Alveolar Ridge Preservation in Period on tally Compromised Extraction Socket – A Literature Review

Dr. Pragya Atray
Post graduate student (3rd year), Department Of Periodontology
Manipal College Of Dental Sciences, Mangalore, Manipal Academy of Higher Education, Manipal

Dr. Ashita S Uppoor
Dean, Department Of Periodontology
Manipal College of Dental Sciences, Mangalore, Manipal Academy of Higher Education, Manipal

Dr. Sangeeta U. Nayak
Associate Professor, Department Of Periodontology
Manipal College Of Dental Sciences, Mangalore, Manipal Academy of Higher Education, Manipal
Corresponding author: **Dr. Ashita S Uppoor**

Abstract: alveolar ridge preservation techniques have been developed to prevent alveolar ridge atrophy and maintain sufficient bone dimensions to enable implant placement in prosthetically driven positions while also maintaining an acceptable ridge contour in regions of cosmetic importance. It has been demonstrated that the alveolar bone undergoes a sequence of healing events following tooth extraction which are different for extraction of periodontally compromised tooth when compared with intact extraction sockets. When left without alveolar ridge preservation at the time of extraction it may be more difficult and necessitate invasive augmentation treatments to place an implant at sites previously impacted by periodontitis the preservation of ridges can be accomplished via a variety of methods, involving the use of bone grafts, barrier membranes, and biologics to provide a better restorative outcome. The literature does not distinguish one technique as being better than another, but several studies have demonstrated that all accepted therapeutic methods for ridge preservation are superior to blood clots alone. The effectiveness of these techniques in periodontally compromised extraction sockets will be assessed in this literature review together with the supporting data.

Keywords: alveolar ridge preservation, bone grafts, tooth extraction, periodontally compromised extraction sockets

Introduction:

The alveolar ridge resorbs both horizontally and vertically throughout the healing phase after tooth extraction.(1)in the initial three to six months following tooth extraction, biological changes occur quickly, and bone resorption continues slowly during the course for the rest of the patient's life.(2)periodontally compromised teeth are the most frequently extracted teeth in clinical setting and numerous investigations revealed that compared to individuals with healthy periodontal tissues, those who had previously received treatment for periodontitis had a higher chance of developing peri-implantitis and implant failure. As a result, it was proposed that periodontitis continued to exist even after teeth were extracted, and that this might have

an effect on the longevity and survival rate of dental implants.(3)hence ridge preservation and augmentation protocols are necessary which reduces the risk for implant failure.

Alveolar ridge preservation (arp) also known as ridge preservation, socket preservation, socket augmentation and socket grafting is used to prevent or reduce ridge resorption in preparation for prosthetic therapy, such as the placement of dental implants.(4)arp therapy significantly minimizes the anticipated requirement for bone augmentation at the time of implant placement when compared with unassisted socket healing. The delayed healing events in periodontally compromised sockets are an essential consideration when selecting the best timing to insert implants, with or without arp. Implant placement in periodontally impaired sites might not be able to follow the schedules established for early and delayed implant placement in intact extraction sockets. In this situation, it may be essential to redefine the timings.(5)this article attempts to summarize the recent supporting data on arp techniques for periodontally compromised extraction sockets and provide guidelines to help clinicians make clinical decisions.

Socket healing and alveolar ridge remodeling:

Both hard and soft tissues found in an extraction socket recover concurrently with a certain level of healing latency. Around the end of the first week, the clot dissolves and retracts, and granulation tissue replaces it. The epithelium develops around the borders of soft tissue incisions, and the superior portion of the alveolar bone ridge is frequently coated in granulation tissue. Osteoid is visible at the apical region (at the base) of the extraction socket during a healthy healing phase as uncalcified bony spicules following the development of a vascular network and immature connective tissue at the end of the first week. Because of the narrow osseous walls in the coronal sections of the socket, internal resorption may cause a reduction in the alveolar ridge following normal healing. The internal socket walls may resorb as a result of the inflammatory or foreign body reaction.(6)coronal cortication, which is a sign of increasing thethe external cortical architecture of the bone in periodontally compromised sockets appears 11 to 20 weeks after extraction.(7) furthermore, the quantity of osteoblastic activity and bone production in these sockets after 12 weeks is similar to8week healing period in unaffected sockets by periodontitis.(5)

