

Review Article

Current Concepts in Alveolar Ridge Augmentation

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Abstract

Ridge augmentation is a predictable procedure that can correct the defects caused by bone loss in areas with missing teeth. More importantly, this procedure allows the chance to return the natural contours of the soft tissues that existed before the loss of the tooth. It is done in patients with insufficient bone height and width by using various bone substitute materials and bone graft procedures where the successful placement of dental implants is difficult with regards to maintaining an ideal pathway and avoiding important anatomical structures. This review article will be carried out to describe the various techniques of ridge augmentation.

Keywords: Ridge Augmentation; Deficient Ridge; Hard and Soft Tissue Ridge Augmentation

Introduction

Periodontium is an important structure that provides support to the tooth necessary to maintain its function and is affected by any changes that the tooth may undergo, including eruption and extraction [1]. It consists of four principal components which includes gingiva, periodontal ligament, cementum and alveolar bone. Healing process occurring post extraction follows uneventful changes in the alveolar bone causing structural and dimensional changes in the overlying soft tissue [2]. These changes can occur in horizontal and vertical dimensions or both and may hamper with the functional and aesthetic success of prosthetic replacements including implants [3].

The predictability and technical difficulty of surgically reconstructing the ridge can be guided by classifications of ridge defects which are helpful to appreciate treatment modality chosen.

According to Glossary of Prosthodontic Terms (GPT) 2009, Ridge augmentation is defined as a procedure designed to enlarge or increase the size, extent or quality of a deformed residual ridge [4]. Ridge augmentation is intended to augment the alveolar ridge volume beyond the existing skeletal envelop on the edentulous site of a deficient alveolar ridge with the variety of materials and techniques to optimize the ridge profile, to re-establish inter maxillary ridge correlation, confirm esthetic outcomes, achieve the biomechanical requisite of the prosthesis and to confirm osseointegration and persistence of Implant. The purpose of soft tissue preservation and bone formation is to provide stability and support for the future dental prosthesis. The sufficient horizontal as well as vertical bone dimensions are a prerequisite to warranty the success of implants.

Techniques For Ridge Augmentation

Ridge augmentation procedures are divided into vertical or horizontal ridge augmentation, which are performed simultaneously and are broadly classified into surgical procedures which undertakes hard tissue procedures, soft tissue procedures and both. Particulate or block autogenous bone grafts with ridge splitting or ridge expansion combined with Guided Bone Regeneration (GBR) are widely used in horizontal ridge augmentations. The outcomes and success rates are more predictable and higher when compared to vertical ridge augmentation. The reconstruction amount has an average 3 to 4 mm target in horizontal ridge

augmentations [5]. Historically, onlay grafts are performed as GBR with particulate or block type autogenous bone grafts in vertical augmentation which involves reconstruction of one wall defects.

1. Socket Preservation

Socket grafting is a preventive procedure for socket preservation at the time of extraction, which does not inhibit the resorption but limits it [6]. The minimal amount of resorption happens after socket grafting but in a predictable manner and the magnitude of volume loss is less in the grafted socket versus the naive socket. The rationale is that it should be performed in aesthetic areas in case of buccal bone thickness ≤ 2 mm or when there is a proximity to anatomic structures, i.e., maxillary sinus or mandibular canal [7].

