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SOCKET PRESERVATION : TECHNIQUE AND MATERIALS

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ABSTRACT

The socket augmentation techniques consist of several important steps: minimal flap reflection, an atraumatic extraction, thorough debridement of the socket, placement of a bone replacement graft, the use of a barrier membrane or membranes, and stabilizing the tissues with sutures. It is important to remember that there is no one perfect technique for the augmentation of extraction sockets at the time of tooth extraction. The type of bone replacement graft used will affect the stability of the graft and the rate of new bone formation. The addition of CaS to the graft materials appears to accelerate the rate of vital bone formation. The only barrier membrane that can be predictably left uncovered with one layer is dense pTFE, but it may result in a healing pattern that may be of concern in esthetic areas. Some collagen membranes can be left exposed but are best used in two layers to prevent premature exposure of the grafted socket. Any resorbable membrane can be covered with a dense pTFE membrane to protect it from early breakdown. By combining the various graft materials for the desired features and using dual membranes, it is possible to augment any extraction socket with a predictable result.

KEYWORDS :

Healing After Extraction

After the extraction of teeth remaining empty socket consists of cortical bone covered by torn PDL with a rim of oral epithelium left at the coronal portion. Extraction sockets is healed by secondary intention and socket is filled with blood that coagulates and seals the socket from the oral environment. Organization of blood clot takes place within 24-48 hrs.

Figure 1 Socket after extraction of teeth

In 1st week clot forms a scaffold upon which inflammatory cells migrate Epithelium at the wound periphery grows over the surface of the organizing clot. Fibroplasia and angiogenesis begins . Osteoclasts accumulate along the alveolar bone crest. It is a setting stage for active crestal resorption.In 2nd week Fibroplasia Continued , Clot continues to organize through fibroplasia and new blood vessels that penetrate the center of the clot. Osteoid deposition begins along alveolar bone lining the socket . In 3rd week Epithelialization starts and Extraction socket is filled with granulation tissue and poorly calcified bone at the wound perimeter. Surface of wound is completely epithelialized and 4th Week onwards Cortical bone continues to be resorbed from the crest and walls of the socket full resorption occurs in 4-6 months. New trabecular bone is laid and epithelium migrates towards the crest and in 4-6 months woven bone is replaced with lamellar bone.

If Patterns of Resorption after Post-Extraction is observed it is found that loss of alveolar ridge is greater in the horizontal dimension as compared to the vertical dimension during a 6-12 month. Period .Most of bone loss occurs in first 3-6 months .There is a greater resorption in the molar region than in anterior region. Height of healed socket never reaches the coronal level of bone attached to the extracted tooth .

Study	Vertical Bone Loss	Horizontal Bone Loss
Schropp et. al	0.7mm (after 12 mo)	6.1mm (2/3 after 3 months)
Lekovik et al	1.5mm (after 6 mo.)	4.5mm (after 6 mo.)
Iasella et al	0.9mm (after 6 mo.)	3.6mm (after 6 mo.)

Crestal portion of buccal bone wall composed mainly of bundle bone (lingual wall composed of both lamellar and bundle bone . There is Resorption of 2.59 mm from buccal side and 2.03 mm on lingual side . (Araujo and Lindhe (2005 . Extraction Sockets in Humans: A Systematic Review) .

Socket Preservation

"Any procedure undertaken at the time of or following an extraction that is designed to minimize external resorption of the ridge and maximize bone formation within the socket"(Darby et al. 2008)

Figure 2 Socket preservation

Goals of Socket Preservation

1. To reduce loss of alveolar bonevolume
2. To enable installation and stability of a dental implant
3. To reduce need for additional bone grafting procedures
4. To improve the esthetic outcome of the final prosthesis
5. To regenerate bone faster allowing earlier implantation and restoration
6. To enable the generated tissues to provide implant osseointegration

Socket Preservation Principles and Techniques

1. Minimally atraumatic tooth extraction with or without debridement/decortication of the socket
2. Guided bone regeneration with bone grafts

3. Membranes
4. Other space fillers
5. Implants as ridge preservers

1. Minimally atraumatic tooth extraction with or without debridement/decortication of the socket

Application of appropriate instruments with minimal force to limit damage to hard/soft tissue. The atraumatic extraction technique is a crucial component of the ridge preservation process. By following this technique, the quantity and quality of bone will be preserved, along with the gingival architecture. This will ultimately lead to more predictable implant positioning and placement. By adhering to the basic principles of atraumatic extractions and the use of atraumatic extraction kit rather or the use of periotome imore predictable healing pattern may be obtained, as the vitality of the periodontal ligament and the surrounding blood supply is maintained.

