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Surgical management of deficient alveolar ridges by means of guided bone regeneration in oral implantology: A case series

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***Abstract*---**Dimensional changes in the alveolar ridge after extraction often compromises on achieving optimal implant stability and placement of implants in the right prosthodontic positions. These situations demand augmentation of the residual ridge to achieve successful implant placement and long-term survival. A minimum amount of bone width and height is essential for the successful placement of implants. Unfavourable local conditions, due to atrophy, trauma and periodontal disease, may provide insufficient bone volume or an unfavourable interarch relationship, which does not allow correct and a prosthodontically guided positioning of dental implants. Guided bone regeneration, ridge splitting, block graft, or distraction

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osteogenesis have all been applied for this purpose and have shown some promising results. Nonetheless, autogenous block graft remains one of the main methods for reconstructing severely resorbed maxilla. These block grafts can be harvested from intraoral or extraoral sites. Significant amounts of autogenous bone can be procured from symphysis or ramus region of the mandible. The cortical grafts of this area provide predictable increase in bone volume with a short healing time and yield a highly dense osseous architecture for implant placement. This review discusses the use of autogenous block grafts and bovine bone allograft for predictable bone augmentation in atrophic ridges.

Keywords---autografts, deficient alveolar ridge, CBCT, combination grafts, guided bone regeneration.

Introduction

Dental rehabilitation of partially or completely edentulous patients with implants has become a successful modality of treatment and has gained popularity in the recent years. This can be attributed to its reliable long-term results while providing superior aesthetics and functionality.[1] However due to unfavourable local conditions of the alveolar ridge caused to do periodontitis, prolonged edentulism, trauma, congenital anomalies and periapical pathologies, there may be insufficient bone volume, quality, decreased vertical, horizontal and sagittal intermaxillary relationship. This makes it difficult for the placement of dental implants from a functional and aesthetic point of view. Augmentation procedures have been carried out to re-establish adequate bone dimensions, which will facilitate implant placement. This can be done by using autogenous bone, allografts, xenografts, alloplastic material or a combination of these.[2]

Types of bone grafts

Based on the source, bone grafts can be divided into the following subtypes:[5]

1. Autografts
2. Isografts
3. Allografts
4. Xenografts
5. Synthetic materials
6. Combination grafts

Based on the structure of the harvested bone, grafts can be divided into:

1. Cortical
2. Cancellous
3. Cortico-cancellous

Based on the intra oral donor site, grafts can be classified into[3]:

1) Maxilla
   A. Maxillary tuberosity
   B. Anterior nasal spine
   C. Palate
   D. Zygomatic buttress
2) Mandible
   A. Symphysis
   B. Ascending ramus
   C. Coronoid process
   D. Horizontal ramus

Role of Cone beam computed tomography (CBCT)

In the recent times, CBCT has become the most preferred technique for 3-dimensional assessment of bone anatomy. It not only offers high image resolution and better image quality but also the radiation exposure s much lower compared to conventional computed tomography (CT). It provides axial, panoramic and trans-planar images of any desired site. CBCT of the jaws helps in describing the bone morphology at the edentulous site and this allows in planning the augmentation procedure and implant placement along with the measurement of bone graft required and donor site selected for grafting.[4]

Type	Source	Pros	Cons
Autograft	Same human	Osteogenic Growth factors No risk of transmission of diseases	Pain Infection Complex surgery Limited supply
Allograft	Different human	Osteoinduction and osteoconduction is seen	Risk of disease transmission
Xenograft	Different species (bovine sources are mostly used)	Stability is similar to autografts and allografts	Osteoinductive only
		Bone formation is accelerated by the collagen present	
Alloplast	Synthetic	Disease transmission is not seen	Osteoconductive only
	Hydroxyapatite	Slow resorption Volume of bone is preserved Presence of growth factors Acts as a good carries	
	Bioglass	Increased bone formation as the material is bioactive Faster rate of resorption Completely replaced by new bone	

