Review Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2021;11:2:62-71.

Ridge Preservation: A Hope for Prosthodontist

Neeraj Mittal[1*] Varun Arora[2] Meenal Arora[3] C V Sruthi Vyaasini[4] Shivani Yadav[5] Jyoti Arneja[6]

[1]Professor, Department of Prosthodontics, Crown, Bridge and Implantology, JCD Dental College, Sirsa, Haryana, India.
[2]Professor, Department of Prosthodontics, Crown, Bridge and Implantology, JCD Dental College, Sirsa, Haryana, India.
[3]Private Consultant, Karnal, Haryana, India.
[4]PG Student, Department of Periodontics and Implantology, J.N. Kapoor DAV(C) Dental College, Yamuna Nagar, Haryana, India.
[5]PG Student, Department of Periodontics and Implantology, JCD Dental College, Sirsa, Haryana, India.
[6]PG Student, Department of Prosthodontics, Crown, Bridge and Implantology, Sudha Rustagi College of Dental Sciences and Research, Faridabad, Haryana, India.

ABSTRACT

Background: Alveolar ridge preservation is a method of decreasing bone resorption following tooth extraction and facilitating prosthetic rehablitation. Clinical procedures can be implemented only when there is proper understanding of the physiological responses occurring after extraction and the effects of ARP. Undesirable horizontal and vertical ridge reduction following extraction can be reduced by ARP with the help of Guided bone regeneration, socket fillers, socket sealers and growth factors. However, presently there is no consensus on case selection, best clinical technique and material choice so ridge preservation is totally dependent on management of socket following tooth extraction.

Keywords: Alveolar bone grafting, Alveolar bone loss, Bone remodeling, Tooth loss.

INTRODUCTION

Bone height is one of the most important criteria for the success of any prosthesis specially dental implant.[1] Loss of bone height occur due to resorption following extraction, this resorption of bone may present a significant problem in implant and restorative dentistry, but it can be preserved by a technique called Ridge preservation.[2] Osseointegrated implant success depend on the level of bone crest surrounding the implant anatomic factors such as the quality and architecture of bone tissue, as well as implant features e.g., length, surface area, coating, implant timing and occlusal load may influence alveolar bone crest resorption.[3] Longevity is the most common parameter to evaluate the success of dental implants and the maintenance of hard and soft tissues surrounding the implant. So, for optimum results one should know not only the causes and consequences of bone loss but we should know how to alter our treatment plan for maximum bone preservation.[4]

DISCUSSION

Events following an extraction

Two type of changes (Internal and External) occur during healing of an extraction socket. Internal changes lead to formation of bone within the socket and external changes lead to loss of alveolar ridge width and height.[2] Bone does not regenerate to a level coronal to the horizontal level of the bone crest or to the level of the neighbouring teeth, due to anatomic, prosthetic, metabolic, functional, genetic and iatrogenic factors. Maximum changes occur from six months to two years following extraction.[5]

Schropp et al (2003) studied the effect of a single tooth extraction of premolar or molar teeth on bone healing and soft tissue changes using clinical and radiographic measurements as well as digital subtraction radiography. They showed that major

Received: Oct. 12, 2020: **Accepted**: Nov. 27, 2020
*Correspondence Dr. Neeraj Mittal.
Department of Prosthodontics, Crown, Bridge and Implantology, JCD Dental College, Sirsa, Haryana, India.
Email: dr.neerajmittal@yahoo.com

pISSN 2278-0076
eISSN 2321-9270

changes take place in the 12 months following an extraction with an average of 50 per cent reduction in the width of the alveolar ridges.Two-third of this reduction occurred within the first three months. This loss averaged between 5 and 7 mm and was similar at all sites in the mouth. Immediately after tooth extraction, the width of the ridge was an average of 12 mm (8.6–16.5 mm) and 12 months later 5.9 mm (2.7–12.2 mm).Given that a standard body implant requires a minimum of 6–7 mm of bone dimension, many of these sites would not be suitable for implant placement.[2]