2. Hard Tissue Augmentation Procedures

a. Guided Bone Regeneration

The application of GBR was described in 1988 by Dahlin, et al., in an experimental study on animals to see the results of healing of bone defects in which the defect on one side of the jaw was covered with a porous Polytetrafluoroethylene (PTFE) membrane and the other side served as the control, without a membrane covering [8]. The results showed that there was increase in bone regeneration on the membrane side as compared to the control after 3, 6 and 9 weeks of healing. GBR, also known as guided bone regeneration, is an evidence based predictable approach for separating the bone graft material (usually particulate) from neighboring soft tissues to allow unimpeded bone formation. The graft material is covered by securing a membrane to stabilize the material, parting it from adjacent connective tissues and limiting resorption. The volume stability of the graft in defect is the main factor on which the choice of membrane depends. Osseous regeneration by GBR depends on the migration of pluripotent and osteogenic cells (e.g. osteoblasts derived from the periosteum and/or adjacent bone and/or bone marrow) to the bone defect site and exclusion of cells impeding bone formation (e.g. epithelial cells and fibroblasts) [8-11]. There are few principles which need to be met to ensure successful GBR: Cell exclusion in which the barrier membrane is used to prevent gingival fibroblasts and/or epithelial cells from gaining access to the wound site and forming fibrous connective tissue; Space maintenance (Tenting) in which the membrane is carefully fitted and applied in such a manner that a space is created beneath the membrane which completely isolates the defect to be regenerated from the overlying soft tissue and also the membrane should be trimmed so that it extends 2 to 3 mm beyond the margins of the defect in all directions. The corners of the membrane should also be rounded to prevent inadvertent flap perforation; Scaffolding is one of the principles of GBR in which tented space initially becomes occupied by a fibrin clot, which serves as a scaffold for the in-growth of progenitor cells; Stabilization in which the membrane must protect the clot from being disturbed by movement of the overlying flap during healing and then fixed into position with sutures, mini bone screws or bone tacks. The edges of the membrane are simply tucked beneath the margins of the flaps at the time of closure, providing stabilization; Framework is necessary in cases of dehiscences or fenestrations where the membrane must be supported to prevent collapse [12]. Bone regeneration follows a specific sequence of events after GBR procedures. After the bone graft, the graft material/barrier created space is filled with the blood clot within the first 24 hours, which releases growth factors (e.g., platelet derived growth factor) and cytokines (e.g., IL-8) to attract neutrophils and macrophages. The clot is absorbed and replaced with granulation tissue which is rich in newly formed blood vessels. Through these blood vessels, nutrients and mesenchymal stem cells capable of osteogenic differentiation are transported and contribute to osteoid formation [13,14].

b. Onlay Grafting

Onlay grafting is indicated in cases of inadequate palatal vault morphology which is caused by excessive bone resorption. It can either be block onlay grafting or particulate onlay grafting. The latter can further be categorized as subperiosteal tunnel grafting or direct particulate onlay grafting

i. Block Onlay Grafting

Indication

It is done for horizontal or vertical deficiency or combined horizontal and vertical deficiency.

Technique

This is one of the most commonly employed technique. The block graft can be autogenous graft harvested from neighbouring intraoral donor sites, distant extraoral donor sites or commercially available xenografts or alloplastic grafts [15]. The recipient bed is prepared by drilling multiple holes after raising the mucoperiosteal flap till the underlying spongiosa is reached (Fig. 1).

Depending on the type of defect, the graft is contoured to adapt in proximity to the recipient site as veneer, block or inverted J Block graft which is placed for the vertical defects while veneer graft is used in the case of horizontal defects. For combined defects, the graft is modified to the shape of the inverted letter J [16-18]. Defects augmented using autogenous onlay grafts provide a labial cortex of bone capable of resisting occlusal loads, especially in the anterior dentition [19].

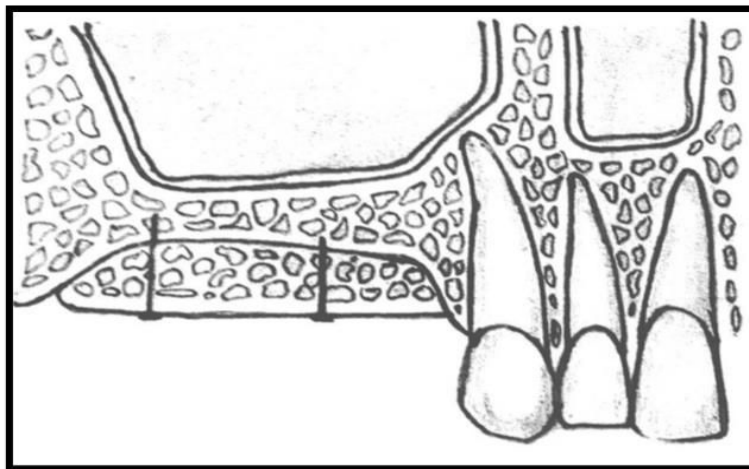


Figure 1: Block Onlay graft (Source: Goyal M, Mittal N, Gupta GK, Singhal M. Ridge augmentation in implant dentistry. J Int Clin Dent Res Organ 2015;7:94-112).

ii. Direct Particulate Onlay Grafting

Indication

It is performed to correct horizontal deficiencies in the anterior maxilla and for saddle depressions, i.e., vertical deficiency. Three-walled and four-walled defect morphology recipient sites with an apical stop are considered to be best amenable to direct particulate onlay grafting.