Table 1. Bone graft classification by material source

SOURCE	TYPE OF BONE	AMOUNT OF BONE	INDICATIONS	REMARKS	COMPLICATIONS
Anterior iliac crest	Corticocancellous or cancellous	50 ml of cancellous bone or 2cmx6cm of corticocancellous bone	Post sinus lift Both vertical and horizontal augmentation	Has the highest osteogeniic potential compared to other autogenous bone grafts	Possible gait disturbances Neurosensory complications Pelvic fracture Peritoneal perforation
Tibial plateau	Cancellous	40 ml of cancellous bone	Post sinus lift Both vertical and horizontal augmentation	Contraindicated in growing children as it may hamper growth	No long term complications seen
Proximal ulna	Corticocancellous	1cmx1cm	Post sinus lift Both vertical and horizontal augmentation	Easier to harvest when compared to other extra oral sites	Minimal post operative discomfort Edema, hematoma, ecchymosis and limitation in range of motion
Ramus	Cortical	0.4x3x5 cm block	Post sinus lift (less preferred) Both vertical and horizontal augmentation	Upto3-4 cm of the alveolar segment or multiple small areas can be reconstructed	Infection, trismus, inferior alveolar nerve injury
Symphysis	Mainly cortical but sometimes corticocancellous	0.7x 1.5x 6cm blocks or 2 blocks of 1.5 x 3 cm	Post sinus lift (less preferred) Both vertical and horizontal augmentation Fill in material for osteotomy gaps	Less complicated than ramus grafts Largest intra oral source	Neurosensory deficits to the lower teeth, lip or chin Alteration in chin contour
Tuberosity	Cancellous	1-3 ml	Small defects (socket grafting, small sinus lifts, fill-in for osteotomy gaps)	-	Oro antral communication Bleeding from posterior superior alveolar artery or sphenopalatine artery

Table 2. Autogenous grafts from intraoral and extraoral origin [5]

Case report
Case 1

A 40-year-old male patient presented with missing teeth in the upper anterior region and deficient alveolar ridge. Sagittal sections of the CBCT shows loss of labial cortex with residual ridge resorption. The regenerative procedure planned for this case was an autograft from the ramus of the mandible, which was carried out under general anaesthesia. The onlay graft was then secured on the recipient site with a single 1.5X8 mm titanium screw and decortication of the autograft were made to facilitate guided bone regeneration. The remaining defect space was filled with xenograft (Bio- Oss) and the flap was sutured back. A scan done 3 months later shows increase in the horizontal dimension of the bone in the grafted region.

Region	Pre-op	Post-op
Alveolar crestal width	2.4-2.6	3.5-3.8
Apical width	2-2.5	3.6-3.9

Table 3. Comparison of pre-op and post-op alveolar bone

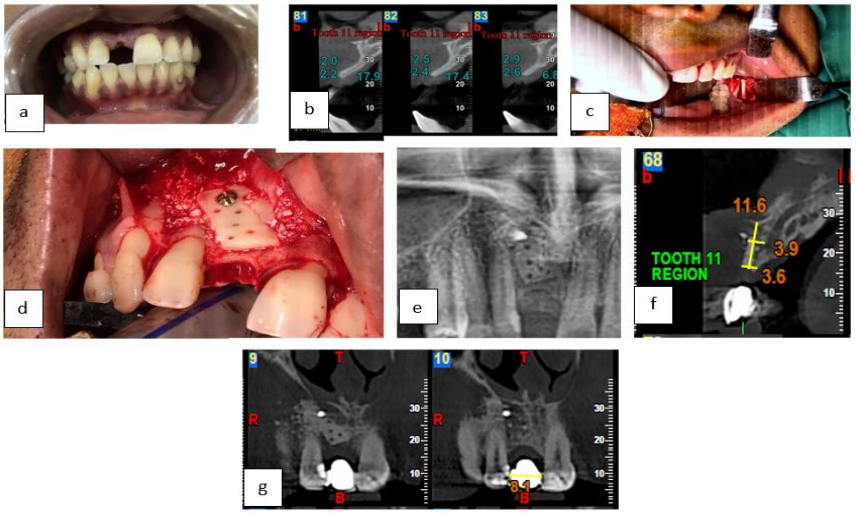


Fig 1. (a) Edentulous area with deficient alveolar ridge (b) Sagittal Section showing loss of labial cortex with residual ridge resorption (c) Harvesting graft from ramus of mandible under GA (d) Onlay graft secured with 1.5*8mm titanium screw with Xenograft (Bio-oss) (e-g) post-operative radiographs

Case 2

A 47-year-old female patient presented with missing teeth in the upper front teeth region for 1 month. The CBCT showed a vertical and horizontal defect in the edentulous region. The donor site used in this case was the anterior nasal spine of the maxilla since it could be accessed with the same approach. Bone particles were scraped from the donor site, mixed with the xenograft (Cerabone) and this combination graft was then placed and secured with a titanium mesh to cover the defect after implant placement. The patient reported 3 months later with a

complaint of mesh exposure. This was then removed and a pedicle gingival graft was placed to cover the soft tissue defect.