Pietrokovski in an examination of healed sockets in dried skulls showed that from the occlusal aspect, the crest of the residual ridge shifts lingually and from the lateral aspect, a concavity is seen or ridge get flattened to form a wall running straight between the alveolar crests of the adjacent remaining teeth. [6]

Ridge preservation

To minimize external resorption of the ridge and maximize bone formation within the socket, a procedure called ridge preservation is done following extraction but in many situations. this procedure cannot be done (e.g., in the presence of acute infection).[4] A recent report has suggested that very minimal changes occur within six to eight weeks of an extraction. Some ridge preservation techniques are based on the principles of guided tissue/bone regeneration.[7] Minimally traumatic tooth extraction, soft and hard tissue grafting, concomitant use of barrier membranes and immediate implant placement are various procedures used for ridge preservation.[4]

Atraumatic tooth extraction

Although tooth extraction is by necessity a traumatic procedure, the application of appropriate instruments with minimal force is recommended to limit damage to the hard and soft tissues. Firstly coronal fibres are severed by the insertion of fine luxators or periotomes into the periodontal ligament, thereby loosening the tooth until forceps can gently deliver the tooth from its socket. Multi-rooted teeth can be decoronated followed by sectioning of the roots and extracted individually to facilitate this procedure.[4,8]

Easy X Trac system

The goal is to destroy or remove as little bone as possible to preserve the extraction site for a dental implant. These newer dental instruments utilize sort of a cork-screw mechanism to pull the tooth out of the socket, leaving much of the cortical plates intact. This system is used to perform an efficient extraction that minimizes patient discomfort and provides the opportunity to successfully place immediate implants.[9]

Timing of extraction

Timings is very important because most of the resorption occur within the first three months after extraction and it should be planned just before when we are planning implant placement, this is specifically applied for immediate implant.[7,10]

Debridement and decortication of the socket

The sockets be debrided to remove anything that may interfere with healing. For greater access of blood vessels into the socket, a round bur should be used to perforate the socket wall. In an experimental study, it has been shown that retention of the periodontal ligament along the socket walls facilitated retention of the clot during the early stages of wound healing.[11,12]

Coverage of the socket by soft tissue

When using non resorbable membrane , soft tissue coverage procedures may be considered to retain, stabilize and protect grafting materials Many techniques have been suggested and include displacing neighbouring tissue to cover the socket such as coronal advancement of a buccal flap, rotating grafts from tissue adjacent to cover the defect or using free gingival or subepithelial connective tissue grafts.[13,14,15]

Pattern of jaw resorption

Atwood divided factors affecting the rate of resorption into 4 categories: anatomic, metabolic, functional and prosthetic.[16] Buccal aspect in both jaws is affected maximum by alveolar resorption post extraction as shown by many studies this can be explained if we closely study the labial anatomy of the alveolar bone surrounding the upper and lower teeth as the margins of the facial alveoli are thin, mostly cortical (though in rare cases, they contain cancellous bone), knife-edged and frail.[8]

Trauma predisposed the jaw bone to resorptive patterns that may lead to unfavourable conditions for implant placement as placement of implant is dependent on bone pattern.[17] Usually post extraction, osseous remodelling also takes place in the presence of dehiscences and fenestrations that magnify the problem, the end result being buccal concavity in the alveolar bone.[8]

Using Membranes and Bone Grafts in Sockets

In the study by Lekovic, the average loss of alveolar height and width in sockets that were left to heal with only a membrane covering them was 0.38 mm and 1.32 mm, respectively, which is less than the socket that are healed naturally.[18] If we consider quality of bone, it is also excellent in sockets that have healed in the presence of a barrier membrane which is favourable for implant placement and this is justified by literature.[19] When demineralized freeze-dried bone allograft (DFDBA) was used in conjunction with a collagen membrane, the width of the alveolar ridge decreased from 9.2 mm to 8.0 mm while the width of the socket sites that healed naturally decreased from 9.1 mm to 6.4 mm on average.[20]