Rationale of alveolar ridge preservation:

Arp by socket grafting inhibits vertical mid-buccal (1.72 mm), vertical mid-lingual (1.16 mm), and horizontal (1.99 mm), bone loss when compared to tooth extraction alone.(8) it is indicated when early or immediate implant placement is not advised, ridge contouring is required for prosthetic treatment, such as the development of pontic site and in order to reduce the necessity for sinus floor elevation.(9)the primary objectives of arp include preventing or at least limiting, ridge alterations after tooth extraction; promoting the healing of soft and hard tissue within the extraction socket; and making it easier to place dental implants in an optimal position for prosthetics without the need for additional augmentation procedures.(10)(11)ridge preservation could compensate for buccal bone and ridge width resorption that result from natural healing on its own. After periodontally compromised teeth are extracted, arp may improve bone volume and alveolar ridge height.(12)

Classification of compromised extraction sockets:

One factor influencing the amount of resorption at an extraction site is socket morphology. Partial or complete loss of an alveolar wall enhances reduction in ridge dimensions after healing. Moreover, compared with intact extraction sockets, sites exhibiting alveolar wall deficiencies receive greater benefit from arp. Various criteria have been used to classify extraction sockets and different classifications have been proposed. Recent classification that has been proposed by jung-jukim et al in 2021(13)

The extraction sockets were classified into 5 types. In this system, the severity of bone and soft tissue breakdown increases from type i to type v, while the reconstruction potential and treatment predictability decrease according to the same sequence of socket types.

Type	Residual bone	The level of soft tissue	Defect configuration	Pathology	Healing potential
Type 1	Wnl	Wnl	4-wall defect	Endodontic origin, fracture, severe caries	Good
Type 2	Buccal or palatal/ lingual bone loss	Wnl	3-wall defect	Periodontal origin, periodontal-endodontic combined	Good
Type 3	Buccal or palatal/ lingual bone loss	Buccal or palatal/ lingual gingival recession	4 or 2-wall defect	Periodontal origin, periodontal-endodontic combined	Poor
Type 4a	Buccal and palatal/ lingual bone loss (≤50%)	Wnl	2-wall defect	Periodontal origin, periodontal-endodontic combined	Poor
Type 4b	Buccal and palatal/ lingual bone loss (>50%)	Wnl	4 or 2-wall defect	Periodontal origin, periodontal-endodontic combined	Very poor
Type 5	Buccal and palatal/ lingual bone loss	Buccal and palatal/ lingual gingival recession	4-wall defect	Periodontal origin, periodontal-endodontic combined	Poor

Table 1:

Materials used for alveolar ridge preservation:

Alveolar ridge preservation can be achieved either by guided bone regeneration, bone replacement grafts, or by soft tissue grafts. The revascularization and remodeling of the grafted bone into viable, load-bearing bone is ultimately what determines if bone grafting treatments are successful. Allografts, xenografts, synthetic biomaterials, osteoactive agents, autografts, and other bone substitutes help retain dental alveolar bone following extraction or replace lost alveolar bone, supporting the ideal placement of dental implants(14). Here are several non-resorbable and resorbable materials available that are used as a barrier membrane for guided bone regeneration.

Guided bone regeneration (GBR);barrier membranes are used in guided bone regeneration (gbr) treatments to stop gingival cells from entering the area that needs to be repaired. Melcher introduced the concept of compartmentalization(15)to describe periodontal wound healing, although it might not be relevant to socket healing, if it were, one would anticipate that the socket would always be filled with soft tissue. The alveolar socket, on the other hand, tends to mend via regeneration of bone up to the alveolar crest, as early observations in humans and animals showed. The prior explanation of the blood clot's stability helps to explain why the compartmentalization notion does not produce a socket filled with epithelium and how epithelial cells migrate across the granulation tissue to close the healing socket. This is like how periodontal wounds heal. Barrier membranes' role in preserving alveolar ridge shape is still up for debate. Several products are available for arp and the materials often come in a number of different forms barrier membranes are often utilised to maintain space for bone growth. These can be either resorbable or non-resorbable.(16)