Technique

It is performed as a staged or simultaneous procedure (Fig. 2). To visualize the defect, the planned recipient area is exposed by raising a mucoperiosteal flap. The releasing incisions should be placed to ensure direct visualization of the defect and tension-free closure. The particulate graft is condensed over the defect after drilling holes in the recipient bed to ensure osseointegration. Demineralized grafts are preferred over mineralized grafts for defects with poorly contained boundaries, (i.e., maxillary sinus) due to their slower resorption [12]. The coverage with membranes is often recommended but can be omitted for small defects with sufficient neighbouring walls to provide volume stability [20,21]. The malleability and workability of particulate graft can be enhanced with tissue adhesives, i.e., fibrin sealants or protein-based regenerative gels.



Figure 2: Particulate graft (Source: Goyal M, Mittal N, Gupta GK, Singhal M. Ridge augmentation in implant dentistry. J Int Clin Dent Res Organ 2015;7:94-112).

iii. Subperiosteal Tunnel Grafting

Indication

It is indicated for small to moderate buccal plate defects. The morphology of such defects is characterized by wider buccal base with narrow crestal width (≤ 4 mm) and intact lingual wall with optimum vertical dimensions [22].

Technique

Access incision is placed distant (often mesially) from the recipient site after administration of local anesthesia, Subperiosteal tunnelling from the incision to graft site is performed with the help of a periosteal elevator. The demineralized particulate bone graft is placed in this subperiosteal tunnel with the help of modified 1 ml carrier syringe. To conform to the recipient bed in the desired form, the graft may need digital manipulation. The mesial incision is closed in a tension-free manner to ensure uneventful healing with minimal risks of dehiscence and graft exposure.

c. Interpositional Bone Graft (Sandwich Grafting)

Indication

It is indicated for vertical ridge defects with alveolar dimensions of 4-5 mm by placing two different layers of bone grafts and then cover them with a barrier membrane, creating a structure like the cross-section of the bone [22].

Technique

The facial aspect of the planned area of augmentation is exposed by giving a vestibular incision in nonkeratinized mucosa. Vertical corticotomies and osteotomies are performed using micro reciprocating and sees to the preservation of ≈ 2 mm of bone around the roots of neighbouring teeth followed by horizontal corticotomy and osteotomy to mobilize the segment.

There should be a minimum clearance of ≈ 3 -5 mm from vital structures such as the maxillary sinus or mandibular canal. It is critical to perform only as much advancement as permitted by the soft tissue envelope to achieve tension-free closure. After careful transportation preserving soft tissue attachments, the bone graft block is sandwiched between the transported segment and basal bone with the advantages of reducing the need for compliance and less infection [23]. The graft fixation is achieved with miniplates. Periosteal releasing incisions are placed to aid tension free closure.

d. Ridge Split Procedure (RSP) (Fig. 3)

Indication

It was introduced in 1970s by Dr. Hilt Tatum to expand the existing residual ridge of the atrophic maxilla and mandible for implant insertion and augmentation has been referred to as ridge splitting, bone spreading, ridge expansion or the osteotome technique [24]. It is also known as Book Bone Flap. It is a technique-sensitive procedure that may be performed with many different instruments, ranging from chisel and mallet to scalpel blades, spatula, osteotomes, piezoelectric surgical systems, lasers and ultra-fine fissure burs. Osteotomes are the most popular used for ridge expansion ones amongst the various instruments and chisel and (hand) mallet are traditionally used devices [25,26].