Bone-to-Implant Contact (BIC) in Grafted Sockets

Several studies have investigated BIC between regenerated or natural bone and rough or machined-surface implants.[8] Trisi and colleagues examined the posterior maxilla, where bone is generally of poor quality, investigating the BIC at 2 and 6 months. For rough-surfaced implants (dual acid-etched), there was 48% BIC at 2 months and 72% BIC at 6 months, compared with only 19% and 34%, respectively for machined-surface implants.[21] Similar results were noted in an animal study, in which there was 74% BIC in type IV bone (poor-quality bone) at 6 months on titanium porous oxide (TiUnite, Nobel Biocare, Gothenburg, Sweden) implants.[22]

Since 25 years of clinical and experimental researches on the concept of immediate implant placement has made it highly predictable treatment modality.[23]

Advantage

Reduction of treatment time, Preservation of alveolar bone and Superior esthetic outcome.

The main hindrance with successful bone healing around immediately placed implants is the formation of soft connective tissue bed. The placement of barrier membrane with immediate implant procedures isolate the extraction socket from outside, helps in stabilization of the clot and maintenance of the space for bone regeneration. Barrier membrane assumed to preclude bacterial invasion and to hold back epithelial tissues from infiltrating the defect.[23]

Hom Lay wang and Lakshmi Botyapati described 4 major biological principles (pass principal) necessary for predictable bone regeneration:

- P-primary wound closure
- A-angiogenesis to provide necessary blood supply
- S-space maintainence
- S-stablization of clot[24]

Towards the end of 1980s, 2nd generation resorbabale membranes were introduced. They were intended to omit the surgery of memrane retieval and reduce the treatment time.

Collagens such as Coletica, Biogide, Biomend, Polyglactin910 knitted mesh such as vicryl, Polylactic acid such as atrisorb, Polyglycolic acid, Freed-dried fasia lata, Laminar bone barrier, Polyhydroxybutarate(PHB), PHB copolymerised with hydroxyvalerate and PHB copolymerised with hydroxyvalerate and polyglactin 910[25]

Immediate placement after extraction[26]

It is done in extractions sockets which have

- Existing soft and hard tissue contours are ideal
- Good primary stability
- No more than 1.5 mm gap between socket and implant
- Ideally 0.5 to 1.5mm gap should be produced between implant surface and buccal plate for protection of this bone

Bone regenerative techniques[4]

- Grafting

  Autografts
  Allografts/ Isografts
  Xenografts

Alloplasts

- Guided bone regeneration
- Bio-col technique
- Osteotomes

Soft tissue regerative techniques[4]

Free grafts and Pedical connective tissue grafts

Guided Bone Regeneration (GBR)

It is a reconstructive surgical procedure that utilizes a membrane to augment bone.[27]

History

First described by Hurley et al in 1959 for experimental spinal fusion. In 1960's Bassett and Boyne tested microporous cellulose acetate filters for the healing of cortical bones.[27] In 1980's, Karring and Nyman were the first to study barrier membranes in periodontal regeneration In 1988, clinical testing of membranes in implants began.[1]

Rationale

A cell occlusive physical barrier or membrane is placed between the gingival connective tissue of the flap and the alveolar bone defect. The barrier is trimmed to shape and fitted over the bone defect so that the barrier completely covers and extends beyond the osseous defect by at least 2 mm. It allows blood clot to form and stabilize. Stabilization is important as even the movement of 10- 20 microns can shift the differentiation of mesenchymal cells from osteoblasts to fibroblasts.[28]

Indications[25]

Local alveolar ridge defects, Post extraction defects and Failing / failed/ periimplantitis defects

Anatomic indications for membrane use in implant sites[29]

Group I: Sites with an anatomic insufficiency of crest width resulting in an exposed implant surface

Group II: Sites in which the prosthetically guided placement of an implant results in exposure of the buccal implant surface(this can include a internal perforation of the buccal surface)

Group III: Sites where voids between the implant and the bone when an implant is placed into an extraction socket.

