adhere to the principles of distraction and rigid fixation.(5)

After placement of a distraction device, a latency period must be observed, the duration of which is 4 to 7 days, depending on the age of the patient and the quality of tissue at the transport site. The latter is significant in patients who have previously undergone irradiation, multiple surgical procedures, or trauma, resulting in scar tissue and compromised blood supply. (10)

The active distraction period varies depending on the distance the segment is transported. Standard principles must be followed. The rate and rhythm of transport is 1 mm/d in divided segments—0.25 mm four times a day is the most practical for appliances as well as the patient. The consolidation phase commences when the distraction is complete. Generally the consolidation period should be three times the length of the distraction period. The extraosseous appliances provide rigid fixation to promote faster maturation of the regenerated bone. At the conclusion of the consolidation phase, the appliance can be removed. Rather than waiting for full mineralization of the regenerate, one can place the implants, which then provide further rigidity to the transport segment and allow for healing of both the implant and the immature regenerate simultaneously. The total treatment time is thus much shorter than with conventional bone grafting with either autogenous or allogeneic bone, and in most cases the appliance does not interfere with day-to-day function. Other than the inability to wear a transitional prosthesis, there is minimal disruption of the normal activity and diet. Morbidity is generally minimal and is related strictly to management of soft tissue flaps, maintenance of adequate transport segment blood supply, and proper positioning of osteotomies.

4)Onlay block grafting

Bone can be harvested from various sites and used to reconstruct alveolar defects (Figures 6A,6B,7). Depending on how block grafts are shaped and used to restore the defect, they may be in the form of inlays, veneers, onlays, or saddle grafts. Ridge defects that have adequate vertical height but are too narrow may be restored with a veneer graft.(12)

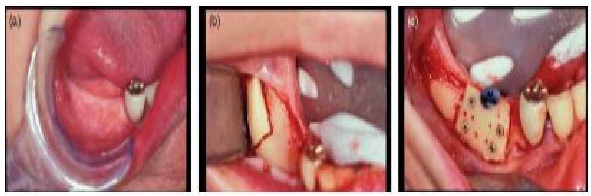
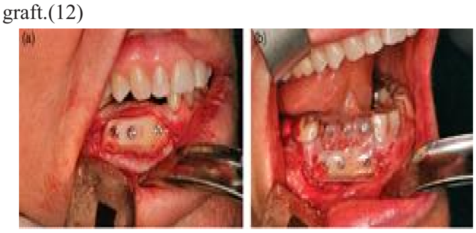
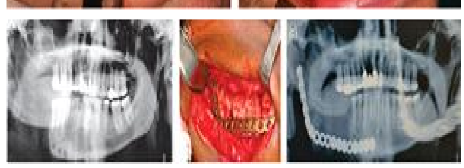


Figure 6A: Posterior mandible: block graft: (a) mandibular posterior defect, (b) harvest of mandibular ramus graft, (c) graft secured into place. (12)

6B: Posterior mandible: onlay graft: (a) mandibular posterior defect treated with ramus graft,(b) surgical guide used to aid in placement of block graft.(12)





7: Mandibular continuity defect: (a) mandibular continuity defect, (b) iliac crest graft placed, (c) reconstructed mandible (12)

5)Guided bone regeneration

PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

Concept of guided bone regeneration (GBR) or osteopromotion, is recognized as a method of alveolar ridge augmentation and for managing localized defects associated with the placement of dental implants.

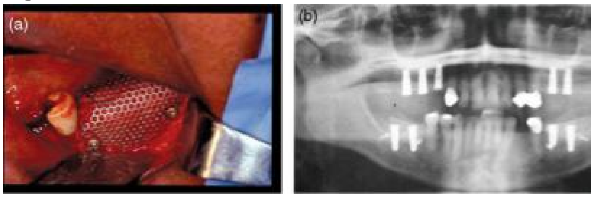


Figure 8: Posterior mandible: GBR: (a) titanium mesh and particulate graft, (b) implant placed.

Figure 8.1: The vertical defect in the posterior mandible treated with a titanium-reinforced polytetrafluoroethylene (PTFE) membrane filled with particulate autogenous bone and bovine hydroxylapatite.

6) Mandibular ridge split

The ridge split technique consists of splitting the vestibular and buccal cortical tables and further opening the space with osteotomes. Splitting is classically performed with chisel and hammer or with rotating or oscillating saws. Use of a bone chisel is traumatizing and stressful to the patient. Rotating and oscillating instruments increase the risk of damaging the gingiva, the lips, or the tongue.