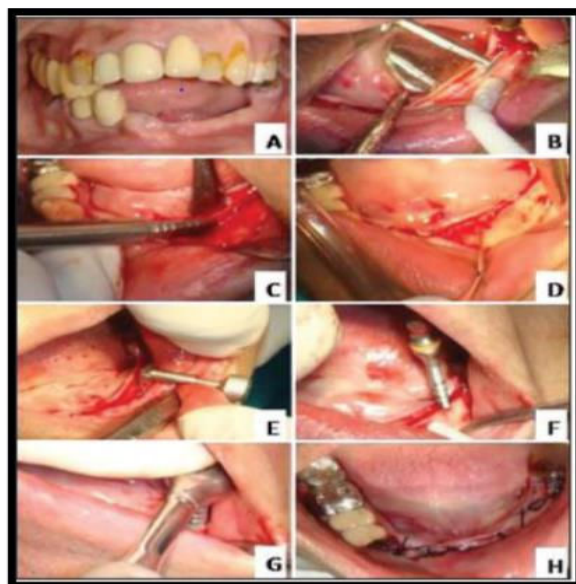


Figure 3: Ridge split. (A) thin alveolar ridge; (B) ridge split using MCT disk (3-mm radius); (C) expansion using rigid osteotome; (D) flexible chisel; (E) MCT ridge splitter; (F) bone expanders; (G) implant placement; (H) closure (Source: Goyal M, Mittal N, Gupta GK, Singhal M. Ridge augmentation in implant dentistry. J Int Clin Dent Res Organ 2015;7:94-112).

Technique I: Maxillary Single-Stage Alveolar RSP

This procedure usually consists of a single-stage, though occasionally a two-stage technique can be performed with the delayed placement of implant. 3 mm of alveolar width and 7 mm of alveolar length (between teeth) should be present for a single-tooth edentulous ridge to undergo RSP. The buccal-palatal dimension can be decreased and a full thickness incision of the appropriate length is performed in the edentulous area at the crest of the ridge. It is recommended to use a papilla-preservation approach. The developed flap is a limited crestal (not buccal) full-thickness flap just large enough to see the top of the alveolar crest with no formation or wide reflection of the buccal flap should occur.

Technique II: Mandibular Two-Stage Alveolar RSP

In the mandible, the procedure usually has 2 stages: stage 1 consists of corticotomy and stage 2 consists of splitting and grafting, which is performed 3-5 weeks later.

Stage 1: Corticotomy

The goal of corticotomy is to section through the exposed buccal cortex around the periphery of the buccal bony plate, which is to be laterally repositioned at the stage-2 surgery.

Stage 2: Splitting and Grafting

This procedure is done in a manner similar to a single stage of the maxillary ridge split, using a limited-reflection flap. A crestal incision just wide enough to see the crestal corticotomy is performed (closed approach). The operator should feel for the crestal groove created at the stage-1 surgery with the scalpel blade. The blade should be held firmly in this groove and run the full extension of this bony groove. Papilla-sparing curved incisions should be created toward the buccal and lingual side at the mesial and distal extensions of the groove. Tissue should be reflected to the lingual side as needed, but the tissue on the buccal side should only be elevated at the points where the buccal curved incisions are carried onto the adjacent bone. The spatula osteotome is tapped to depth with the osteotome of the next thickness and a controlled lateral force should begin to be used to mobilize the buccal plate. Thus, a buccal mucoosteo-periosteal flap with its own buccal soft-tissue blood supply is created and can be manipulated (widened). An overall ridge expansion up to 8-10 mm is usually adequate and grafting is performed. Primary closure of the wound is not needed nor is it usually possible. A 4 to 6 month waiting period is suggested before an implant treatment. The most common regions of the jaws that undergo RSP are the anterior and posterior maxilla and the posterior mandible [27].