Membrane work by[25]

Fibroblasts inhibition, Exclusion of cell derived soluble inhibitory factors, Contact inhibition by heterotropic cell interaction, Local concenteration of growth stimulating factors and Stimulation properties of the membrane itself.

Classification of ridge augmentation techniques has been described in (Table 1)[30]

Table 1: Classification of Ridge Augmentation Technique.

Ridge thickness	Procedure
8 to 10mm	Barrier membrane alone
7 to 8mm	Particulate graft and barrier membrane with pin fixation
6 to 7mm	Osteotomes for ridge expansion
5 to 6mm	Allogenic block of bone
4 to 5mm	Autogeneous block of bone
1 to 4mm	Down fracture of the maxilla or titanium mesh crib (both with autogeneous bone) or distraction osteogenesis

Criteria for determining GBR approach[25]

Primary stability of the implant to be inserted, Implant position from a prosthetic point of view and size and type of bone defect.

Enamel matrix derived barrier[23]

A commercial enamel matrix derivative (emdogain,biora AB)is now available for guided tissue regeneration. It is an acidic extract of developing enamel and it helps in stimulating periodontal regeneration and acts as tissue healing modulator. Hammerstorm et al showed that the use of EMD results in limited epithelial down growth, in contrast to control sites where greater epithelial down growth takes place. It was concluded that biochemical environment at the root surface after application of EMD may prevent the epithelial down growth in a similar manner as mechanical prevention achieved with barrier membrane in GTR.

Dermal matrix barrier[23]

Novaes et al reported a case in which a destroyed buccal plate was completely restored by use of Frialit-2 implant placed in extraction socket of maxillary 1st bicuspidan acellular dermal matrix material was used as a membrane barrier to cover the implant,and bioactive glass is used as grafting material. After 6 month defect was completely filled by mineralized tissue.

Properties of barrier membrane[25]

- All made of biocompatible material
- Resorbable GBR membrane made of synthetic polymers which usually degrade by prosess of hydrolysis
- The immunogenic hazard of of collagens can be diminished by cross linking and reducing telopeptide residues
- All posses occlusive properties
- Regenerative possess the property of clinical manageability,as they can be manipulated from incising to shaping and eventually can be secured in place by tacks and sutures.

Management of barrier exposure[31]

- In the event that the membrane is exposed in 1st 6 to 8 weeks of healing, the site can be rinsed of daily with 12 percent chlorhexidine.
- 8 weeks later partial thickness flap is made and barrier is removed and then flap margins are sutured
- If the membrane was attached with a cover screw, a new sterile cover screw should be sutured to implant.
- Attention should be paid not to disturb the granulation tissue.

Bio Col technique[32,33]

Two components: Surgical and Prosthetic Protocol

Osseonews

The technique combines a surgical and prosthetic treatment protocol. To start, minimally traumatic tooth removal is accomplished with the use of a periotomes or by sectioning the tooth. Next the socket is degranulated and prepared to ensure active bleeding. The intra-osseous portion of the socket is grafted with BioOss cancellous bone graft (Osteohealth) condensed in the socket to eliminate voids. The supra-osseous soft tissue socket is filed with CollaPlug absorbable collagen dressing (Zimmer Dental) and sealed with IsoDent tissue Cement (Ellman International, Inc.) to isolate the site and render it impervious to the deleterious effect of oral liquids and debris.