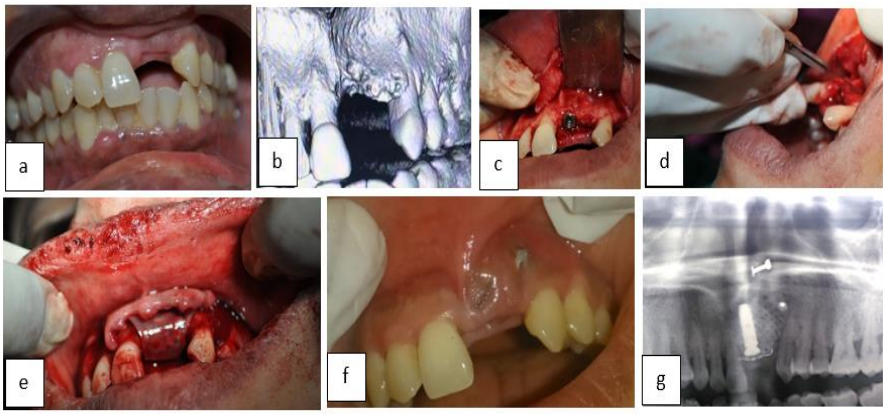


Fig 2. (a) Edentulous area with deficient alveolar ridge (b) CBCT 3D image showing the bony defect in anterior region (c) Implant Placement (d) Harvesting autograft from anterior nasal spine (e) Xenograft (Cerabone) secured with titanium mesh placement and collagen membrane (f) Post operative mesh exposure after 6 months (g) Post operative X ray

Case 3

A 19-year-old male patient presented with a Ellis class III fracture of 21along with a dento-alveolar fracture which was caused by a trauma to the region. Since the tooth was not restorable endodontically, an immediate extraction and implant placement was planned. On elevation of the flap, a huge buccal wall defect was uncovered. The fractured dento-alveolar segment was used as an autograft and combined with a xenograft (Cybograf) to fill the defect.

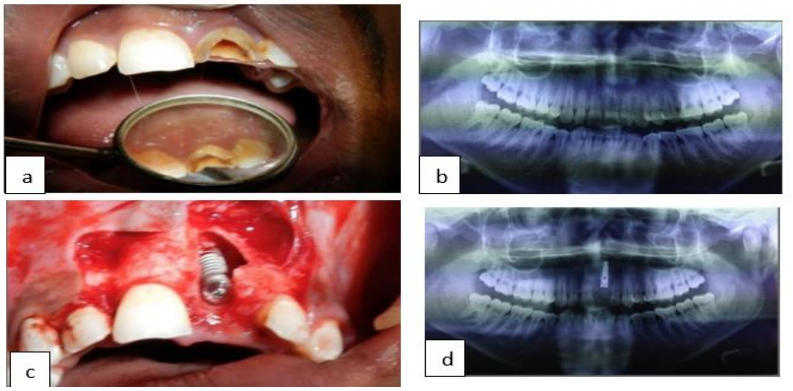


Fig 3. (a) Preoperative photograph showing non restorable Ellis 3 fracture of 21 due to trauma (b) Pre-operative X ray (c) Immediate implant placement and harvesting graft from extracted site (d) Post-operative X ray showing mixture of auto and xenograft with implant in situ

Case 4

38-year-old male patient presented with pain and swelling in the upper left back tooth region which showed an intermittent occurrence. Patient gave a history of root canal treatment done with respect to 26 which. The tooth being symptomatic with no scope for re treatment was planned for extraction and immediate implant placement. The thick inter-radicular bone was taken advantage of and an indirect sinus lift was performed to increase the height of the available bone. Autograft which was harvested from the osteotomy site was mixed with xenograft and used in the indirect sinus lift technique.