RSP Using Piezosurgery

A papillary sparing crestal incision is performed on the atrophic ridge under local or general anaesthesia followed by two vertical releasing incisions beyond the mucogingival line. A full thickness mucoperiosteal flap is raised and when the bone surface is exposed, the planned osteotomies are outlined using tip number one at low power, in order to avoid oscillation of the tip and obtain a cut depth 1 mm [28]. Care must be taken to keep the lingual/palatal periosteum attached to the bony surface. The first osteotomy is carried out at the centre of the occlusal aspect of the ridge by tracing it, extending the incision in anteroposterior direction for the planned length. Subsequently, the vertical osteotomies are performed on the proximal and distal ends of the crestal incision. In surgical procedure, the vertical osteotomies are convergent and oblique, going from the outer surface of the vestibular cortex to the cancellous bone. The distance between the two vertical osteotomies is greater on the outer side than on the inner side of the vestibular cortical plate. The osteotomy lines should be traced using the tips progressively in order of size, varying the power level of the characteristics of the incision change too [29]. The tips are used in progression from number one to number five to deepen the osteotomies. As the groove on the bone surface becomes retentive, the tips can be used at high power resulting in more aggressive and faster cutting. The tips are calibrated to achieve the exact depth of cut desired but, if the cortical width exceeds 5 mm, a normal tip or chisels can be used to complete the osteotomy. Once the desired depth of the crestal and vertical osteotomies are achieved, the caudal ends of the vertical osteotomies are connected by a horizontal incision and the incision is a partial thickness osteotomy. The greenstick fracture is made using chisels. A cortical bone graft of appropriate size and shape is harvested from the ipsilateral mandibular ramus by means of the aforementioned tips and chisels. Bone chips are collected from the same donor site. The cortical graft is gently hammered between the vestibular and lingual cortex, acting as a bone wedge until the desired separation of the two cortices is reached. It is then stabilized using titanium osteosynthesis screws. In order to obtain supracrestal regeneration, the bone graft between the vestibular and lingual/palatal cortices can be fixed at a higher level in order to let it protrude from the occlusal aspect of the two bone plates. Finally, the grafted site is covered by a resorbable collagen membrane. The mucoperiosteal flap is repositioned and sutured.

e. Distraction Osteogenesis

Indication

It was developed by Gavriel Ilizarov in 1989 to treat skeletal deformities which works on principle of "tension-stress" with slowly incorporated tensile stress promoting histogenesis [30]. Bone traction generates tension and promotes osteogenesis, which occurs parallel to the distraction site and can be in vertical and/or a horizontal direction.

Technique

This technique allows significant augmentation of both hard and soft tissues in areas with extensive tissue loss in a staged manner [31-34]. A transport segment is mobilized in a similar manner as for interpositional bone grafting, preserving attachment to the crestal and lingual tissues.³⁰ The distractor is fixed to transport basal bone segments with approximately 1-2 mm gap between the two segments. This is left in situ for a latency period of 5-7 days to allow the formation of soft tissue callus between the two segments and then activation is started at the rate of 0.5-2 mm/day for periodic distraction. After completion of the desired amount of distraction, the distraction device is removed and quality of the bone is explored. The newly formed bone is hourglass shaped and placement of additional grafts may be required for proper implant placement at this time. The implant placement is performed after a period of 4-6 months. It undergoes a more active remodeling process because of the better vascularization when compared to a block graft and minor complications could be averted using an appropriate technique [35,36].

f. Orthodontic Extrusion

In this method, forces are applied to the periodontally hopeless teeth, which brings the alveolar bone along with it. Elongation of the tooth in its alveolus causes shifting of gingival and Periodontal Ligament (PDL) fibres. The slow orthodontic extrusion technique is used to obtain a good amount of hard and soft tissue before dental implant placement. This technique avoids the surgical steps of the bone regeneration technique and is more simply managed by the clinicians. However, this technique requires more time to see the final results compared with surgical Guided Bone Regeneration (GBR). It is a non-traumatic technique whereas GBR is usually associated with pain and swelling in the immediate post op period [37,38].

g. Sinus Lift Procedure

It was proposed by Tatum for implant placement when there is insufficient bone between the maxillary alveolus and sinus [24]. The two procedures of sinus lift available are lateral window technique (lateral or direct sinus lift) and crestal approach (crestal or indirect sinus lift) [39-44].

Crestal Approach (Indirect Sinus Lift)

Indication

It is indicated when the Residual Alveolar Bone (RAB) is less than 6-8 mm.

Technique

After local anaesthesia is given, a pilot drill is used, followed by drills in increasing diameters and the osteotomy site is prepared. Care is taken to ensure that the drill length is maintained at 2 mm away from the floor of the sinus. As drills of higher diameter are introduced, it is observed that the sinus floor gets fractured and the sinus is slowly elevated to avoid injury to the Schneiderian membrane, by using a surgical mallet/osteotome with controlled force. Autogenous graft material is inserted within the socket, if required.

Lateral Window Technique (Direct Sinus Lift)

Indication

It is indicated when the residual alveolar bone is 5 mm or less.