A tooth or tissue borne ovate pontic is modified to provide shallow but broad circumferential support to the surrounding soft tissue and adjacent papilla. Fixed provisional restorations are preferred, but removable restorations are worn by the patient without removal for 72 hours after which they are removed for hygiene and immediately replaced. The perceived disadvantage of the BioOss material is actually its greatest strength. The slow substitution rate ensures long term maintenance of alveolar ridge contours. Although some of the material may persist at the site indefinitely, studies demonstrate vital bone growth through the porous mineral structure and equivalent percentages of bone to implant contact compared to control site implants placed in non grafted alveolar ridges. The main advantage of this technique is our long term documentation and excellent clinical results in a private practice setting since 1989.

Indications

In all cases after extraction and in patients with thin periodontal biotype.

Bio Oss[34]

It is as natural bone grafting material and osteoconductive bone substitute that promotes bone growth in periodontal and maxillofacial osseous defects. It consists of the mineral portion of bovine bone and have high similarity of Bio-Oss to human bone.

Advantages

- provides mechanical strength and stiffness due to retention of the natural mineral content when integrated and thus act as effective space maintainer
- chemical composition is analogous to human bone with fewer hydroxyl and more carbonate groups than most synthetic materials which help in integration with patient's own bone.

- due to small crystallite size which is comparable to human bone, it gets naturally integrated during the natural remodelling process of the human bone

Bio Gide[35]

It is resorbable Bilayer Membrane. It consists of highly purified collagen types I and III (porcine origin) which are strongly hydrophillic. The membrane is highly biocompatible and supports wound healing. Cell adhesion is promoted by three-dimensional, natural fiber structure, which serves as a matrix for soft tissue support and provides a barrier to the in growth of overlying soft tissue into underlying bony defects. As a result, once moistened, the membrane adapts very well to the surgical site.

Safety

Bio-Gide satisfies the strict safety requirements for medical devices in all respects and is subject to a quality-assurance system in accordance with international norms.

Isodent tissue cement: Cyano 2-acrylate d'isobutyle

Colla plug : Absorbable collagen dressing serves as matrix for connective tissue growth

Biologic mechanism of bone grafting[36]

- Osteoproliferative/osteogenenis: Contain living cells and start forming new bone and induce the adjacent cells to start forming bone.
- Osteoinduction: Do not contain cells per se in the graft but induce the formation of new bone from the adjacent cells.
- Osteoconduction: Do not induce the formation of new bone but merely act as scaffolds for the strengthening the blood clot and providing a stable medium for the cells to migrate and start depositing new bone.

Ideal requirements of bone graft material[37]

Should help in the formation of new bone, Be inert and biocompatible, Easy to obtain, Predictable, Cost effective, Non toxic and strong and resilient.

Classification of bone grafts

I) *Origin*[30]

Autograft, Allograft, Hetero or Xenografts and Alloplasts

II) *Osseous grafts* [Ellegaard (1973) and Nielsen (1980):][38]

Osteoproliferative (osteogenesis), Osteoinduction and Osteoconduction

Autogenous grafts

These are considered as the gold standard and are harvested from the patient's own body. It contain live osteoblasts and osteoprogenitor stem cells and healed by osteogenesis. No risk of disease transfer and tissue matching.[38]

Classification (Marx 1993)[39]

Vascularized and Nonvascularized

Sites for I/O autografts[1]

Edentulous ridges, Ramus and symphysis of mandible, Tori, Maxillary tuberosity, Healing bony wound or extraction sites and Bone removed during osteoplasty and osteotomy

Sites for E/O Grafts[1]

Iliac crest, Ribs and Femur

Types of autografts[38]

Osseous coagulum, Bone blend, Intraoral cancellous bone marrow transplant and Bone swagging

1. Osseous coagulum: Made by harvesting intraoral bone with round burs then mixing it with blood.
2. Bone blend

Option was designed to overcome some of the disadvantages of using osseous coagulum such as inability to use aspiration during accumulation of the coagulum, the unknown quality and quantity of the collected bone fragments, and the material's fluidity. The combination of cortical and cancellous intraoral bone is placed in an autoclaved plastic capsule and triturated until it becomes slushy.

3. Intraoral cancellous bone marrow transplants

Site: maxillary tuberosity, edentulous areas and healing sockets.