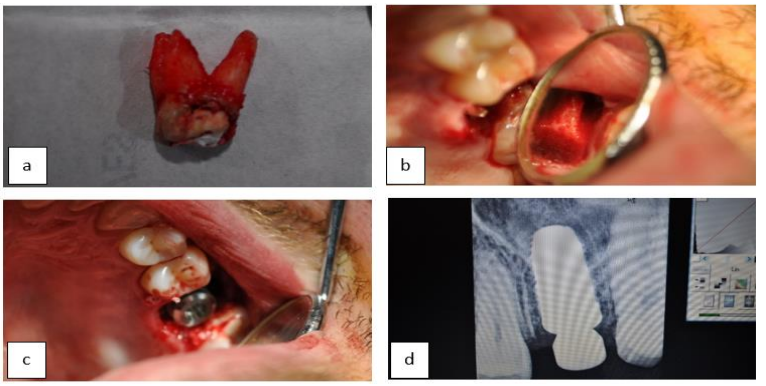


Fig 4. (a) Post atraumatic Extraction 26 due to RCT failure (b) Atraumatic extraction site showing good interradicular bone (c) Immediate implant placement with indirect sinus lift and harvesting graft from osteotomy site (d) X ray showing implant placement with indirect sinus lift mixture of auto and xenograft

Discussion

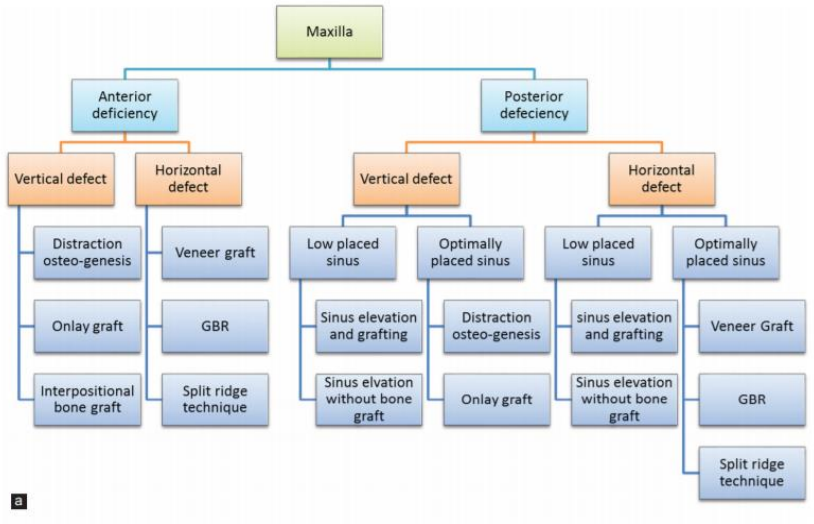
There is a great deal of confusion among practitioners concerning the type of bone graft to be selected based on the type of defect. A thorough knowledge about the mechanisms through which the grafts incorporate into the recipient site will make it easier to select the type of graft to be used. Various mechanisms are involved at the recipient site which are responsible for bone augmentation, which include,[6]
1.Osteogenesis: Bone formation by living transplanted cell within the graft is termed as an osteogenic bone graft. Survival of osteoblasts and osteocytes present in the graft material determine the success of the osteogenesis. Diffusion from the surrounding host tissue preserve the cells until revascularisation.

2.Osteoconduction: It is the process in which the graft material provides a scaffold which facilitates the migration. Attachment and differentiation of the cells involved in vascularisation and bone healing. They vary greatly in different grafting materials and rely on the graft's 3 dimensions; structure, porosity, surface chemical and biological properties, rate and mechanism, of degradation.
3.Osteoinduction: It is the process of bone formation by active employment of bone forming cells or growth factors from within the transplanted graft. The graft material recruit osteoblasts or their progeny to enter the material, which involves migration and chemoattraction which then causes the multipotent cells to