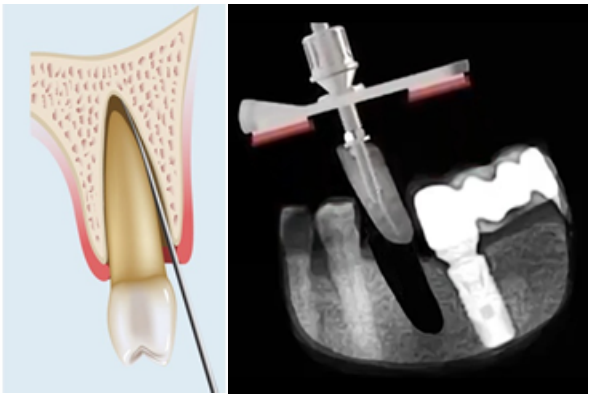


Figure 2 Atraumatic extraction with Periotome and with atraumatic extraction kit

2. Guided bone regeneration with bone grafts

The bone grafting material performs the important functions of assisting the barrier membrane in holding space and providing a biocompatible matrix for bone formation. The materials that have been used are primarily osseoconductive, providing a scaffold for bone formation. One material, demineralized freeze-dried bone allograft (DFDBA), is also somewhat osseoinductive, interacting with host cells to induce bone formation. The materials commonly used are autogenous bone, anorganic bovine bone, freeze-dried bone allograft, and beta tricalcium phosphate (bTCP), which all are osseoconductive, as well as DFDBA, which is osseoinductive.

It is important to remember that all of these materials actually slow the rate of new bone formation, but the clinician is trading volume of bone for new vital bone.Studies have reported 5% to 35% residual graft materials and 30% to 60% vital bone at varying time intervals.14-16 Iasella and associates reported 58% new vital bone in untreated extraction sockets at 4 months.

The addition of surgical-grade calcium sulfate (CaS) to autogenous grafts or to grafts of DFDBA has shown increased angiogenesis and more rapid formation of vital bone.18-20 Vance and colleagues compared a putty DFDBA plus calcium sulfate with carboxymethylcellulose to anorganic bovine hydroxyapatite (ABH) and a membrane in extraction sockets. At 4 months they reported equivalent volumes, but the CaS and DFDBA combination demonstrated 61% vital bone compared to 26% vital bone for the ABH.21 This is consistent with the findings of Guarnieri and colleagues, who reported 58.6% vital bone in extraction sockets after grafting with medical-grade calcium sulfate. Therefore, the addition of CaS to grafts (particularly DFDBA) may result in the acceleration of new vital bone formation and healing that is similar to an ungrafted socket but with increased ridge volume.

The various grafting materials can be combined to change the characteristics of the bone replacement graft. If DFDBA plus CaS is used as the basic graft, it can be made more substantial for badly damaged sockets by the addition of ABH or bTCP (BioOs, Geistlich Biomaterials; Cerasorb, Curason, Research Triangle Park, NC). For those patients who do not want a bone replacement graft from human or animal sources, bTCP is a suitable alternative that has been reported to be 60% to 70% resorbed at 6 months.

3. Membranes

The first barrier membrane used for extraction socket augmentation was expanded polytetrafluoroethylene (pTFE), which required primary closure and a second surgical procedure.This technique is still used for large augmentations of deficient edentulous ridges. The key characteristics of an ideal barrier membrane are biocompatibility, suitable occlusive (barrier) qualities, and durability upon exposure. A membrane that can be exposed eliminates the need for primary closure.11 There are numerous barrier membranes available today for a variety of guided tissue techniques. The two that have the best characteristics for extraction socket augmentation are dense pTFE and porcine collagen.

Porcine collagen membranes (Bio-Gide®, Geistlich Biomaterials, Zurich, Switzerland) have an excellent combination of characteristics. The membrane is biocompatible, resorbable, it is easy to use, it has suitable occlusive qualities, and it can be left exposed on relatively small spaces. The weakness of the membrane is a lack of rigidity, requiring support from a bone replacement graft, and one layer of the membrane may not withstand wide exposures. Therefore, two layers of the membrane should be used in the exposed area. The biocompatibility of this membrane makes it an excellent choice for use in esthetic areas where preservation of the gingival tissues is critical.

Dense pTFE is also a useful barrier membrane for extraction socket augmentations. It does not require primary closure, it has excellent occlusive qualities, and it is easy to use. The primary weakness of the membrane is that it must be removed at 4 to 5 weeks, and the placement position is critical to avoid a superficial soft tissue defect and/or a loss of papillae height. Therefore, this can be the barrier membrane of choice in the posterior where papillae height is not as critical .

In badly damaged sockets, a combination of membranes can be used. For extraction sockets with complete loss of the buccal plate, a stiffer collagen membrane, such as BioMend® Extend (Zimmer Dental, Carlsbad, CA), can be placed on the buccal to assist with space maintenance, and a more flexible and exposure-resistant collagen membrane (Bio-Gide) can be placed over the socket . Dense pTFE can be used to protect any resorbable membrane from premature breakdown.