4. Bone swaging

It is the technique which requires the existence of an edentulous area adjacent to the defect from which the bone is pushed into the defect thats why it is s technically difficult and is of limited usefulness.[38]

Advantages[38]

Better predictability and No antigenicity

Disadvantages[38]

Time consuming, Insufficient quantity, Injury to Mentalis and Depressor labii inferioris muscles, Maxillary sinus fistula and Inferior alveolar nerve damage.

Allograft

Grafts which are harvested from one human and transplanted to another.[40]

1. Freeze-dried bone allograft (FDBA): not demineralized and osteoconduction is mechanism of working.
2. Demineralized freeze-dried bone allograft (DFDBA): more bone filling capacity than FDBA. Urist and Strates showed that demineralizing and freeze-drying graft material works on principle of osteoinduction.

Advantages

Commercially available, Less time consuming and Predictable and rich source of BMPs

Disadvantages

Risk of disease transfer (1 in 8 million), Expensive and Age of donor[41]

Xenografts

A graft obtained from different species. Currently, there are three available sources of xenografts used as bone substitutes in clinical practice: Bovine bone, Porcine bone and Coral derived graft material.[30]

Synthetic bone substitutes[36]

Avoid the problems of finding suitable autograft bone and the small infective risks.

Types of synthetic bone substitute available are :

a) Hydroxyapatite

b) Ceramics (other than hydroxyapatite) :Bioactive glasses.

c) Polymers

1. Combinations of polyglycolic acid (PGA) and polylactic acid (PLA)
2. HTR polymer
3. Bioresorbable fixation materials

d) GIC derived bone substitute

e) Calcium Phosphate Biomaterials : Tricalcium phosphate and Calcium sulphate.

Requirements of synthetic bone substitutes[37]

Local and systemic compatibility, No allergenic potential, Positional stability when applied, Resorbability and full bone infiltration, Stimulation of bone healing, Mechanical strength, Volumetric stability and cost-effective

Several bone grafting procedures have been described in (Table 2)[30]

Table 2: Bone Grafting Procedures.

Mandibular ridge augmentation	Maxillary ridge augmentation
Superior border augmentation	Onlay bone grafting
Inferior border augmentation	Interpositional bone grafts
Hydroxyapatite augmentation	Maxillary hydroxyapatite augmentation
Guided Bone Regeneration	Sinus lift augmentation

Partially edentulous ridge (Soft tissue graft)[42]

a) Technique depending on vascular perfusion:

Autogenous onlay soft tissue grafts

Autogenous inlay soft tissue grafts

Combination

b) Local flap approach:

Subperiosteal tunnel

Roll technique

Coronally positioned flap

c) Local and Distant flaps

Anterior advanced flap

Controlled tissue expansion

General Surgical Considerations[43]

Proper surgical settings, Dentition free of signs of destructive periodontitis, Cleaning of perioral skin, Ask patient to rinse his/her mouth with 0.12-2.0 % solution of chlorhexidine and performed under light sedation and local anesthesia

Flap design[44]

- Full thickness crestal incision placed within the keratinized mucosa of the edentulous ridge
- In partially edentulous patient, crestal incision extended into intrasulcular incision
- Vertical releasing incision
- Flap is reflected using periosteal elevator, care to be taken not to damage the palatine artery and mental nerve