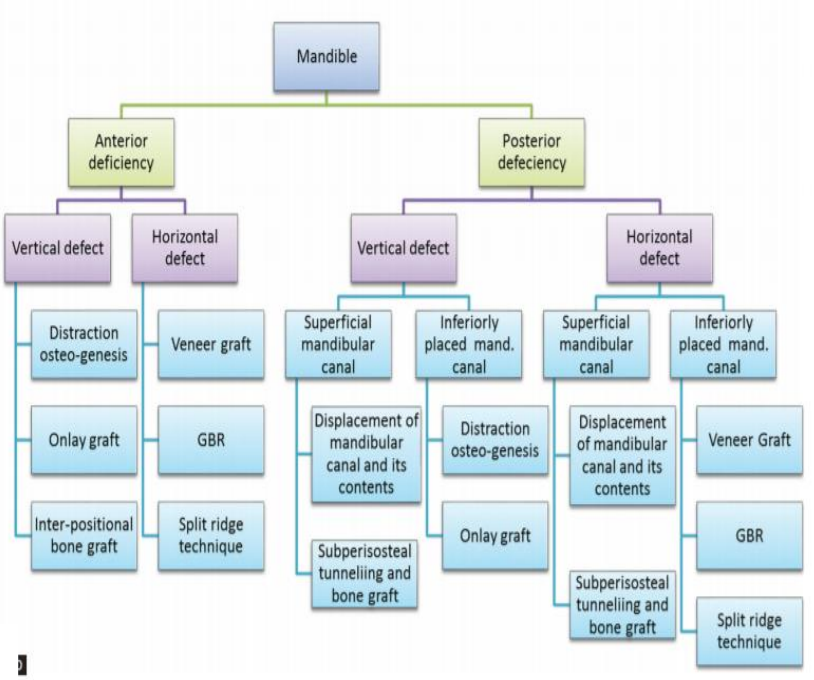
increase in number and regenerate bony callous i.e., proliferation and differentiation.[7]

An ideal bone graft should have all the following characteristics (1) Osteo-inductive and conductive, (2) biomechanically stable and (3) disease free, among other properties.[6] Autograft is considered the gold standard in grafting although it has some disadvantages. It warrants an additional donor site, a separate incision, increased operative time and a possibility of donor site morbidities. It has also been seen that the rate of resorption of autografts is higher when compared to alloplastic or xenografts, thus rendering it a poor choice of grafting material for defects requiring a longer time for regeneration. [3] In these scenarios one must take advantage of combination grafts. Autografts can be used along with xenografts or alloplastic materials to preserve the graft in-situ for longer periods of time thus enabling adequate bone regeneration. There are several other advantages of using combination grafts. It reduces the amount of bone required to be harvested from the donor site, increases the volume of the graft material and improves the handling properties. Alloplasts and xenograft particles are available in different sizes and consistencies, making it useful to fill defects of various shapes and sizes.

The density of the graft material and the rate of resorption is inversely proportional to graft incorporation. Therefore, osteoconductive materials which have internal spaces that interconnect and extend till the external surface are better scaffolds as they lead to 3-dimensional bone formation in the graft. This provides a grater surface area for the osteoclasts which are present in the surrounding tissue to attach themselves and start resorbing the graft material. This is the first step in graft incorporation. 2 steps are involved in incorporation of the bone graft in the recipient site: the edges of the graft and the edges of the native bone segment form a bony union initially and thereafter graft remodelling takes place. Later there is replacement of new bone along with gradual resorption of the graft material.



Flowchart a- Defects seen in the maxilla and their optimal grafting technique [5]



Flowchart b- Defects seen in the mandible and their optimal grafting technique[5]

Many factors determine this process of graft incorporation. It may be related to either the recipient site, the graft or the junction between them. The type of bone grafting technique is also dependent on the recipient site and the type of defect present as explained in flowcharts a and b. Rigid fixation, which is one of the main principles of fracture fixation is essential for integration of the graft to its bed as well. Bone formation usually requires very low tissue strain levels. The speed of incorporation of the graft material is majorly dependent on the ratio between contact area with its surrounding circulation and the graft size. The bone graft needs to be in contact with to viable bone which have bleeding edges.[9] The regenerative technique used in the above cases provided adequate bone formation which facilitated implant placement. Implant placement was carried out secondary to bone grafting in two cases whereas it was simultaneously carried out in the other two. When it comes to simultaneous bone grafting, especially in immediate extraction cases, preparation of the recipient site is of utmost importance. Any existing pathological tissue present after extraction may compromise the survival of the graft material. The tissue biotype also becomes an important consideration while planning implant placements. When augmentation procedures involving a titanium mesh or screws are used, a tissue with a thin biotype will easily give away causing mesh or screw exposure and this will require additional periodontal procedures to restore the defect.

Conclusion

A combination of autograft obtained from various intra oral sources along with xenograft or alloplast in any of the forms followed by a membrane as a cover is a predictable technique in augmenting atrophic ridge. It can be used to increase the

alveolar ridge in all dimensions thereby facilitating immediate or delayed implant placement with a successful outcome.

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