Technique

A full-thickness flap is raised giving a crestal incision and a vertical releasing incision. The bone is exposed and sometimes a bluish hue is seen on the bony surface, which is indicative of the sinus. Then a window is made either using bur or piezosurgical instruments to delineate the sinus. After the window is prepared, it is slowly disengaged to expose the sinus. Care is taken to avoid perforation of the Schneiderian membrane that lines the sinus. The sinus is then slowly elevated using the appropriate sinus lift instruments. If the window created has not been totally disengaged, it could be placed below the relocated sinus to form its floor. The empty void created between the elevated sinus and the basal bone is filled with either autologous or allogeneic graft material and a membrane is stabilized over it.

3. Soft Tissue Augmentation Procedures

a. Onlay Graft Procedures

Indication

It was first described by Seibert in 1983 for correcting horizontal deficiencies in the anterior maxillary arch and for saddle depressions, i.e. vertical deficiency [45,46].

Technique

A recipient bed is prepared with two parallel split-thickness incisions in the lamina propria of the edentulous area and the epithelium is removed in order to expose the underlying connective tissue. A free gingival graft is then harvested from the palate and secured on the recipient vascular bed with interrupted and compressive sutures, with the amount of augmentation depending on the thickness of the applied graft. There is no shrinkage of the tissue grafted, but a varying amount of volume is lost during the healing phase for which, it is frequently necessary to repeat the surgical procedure at 2 to 3 month intervals in order to reach the desired ridge height [45-48].

b. Roll Flap Technique:

Indication

It was introduced by Abrams in 1980 to correct small or moderate soft tissue defects associated with buccolingual defects of ridge [49].

Technique

It involves a connective tissue pedicle flap that originates from the de epithelialization of the palatal tissue close to the edentulous area in which two parallel incisions are made from the occlusal edentulous area towards the palate and connected with a horizontal incision. A split-thickness palatal flap is then elevated and a pouch is prepared in the defect area with a split dissection of the supra periosteal connective tissue. The palatal flap is 'rolled' into the pouch area and then sutured [50].

Modified Roll Technique

Indication

This technique is a modification of the roll technique which was introduced by Scharf and Tarnow for class I deformities wherein the epithelium over the connective tissue is not scraped but preserved to cover the donor site [51].

Technique

An incision is made using a Bard-Parker blade from the crest to the palatal area to include a sufficient length of the tissue to be rolled to the desired area on the buccal aspect. A similar incision is made on the other side to include sufficient width of the graft and the two vertical incisions are connected by a horizontal incision. A partial-thickness trap door-type flap is reflected. The pedicle is rolled on the buccal aspect and stabilized using a horizontal mattress suture.

c. Interpositional (Inlay) Graft Procedures

Indication

It was described in 1979 by Meltzer which involves the placement of graft without scraping the epithelium from the connective tissue to treat buccolingual and apicocoronal ridge defects [52].

Technique

A pouch is prepared in the defect area and a free graft derived from the palatal or maxillary tuberosity is harvested which is partially de-epithelialized and the exposed connective tissue is inserted in the pouch area like a wedge (inlay graft). Thus, the epithelialized part of the graft remained outside the pouch and sutured at the level of the epithelial surface of the surrounding tissues [45,46,52-54].

d. Combination Onlay-Inlay Grafts

Indication

It was introduced by Seibert and Louis in 1996 to treat buccolingual and apicocoronal ridge defects [55].

Technique

It is done to obtain simultaneous tissue augmentation in the horizontal and vertical dimensions. The donor site is prepared with a full-thickness coronal dissection and a partial thickness apical dissection. The graft is thus composed of two parts: the coronal part, which is epithelialized and the apical part, which is formed of connective tissue only. On the defect area, the crestal surface is de-epithelialized with a beveled incision and the apical surface is prepared with a partial-thickness dissection with two vertical-releasing incisions extended apically, without involving the adjacent papillae to create a pouch area. The onlay section (epithelialized area) of the graft is sutured on the crestal surface of the defect, while the inlay section (connective tissue) is inserted and secured in the vestibular pouch area.

e. Pouch Procedures

Indication

It was put forward by Burton Langer and Lawrence Calagna to treat ridge deformities in which a connective tissue graft was procured from the palatal area or maxillary tuberosity to increase the thickness of the soft tissue on the buccal surface of ridge [56,57].

Technique

A pouch is prepared with a split dissection of the supra periosteal connective tissue and the connective tissue graft is sutured to

the periosteum and then the flap is sutured in its original position and covers the connective tissue graft completely.