CONCLUSION

Prosthetic rehabilitition is one of the most important step of any dental treatment in association with proper diagnosis and treatment planning of every case .For proper prosthesis bone level of the extraction site is important and for this ridge preservation following extraction is important. In case of hard tissue defects go for Gbr Or Biocol technique for ridge preservation and in case if going for extraction, follow bio-col technique precisely. Further studies are needed for understanding importance and methods of ridge preservation.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1. Tomlin EM, Nelson SJ, Rossmann JA. Ridge preservation for implant therapy : A review of the literature. Open Dent J 2014;8(Suppl 1-M4): 66-76.
2. Schropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. Int J Periodont Restorat Dent 2003; 23(4): 313-23.
3. Elsayed MD. Biomechanical factors that influence the bone-implant –interface. Res Rep Oral Maxillofac Surg 2019;3: 023.
4. Darby I, Chen S, Poi RD. Ridge preservation : What is it and when should it be considered. Aus Dent J 2008;53(1): 11-21.
5. Araujo MG, Lindhe J. Dimensional ridge alterations followingtooth extraction. An experimental study in the dog. J Clin Periodontol 2005;32:212–18.
6. Pietrokovski J. The bony residual ridge in man. J Prosthet Dent1975;34:456-62.
7. Chen ST, Wilson TG, Hammerle CHF. Immediate or early placement of implants following tooth extraction: review of biologic basis, clinical procedures and outcomes. Int J Oral Maxillofac Implants 2004;19(Suppl):12–25.
8. Irinakis T. Rationale for socket preservation after extraction of single-rooted tooth when planning for future implant placement. J Can Dent Assoc 2006;72(10): 917-22.
9. Babbush CA. A new atraumatic system for tooth removal and immediate implant restoration. Implant Dent 2007;16:139-45.
10. Hammerle CHF, Chen ST, Wilson TG. Consensus statements andrecommended clinical procedures regarding the placement ofimplants in extraction sockets. Int J Oral Maxillofac Implants2004;19(Suppl):26–28.
11. Buser D, Dula K, Belser U, Hirt HP, Berthold H. Localized ridge augmentation using guided bone regeneration. I. Surgical procedure in the maxilla. Int J Periodontics Restorat Dent1993;13:29-45.

12. Cardaropoli G, Araujo M, Lindhe J. Dynamics of bone tissue formation in tooth extraction sites. An experimental study in dogs. J Clin Periodontol 2003;30:809-18.

13. Armagnola D, Berglundh T, Lindhe J. The effect of a fibrin glue on the integration of Bio-Oss with bone tissue. An experimental study in labrador dogs. J Clin Periodontol 2002;29:377-83.

14. Misch CE, Dietsh-Misch F. A modified socket seal surgery with composite graft approach. J Oral Implantol 1999;25:244-50.

15. Landsberg CJ, Bichacho NA. A modified surgical/prosthetic approach for optimal single implant supported crown. Part 1. The socket seal surgery. Pract Periodontics Aesthet Dent 1994;6:11–17.

16. Atwood DA. A cephalometric study of the clinical rest position of the mandible. Part II. The variability in the rate of bone loss following the removal of occlusal contacts. J Prosthet Dent 1957; 7:544–52.

17. Mecall RA, Rosenfeld AL. Influence of residual ridge resorption patterns on implant fixture placement and tooth position.1. Int J Periodontics Restorat Dent 1991; 11(1):8-23.

18. Lekovic V, Camargo PM, Klokkevold PR, Weinlaender M, Kenney EB, Dimitrijevic B et al. Preservation of alveolar bone in extraction sockets using bioabsorbable membranes. J Periodontol 1998; 69(9):1044-9.

19. Carmagnola D, Adriaens P, Berglundh T. Healing of human extraction sockets filled with Bio-Oss. Clin Oral Implants Res 2003; 14(2):137–43.

20. Iasella JM, Greenwell H, Miller RL, Hill M, Drisko C, Bohra AA et al. Ridge preservation with freeze-dried bone allograft and a collagen membrane compared to extraction alone for implant site development: a clinical and histologic study in humans. J Periodontol 2003; 74(7):990–9.

21. Trisi P, Lazzara R, Rebaudi A, Rao W, Testori T, Porter SS. Bone-implant contact on machined and dual acid-etched surfaces after 2 months of healing in the human maxilla. J Periodontol 2003; 74(7):945–56.