- **Non-resorbable membrane:** non-resorbable membranes made of expanded polytetrafluoroethylene (e-ptfe) have been successfully employed for gbr treatments in dentistry for many years. Additionally, titanium has been added to e-ptfe membranes to strengthen the framework and create enough room for bone filler.(17)among the drawbacks they must be removed via a second surgery, which increases morbidity, and membrane exposure from extrusion frequently prevents healing and regeneration in a significant way. To resolve this problem the development of high-density polytetrafluoroethylene (d-ptfe) has taken place. Since releasing incisions are not required in d-ptfe to seal the flap and has fewer pores and less bacterial infiltration, it can be exposed in the oral cavity for up to four weeks without showing any signs of impairment in healing.(18)

- **Resorbable membrane**: they consist of the acellular dermal matrix (adm), calcium sulphate, synthetic polyglycoside copolymers, and collagen matrix. The benefit of these membranes is that they can be removed surgically without a second treatment. Collagen sponges, like haemocollagene, are often made of type 1 collagen that is not denatured and has been frozen-dried. Within two to three months these materials resorb completely. They are less expensive than bone substitutes and can be found in bullet shapes for simple socket installation. The advantages of collagen that help in clot formation, stabilization, and consequently regeneration include their hemostatic properties, encouraging fibrin linkage, stimulating platelet attachment, attracting fibroblasts, adapting to the bone, and easy to manipulatehuman skin tissue that has undergone numerous washings and freeze-drying processes is known as acellular dermal matrix (adm). It was first created for burn patients. In arp, it has been demonstrated that adm can preserve ridge thickness. By including hydroxyapatite, which has been shown to increase the width of keratinized tissue, one can enhance this effect.(19)

Bone grafts: autografts, allografts, alloplasts, xenografts, and growth factors that either function through osteoinduction or osteoconduction are all types of bone grafts used for socket grafts. Osteoinduction is the

process by which mesenchymal cells that differentiate into osteoblasts stimulate bone formation. Autogenous bone chips most frequently used to facilitate this process. The process of osteoconduction involves the growth of progenitor cells and capillaries both inside and outside the graft material, which acts as a scaffold.

- **Autografts:** autografts are rarely used for arp due to their extremely high morbidity. If the bone is to be used, it must be removed with burs and combined with blood to form an osseous coagulum, or it must be triturated for 60 seconds in an amalgam capsule to generate a bone blend. Scraping tools such as rhodes back-action chisels are frequently used to extract bone(17)
- **Allograft:** demineralized freeze-dried bone (dfdba) and mineralized freeze-dried bone (fdba) are two types of allografts. When compared to dfdba, fdba is resorbed more slowly and functions via osteoconduction. Allografts are collected in various ways and are stored in tissue banks which have several protocols to prevent the transmission of diseases.(20) after arp, there is no difference in alveolar ridge size between dfdba and fdba, but at 4-5 months, dfdba exhibits more vital bone and less residual graft particles.(21) since larger particles limit the amount of space available for vascularization and can also be sequestered, and smaller particles are resorbed by macrophages, it has been suggested that the optimal particle size for these grafts be between 100 and 380 m.(21)
- **Xenografts:** bovine-derived deproteinized grafts (dbbm) are very often used, among which are the brand names bio-oss, hypro-oss, directoss, and cerabonedbbm predominantly uses osseoconduction and resorbs at a 10% annual rate. Due to their wide availability, lack of known transmissible diseases, medical acceptability, and long-lasting advantages, membrane-coated dbbm containing substances are currently recognized as the "gold standard". It has been demonstrated that the bio-oss collagen blend, which consists of ninety percent dbbm and ten percent porcine collagen, acts as a scaffold for the development of new tissue.
- **Alloplasts coupled with growth factors:** examples of such include calcium sulphate, tricalcium phosphate, polylactic acid, bioactive glass polymers, polyglycolic acid, and hydroxyapatite. These inert substances function via osteoconduction. When comparing hydroxyapatite and tricalcium phosphate to dbbm for the measurement of alveolar bone crest levels, the results were comparable. Calcium sulphates produce considerably reduced bone resorption along with more mineralized bone when combined with platelet-rich plasma.(22) sponge made of collagen, polylactic acid, or polyglycolic acid can also be utilized, and they can all be impregnated with different substances. Furthermore, it has been shown that the bio-col method, which involves implanting collagen plugs or membranes after dbbm particles, facilitates the placement of implants.(23) when coupled with hydroxyapatite, cell-binding peptide and bone morphogenic protein, collagen sponges significantly increase augmentation of bone up to 2mm mean width of the ridge.(24) furthermore, these proteins cut in half the possibility that additional grafting would be required at implant insertion sites.