Ultrasonic bone surgery (USBS) represents a novel alternative technique for bone surgery. Ultrasonically moved knives have the ability to cut hard tissues, such as teeth and bone. In contrast, soft tissues such as gingiva, blood vessels, nerves, and sinus membranes are preserved from injury because they vibrate with the knife tip. In the mandible, there is a higher risk of bone fracture, as the bone is less flexible because of thick cortical plates. (13)

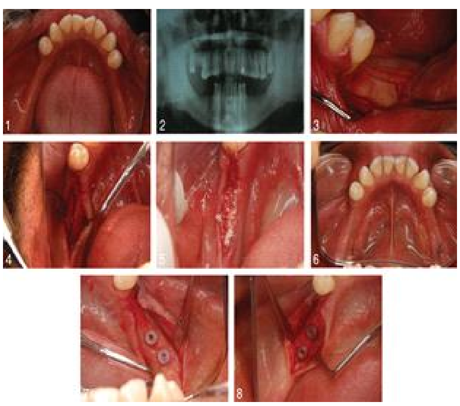


Figure 9.1 Preoperative occlusal view showing inadequate width of the ridge bilaterally.

9.2 Orthopantomogram.
9.3 Stage I – Corticotomy with crestal, vertical, and apical horizontal cuts.
9.4 Stage II – ridge split after 1 month.
9.5 Bone graft (OssiFi) placed.
9.6 Postoperative occlusal view showing 3 mm increase in width of ridge bilaterally.

Figures 9.7 and 9.8 UniTi implants placed within sound bone and excellent ridge expansion can be appreciated. (13)

With the evolution and success of dental implant technology, guided tissue regeneration, and genetically engineered growth factors such as BMP, current indications for grafting and augmentation are usually related to facilitation of implant placement. Time-honored reconstructive procedures including bone grafting and augmentation are also evolving to create the ideal environment for implant-supported and stabilized prosthetic reconstruction.

REFERENCES

1) Curtis T, Ware W. Autogenous bone graft procedures for atrophic edentulous mandibles. J Prosthet Dent 1977;38:366–79.
2) Sanders B, augmentation rib grafting to the inferior border of atrophic edentulous mandible. Journal of prosthetic dentistry,January 1982,volume 47,numer 1
3) Davis WH, Delo RI, Ward WB. et al. Long termridge augmentation with rib graft. J Maxillofac Surg 1975; 3:103–6.
4) Bell WH, Buche W, Kennedy J III, et al. Surgical correction of the atrophic alveolar ridge: a preliminary report on a new concept of treatment. Oral Surg 1977;43:485–98.
5) Miloro M, Quinn PD. Prevention of recurrent pathologic fracture of the atrophic mandible using inferior border grafting: report of two cases. J Oral Maxillofac Surg 1994;52:414–20.
6) Peterson LJ, Slade E. Mandibular ridge augmentation by a modified visor osteotomy: a preliminary report. J Oral Surg 1977;35:999–1004.
7) Harle F. A follow up investigation of surgical correction of the atrophied alveolar ridge with visor osteotomy. J Maxillofac Surg 1979;7:283–93.
8) Schettler D, Holtermann W. Clinical and experimental results of a sandwich-technique for mandibular alveolar ridge augmentation. J Maxillofac Surg 1977;5:199–202.
9) Frank Moloney, Stoelinga PJW, Tideman H. Interpositional bone graft augmentation of the atrophic mandible: a review, Australian dental journal, June 1985, volume 30, number 3
10) Peterson`s principles of oral and maxillofacial surgery 2nd edition , Daniel B. Spagnoli et al. Preprosthetic and Reconstructive Surgery, Chapter 9, page number 181-185.(Excluding figures)
11) Peterson`s principles of oral and maxillofacial surgery 2nd edition , Daniel B. Spagnoli et al. Preprosthetic and Reconstructive Surgery, Chapter 9, page number 181-185.(Including figures)
12) Alan S. Herford, Katina Nguyen, Chapter 8, Alveolar ridge augmentation: An algorithmic approach, Horizontal Alveolar ridge augmentation in implant dentistry, A surgical manual, 1st edition, 2016.
13) Mohit Kheur et al. Staged Ridge Splitting Technique for Horizontal Expansion in Mandible: A Case Report, J Oral Implantol (2014) 40 (4): 479–483.