Discussion

The onlay technique is done mostly with an autogenous bone graft. Before the year 2000, most implants were immediately placed together with the bone grafts. The implants were used to secure the graft. The capacity and volume of the bone grafts are variable between the studies. These differences could be explained by different follow-up periods, timing of implants placement, different sites and different bone grafting material. Over all the resorption rate is higher in the first year, but stabilizes after it [18].

Alveolar distraction is only indicated for the mandible because of the pneumatization of the sinus in the maxilla. A disadvantage is the early resorption of the distracted bone. It undergoes a more active remodeling process because of the better vascularization when compared to a block graft as reported by Hodges NE [35].

The ridge split technique has been used in horizontal deficiency requiring 2-5 mm of augmentation. It is a minimally invasive technique indicated for alveolar ridges with adequate height, which enables immediate implant placement and eliminates morbidity and overall treatment time. The classical approach of the technique involves splitting the alveolar ridge into 2 parts with use of osteotomes and chisels. Tatum developed specific instruments including tapered channel formers and D-shaped osteotomes to expand the resorbed residual ridges of both the upper and lower jaws having a ridge width of <3 mm [24-26].

Ridge Expansion is indicated in patients with ridge width <6 mm. A full-thickness flap is raised to expose the bone. Scipioni, et al., reported a 98% 5-year implant survival rate when utilizing ridge expansion with simultaneous implant placement [58]. The split-crest technique had previously been compared to lateral ridge augmentation with autogenous bone block graft disclosing no significant differences in implant survival between the two treatment modalities, although the gain in alveolar ridge width was significantly higher with lateral ridge augmentation with autogenous bone block graft [59].

Liu J, et al., stated that guided bone regeneration is a surgical procedure that uses barrier membranes with or without particulate bone grafts or/and bone substitutes [60]. Wang HL, et al., stated that four principles need to be met to ensure successful GBR [13]. Sandwich grafting is done with vertical ridge deficiency with preexisting minimal vertical alveolar dimensions of 4-5 mm and without any soft tissue deficit. Choi BH, et al., concluded that sandwich osteotomy combined with interpositional allografts technique was safe although it leads to some resorption of the superior and anterior parts of the alveolar fragment [23].

Interpositional graft procedures were described by Meltzer which involves the placement of graft without scraping the epithelium from the connective tissue to treat buccolingual and apicocoronal ridge defects [52]. Tatum proposed a technique, "sinus lift procedure", for implant placement when there is insufficient bone between the maxillary alveolus and sinus [24]. Alveolar height <10 mm is often an indication for sinus lift surgery via the crestal (indirect) approach, while alveolar height <5 mm via is an indication for the lateral (direct) approach.

In orthodontic extrusion, forces are applied to the periodontally hopeless teeth, which will bring the alveolar bone along with it. Salama and Salama have documented clinical cases employing forced eruption on hopeless teeth to augment bony tissues in implant sites and also proposed a classification for extraction socket according to their morphology and placement of the implant into the socket [37]. PDL cells play a crucial role at a molecular level, thereby aiding in optimal results after implant placement [38].

The Roll technique introduced by Abrams was employed to correct small or moderate soft tissue defects associated with buccolingual defects of ridge [49]. Padhye, et al., compared the Subepithelial Connective Tissue Graft (SCTG) and buccally displaced flap [61]. The results showed that there was an increase in the width and thickness of keratinized mucosa in the buccally displaced flap group than the SCTG group, with reduced surgical sites, less postoperative pain and good blood supply. Pouch procedures were put forward by Burton Langer and Lawrence Calagna to treat ridge deformities in which a connective tissue graft was used which was procured from the palatal area or maxillary tuberosity to increase the thickness of the soft tissue on the buccal surface of ridge [56,57].

Conclusion

Reconstructive surgical procedures aimed at restoration of the alveolar ridge to its former dimensions are increasingly prescribed, particularly in the anterior region where esthetic issues are concerned. Nevertheless, there is a lack of clinical studies in the literature investigating this concern and therefore evidence-based conclusions cannot be drawn. Furthermore, because of the high esthetic impact it is advised that patient-centered outcomes be incorporated in clinical trials.

Conflict of Interests

The authors have no conflict of interest to declare.

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