  Resorbable collagen membranes and demineralized bovine bone minerals with 10% porcine type 1 collagen matrix is considered as one of the best biomaterials used for arp in compromised extraction sockets. (12)the use of slow degrading xenograft along with secured collagen membrane might have contributed to the shape and size maintenance in an uncontained extraction socket during the early healing phase. In addition, the fast resorption of the porcine collagen matrix might have played an additional positive role by providing spaces for blood clot and allowing the incorporation of newly formed bone with xenograft particles. Such combination of xenograft, collagen matrix, and secured membrane could have achieved adequate regenerated bone and ridge dimensions, albeit after 6–12 months of healing time, to place implants without further augmentation procedures.

Soft tissue grafting:

When compared to resorbable membranes, autogenous free gingival grafts, and connective tissue grafts offer highly effective projected soft-tissue grafting for maintaining as well as enhancing keratinized soft tissue.(25) however, resorbable membranes have some advantages over soft tissue transplantation, including quicker recovery times, decreased morbidity, and often better color matching with surrounding tissues. Landsberg and bichacho made the initial attempt to use an autogenous soft tissue implant to fill the socket graft in 1994. Later, it was advised to use soft tissue grafts in conjunction with quick implant implantation to improve the morphology of the ridge after teeth were extracted.(26) to support the soft tissue transplant, a collagen sponge can be inserted into the socket. Once the socket has healed for six to eight weeks, implants can be placed there. The use of a free soft-tissue graft to cover the alveolar socket was pioneered to minimize soft tissue shrinkage, enhance the aesthetics of implant restorations, and establish a primary closure that protects the graft from infections and secondary graft failure.(27)

Protocol for alveoloar ridge preservation at compromised extraction sockets:

The arp method is intended for severely compromised extraction sockets. Indeed, extraction sockets with deficient and intact alveolar walls are clinically and biologically distinct. Requirements for bone regeneration include space provision, clot stability, availability of cellular resources (osteoprogenitor cells), and new vessel formation. Thus, an intact extraction socket provides a favorable environment for this process. At a site with one or more deficient alveolar walls, the clot is less protected from mechanical forces, and space provision is compromised. In addition, cellular resources and vascularity are reduced when alveolar walls are missing. It is not surprising, then, that the reduction in alveolar ridge dimensions accompanying tooth extraction is enhanced when socket walls are deficient. Few authors have recommended specific protocols for managing extraction sockets presenting severe alveolar wall deficiencies

Given the lack of evidence in the literature to favor one technique over another, it is challenging to provide a clear protocol. Before surgery, the clinician can be guided as to the most likely anatomy of the socket by evaluating the depth of the periodontal pocket, bone sounding, and radiographs. With all techniques, it's essential to maintain a non-traumatic extraction technique to save the maximum bone possible. By avoiding socket expansion, the possibility of damaging delicate bone walls can be decreased. If granulation tissue is still present after tooth extraction, debridement should be done using a surgical instrument. A full-thickness flap's elevation causes the resorption of thin bone walls, according to several studies. This might happen because the nutrients that are available to the bone are impacted by the buccal bone's blood supply, which depends on the periosteum and is prone to disruption.(28) the graft material can be drenched in blood or saline solution before use to facilitate handling. As moisture accumulates in the socket, this will lessen the capillary action of blood absorption onto the graft and make the material simpler to pack. A membrane can also be used as a replacement. However, it may be difficult to establish primary closure in order to maximize the benefits of using a membrane. To accomplish primary closure, xenograft materials, free soft tissue flaps, or coronally advanced techniques could be used. The patient should receive standard post-operative advice on analgesia and oral hygiene practices. Given the danger of developing antibiotic resistance and other adverse effects, the authors do not support routinely prescribing antibiotics for arp. To reduce bacterial penetration and the danger of wound infection, once the wound is sufficiently stabilized, sutures should be removed.(29)

Novel tissue engineering approaches:

The commonly utilized biomaterials allografts, xenografts, and alloplasts have limitations with regard to the quality of bone development and the ability to maintain alveolar ridge morphology. Some cutting-edge tissue engineering treatments, like gene therapy, growth factor delivery in carriers, and distribution in the form of enlarged cellular constructions, have been created to get around these limitations. Osteoinduction growth factors, such as bone morphogenic proteins (bmps), can initiate the differentiation of host stem cells into cells that produce bone.(30)

In the healing of sockets, tissue repair cells (trc), a patient-specific cell construct generated in automated bioreactors to concentrations not achievable with simple bone marrow aspiration, have been studied more recently. It has been demonstrated that this cell construct may produce large amounts of cytokines while preserving the ability of the cells to produce angiogenic factors and differentiate along both the mesenchymal and endothelial pathways. As early as six weeks after implantation, trc therapy increased the development of highly vascular mature bone as compared to directed bone regeneration. Furthermore, there was less alveolar ridge resorption.(31)

Conclusion:

Arp is an effective way to preserve bone mass so that implants may be delivered more easily. In periodontally compromised extraction sockets it is safe and results in maintenance of ridge dimensions 6 months after extraction and is likely to keep the bone's width and height at or near 2 mm. This article summarizes the many materials and techniques that are accessible. The use of these treatments in everyday practice may not be fully justified by the evidence currently available, hence more studies exploring core biological ideas are needed.(32)

References

1. Lee j, yun j, kimjj, koo kt, seolyj, lee ym. Retrospective study of alveolar ridge preservation compared with no alveolar ridge preservation in periodontally compromised extraction sockets. International journal of implant dentistry 2021 7:1. 2021 mar 26;7(1):1–10.
2. Tan wl, wongtlt, wong mcm, lang np. A systematic review of post-extractional alveolar hard and soft tissue dimensional changes in humans. Clin oral implants res. 2012 feb;23(suppl. 5):1–21.
3. Alqahtani na, alqahtanina. Immediate implant placement with immediate loading in periodontally compromised patients: a literature review … alqahtanina conflicts of interest: none source of support: nil immediate implant placement with immediate loading in periodontally compromised patients: a literature review. Journal of international oral health. 2016;8(5):632–8.
4. Atieh ma, alsabeehanh, payne ag, duncan w, faggion cm, esposito m. Interventions for replacing missing teeth: alveolar ridge preservation techniques for dental implant site development. Cochrane database of systematic reviews. 2015 may 28;2015(5).
5. Consensus statements and recommended clinical procedures regarding the placement of implants in extraction sockets - pubmed [internet]. [cited 2023 oct 25].
6. Srinivas b, das p, rana mm, qureshiaq, vaidya kc, raziuddinsja. Wound healing and bone regeneration in postextraction sockets with and without platelet-rich fibrin. Ann maxillofac surg. 2018 jan 1;8(1):28–34.