22. Huang YH, Xiropaidis A, Sorensen RG, Albandar JM, Hall J, Wikesjo UM. Bone formation at titanium porous oxide (TiUnite) oral implants in type IV bone. Clin Oral Implants Res 2005; 16(1):105–11.

23. El Helow K, El Askary AES. Regenerative barriers in immediate implant placement : a literature review. Implant Dent 2008;17(3): 360-71.

24. Wang HL, Lakshmi B."PASS" principles for predictable bone regeneration. Implant Dent 2006;15(1): 8-17.

25. Sheikh Z, Abdallah MN, Hamdan N, Javaid MA, Khurshid Z. Barrier membranes for periodontal guided tissue regeneration appliances. Handbook of oral biomaterials. Pan Stanford Pub 2014.

26. Wheeler SL. Implant complications in the esthetic zone. J Oral Maxillofac Surg 2007;65(7): 93-102.

27. Elgali I, Omar O, Dahlin C, Thomsen P. Guided bone regeneration: materials and biological mechanisms revisited. Eur J Oral Sci 2017;125(5): 315-37.

28. Hitti RA, Kerns DG. Guided bone regeneration in the oral cavity: A review. Open Pathol J 2011;5: 33-45.

29. Rodella LF, Favero G, Labanca M. Biomaterials in maxillofacial surgery: Membranes and grafts. Int J Biomed Sci 2011;7(2): 81-88.

30. Goyal M, Mittal N, Gupta GK, Singhal M. Ridge augmentation in implant dentistry. J Int Clin Dent Res Organ 2015;7, Suppl S1:94-112.

31. Almutairi AS. Case report : Managing the postoperative exposure of a non-resorbable membrane surgically. F1000 Res 2018;7:685-95.

32. Sclar AG. Preserving alveolar ridge anatomy following tooth removal in conjuction with immediate implant placement : The bio-col

technique. Atlas Oral Maxillofac Surg Clin 1999;7(2): 39-60.

33. Sclar AG. Soft tissue and esthetic considerations in implant therapy. Surrey, Quintessence 2003.

34. Mittal Y, Jindal G, Garg S. Bone manipulation procedures in dental implants. Indian J Dent 2016;7(2): 86-94.

35. Schlegel AK, Mohler H, Busch F, Mehl A. Preclinical and clinical studies of a collagen membrane (Bio-Gide). Biomater 1997;18(7): 535-38.

36. Kumar P, Vinitha B, Fathima G. Bone grafts in detistry. J Pharm Bioallied Sci 2013;5 (Suppl1): S125-S127.

37. Haugen HJ, Lyngstadaas SP, Rossi F, Perale G. Bone grafts : which is the ideal biomaterial? J Clin Periodontol 2019;46(Suppl 21): 92-102.

38. Mellonig JT. Autogenous and allogeic bone grafts in periodontal therapy. Critical Rev Oral Biol Med 1992;3(4): 333-52.

39. Mounir M. Vascularised versus Non Vascularised Autogenous Bone Grafts for Immediate Reconstruction of Segmental Mandibular Defects: A Systematic Review. Oral Health Dent Management 2015;14(6): 1-13.

40. Jamjoom A, Cohen RE. Grafts for ridge preservation. J Funct Biomater 2015;6:833-48.

41. Haggerty CJ, Vogel CT, Fisher GR. Simple bone augmentation for alveolar ridge defects. Oral Maxillofacial Surg Clin North Am 2015;27:203-26.

42. Marzadori M, Stefanini M, Mazzotti C, Ganz S, Sharma P, Zucchelli G. Soft tissue augmentation procedures in edentulous esthetic areas. Periodontol 2000 2018;77: 111-22.

43. Burkhardt R, Lang NP. Fundamental principles in periodontal plastic surgery and mucosal augmentation- a narrative review. J Clin Periodontol 2014;41 (Suppl 15): S98-S107.

44. Jephcott A. The surgical management of the oral soft tissues: 1. Flap design. Dent Update 2007;34(8): 518-22.