7. Bone tissue formation in extraction sockets from sites with advanced periodontal disease: a histomorphometric study in humans - pubmed [internet]. [cited 2023 oct 25].
8. Avila-ortiz g, chambrone l, vignoletti f. Effect of alveolar ridge preservation interventions following tooth extraction: a systematic review and meta-analysis. J clin periodontol. 2019 jun 1;46(s21):195–223.
9. Hämmerlechf, araújo mg, simion m. Evidence-based knowledge on the biology and treatment of extraction sockets. Clin oral implants res. 2012 feb;23(suppl. 5):80–2.
10. Horváth a, mardas n, mezzomo la, needlemanig, donos n. Alveolar ridge preservation. A systematic review. Clinical oral investigations 2012 17:2. 2012 jul 20;17(2):341–63.
11. Mardas n, trullenque-eriksson a, macbeth n, petrie a, donos n. Does ridge preservation following tooth extraction improve implant treatment outcomes: a systematic review: group 4: therapeutic concepts & methods does ridge preservation following tooth extraction improve implant treatment outcomes: a systematic review : group 4: therapeutic concepts & methods mardas et al. Clin oral implants res. 2015 sep 1;26:180–201.
12. Atieh ma, alnaqbi m, abdunabi f, lin l, alsabeehanhm. Alveolar ridge preservation in extraction sockets of periodontally compromised teeth: a systematic review and meta-analysis. Clin oral implants res [internet]. 2022 sep 1 [cited 2023 oct 25];33(9):869–85.
13. Kim jj, amara h ben, chungi, koo kt. Compromised extraction sockets: a new classification and prevalence involving both soft and hard tissue loss. J periodontal implant sci [internet]. 2021 apr [cited 2024 jan 3];51(2):100–13.
14. Tomlin em, nelson sj, rossmann ja. Ridge preservation for implant therapy: a review of the literature. Open dent j. 2014 may 29;8(1):66–76.
15. Melcher ah. Role of the periosteum in repair of wounds of the parietal bone of the rat. Arch oral biol. 1969 sep 1;14(9):1101-in25.
16. Pagni g, pellegrini g, giannobile w v., rasperini g. Postextraction alveolar ridge preservation: biological basis and treatments. Int j dent [internet]. 2012 [cited 2023 jan 20];2012.
17. Kalsi as, kalsijs, bassi s. Alveolar ridge preservation: why, when and how.
18. Hoffmann o, bartee bk, beaumont c, kasaj a, deli g, zafiropoulos gg. Alveolar bone preservation in extraction sockets using non-resorbable dptfe membranes: a retrospective non-randomized study. J periodontol. 2008 aug 1;79(8):1355–69.
19. Luczyszynsm, papalexiou v, novaes ab, grisimfm, souzasls, taba m. Acellular dermal matrix and hydroxyapatite in prevention of ridge deformities after tooth extraction. Implant dent. 2005 jun;14(2):176–84.
20. Ti m, ht t, ak g, malinin t. Bone allografts in dentistry: a review. Bone allografts in dentistry: a review dentistry. 2014;4(2):199.
21. Hoang tn, mealey bl. Histologic comparison of healing after ridge preservation using human demineralized bone matrix putty with one versus two different-sized bone particles. J periodontol. 2012 feb 1;83(2):174–81.
22. Kutkut a, andreana s, kim h ll, monaco jr. E. Extraction socket preservation graft before implant placement with calcium sulfate hemihydrate and platelet-rich plasma: a clinical and histomorphometric study in humans. J periodontol. 2012 apr 1;83(4):401–9.
23. Sclar ag. Preserving alveolar ridge anatomy following tooth removal in conjunction with immediate implant placement. The bio-col technique. Atlas oral maxillofac surg clin north am. 1999;7(2):39–59.
24. Fiorellinijp, howellth, cochran d, malmquist j, lilly lc, spagnoli d, et al. Randomized study evaluating recombinant human bone morphogenetic protein-2 for extraction socket augmentation. J periodontol. 2005 apr 1;76(4):605–13.

25. Thoma ds, sancho-puchades m, ettlin da, hämmerlechf, jung re. Impact of a collagen matrix on early healing, aesthetics and patient morbidity in oral mucosal wounds – a randomized study in humans. J clin periodontol. 2012 feb 1;39(2):157–65.
26. Tal h. Autogenous masticatory mucosal grafts in extraction socket seal procedures: a comparison between sockets grafted with demineralized freeze-dried bone and deproteinized bovine bone mineral. Clin oral implants res. 1999;10(4):289–96.
27. Stimmelmayr m, allen e, reichert t, iglhaut g. Use of a combination epithelized-subepithelial connective tissue graft for closure and soft tissue augmentation of an extraction site following ridge preservation or implant placement: description of a technique. Int j periodontics restorative dent. 2010;
28. Chan hl, lingh, fu jh, wang hl. Alterations in bone quality after socket preservation with grafting materials: a systematic review. Int j oral maxillofac implants. 2013;28(3):710–20.
29. Burkhardt r, lang np. Influence of suturing on wound healing. Periodontol 2000. 2015 jun 1;68(1):270–81.
30. Lynch se. Tissue engineering : applications in oral and maxillofacial surgery and periodontics. 2008;296.
31. Kaigler d, pagni g, park ch, tarlesa, bartelrl, giannobile w v. Angiogenic and osteogenic potential of bone repair cells for craniofacial regeneration.
32. Gupta a, kedigesd, jain k. Amnion and chorion membranes: potential stem cell reservoir with wide applications in periodontics. Int j biomater [internet]. 2015 [cited 2023 jun 20];2015.