Membrane category	Advantages	Disadvantages	Commercial examples
Nonresorbable	• Numerous studies demonstrate their success • May be titanium reinforced • Remain intact until removal • Easily attached with titanium or resorbable tacks • Greater bone fill if membrane not exposed • Minimal tissue response if membrane not exposed	• Require a second surgery for removal • Increase patient morbidity • If exposed, must be removed • Can be technique sensitive	• ePTFE membranes, e.g., Gore-Tex (Gore Medical, Flagstaff, Ariz.) • Titanium-reinforced Gore-Tex
Resorbable	• Numerous studies demonstrate their success • Does not require surgical removal • Decreased patient morbidity • Improved soft-tissue healing • Tissue-friendly reaction to membrane exposure • Cost effective; one surgery only • Does not have to be removed if exposed	• Uncertain duration of barrier membrane function • Difficult to tack down • Slightly less bone fill than nonresorbable membranes • Inflammatory response from tissues may interfere with healing and GBR • Can be technique sensitive	• Neomem (bovine collagen matrix; Citagenix Inc., Laval, Que.) • Bio-Gide (porcine collagen matrix; Geistlich AG, Wolhusen, Switzerland) • Ossix (cross-linked collagen barrier; Implant Innovations Inc., Palm Beach Gardens, Fla.)

4. Other Space Fillers

Sponges made of collagenor polyactic/polyglycolic acid can be used

5. Implants as Ridge Preservers

Clementini et al 2015: Systematic review/meta analysis on dimensional changes after immediate implant placement with/without simultaneous regenerative procedures Concluded that no conclusive evidence regarding efficacy of concomitant regenerative technique on preventing alveolar reduction.

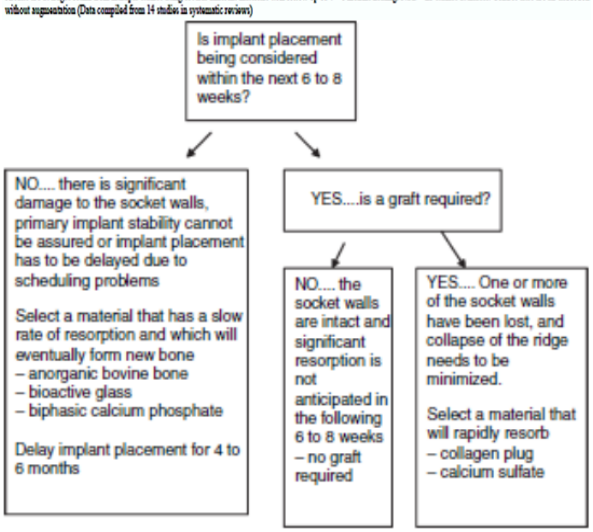
Van Kersteren et al. 2011.did RCT to compare the efficacy of immediate implant with ridge preservation with delayed implant. Immediate implant sites received bone graft for defects >2mm. and concluded that no difference in between both groups, but greater decreases in width observed in site lacking bone graft.

Systematic Reviews: Treatment Modalities and Expected Dimensional Changes

Table 1. Treatment modalities and expected dimensional changes.

	Control Sites (No Treatment)	Bone Graft Only	Membrane Only	Combined Bone Graft + Membrane
Horizontal bone changes	-2.51 mm Range: 0.16 – 4.5 mm (loss)	-1.18 mm Range: 0.75 – 2.0 mm (loss)	-0.08 mm Range: 0.1 (loss) – 2.90 mm (gain)	+0.47 mm (gain) Range: 3.48 (loss) – 3.27 mm (gain)
Vertical bone changes	-2.07 mm Range: 0.8 – 5.24 mm (loss)	-1.31 mm Range: 0.48 – 2.48 mm (loss)	+0.14 mm (gain) Range: 0.38 (loss) – 1.30 mm (gain)	-0.15 mm Range: 0.02 (loss) – 1.3 mm (gain)
Percentage of vital bone	42.4% Range: 25.7 – 54.0%	46.2% Range: 32.4 – 59.5%	N.A.	31.7% Range: 28 – 35.5%

Results are averages found from multiple studies using several different materials with follow-up of 4 – 6 months healing. N.A. = no studies available. Control sites are all extraction without augmentation (Data compiled from 14 studies in systematic reviews)



Proposed Treatment Algorithm

Subsequent to extraction of a tooth, the alveolus loses both bone volume and height within first 6 months (horizontal > vertical, buccal > palatal) . Research demonstrates that socket grafting can preserve the structural integrity and volume of the alveolar ridge by slowing the resorption process.

An ideal graft material/technique should be one that is easy to use, minimally invasive, leave no residual foreign body particles with 100% turnover to native bone, involve no "floppy" membranes likely to collapse into the socket . No material or technique fully meets these criteria.

Potential benefits of the different materials and techniques used for socket preservation are still debatable . No correlation that socket grafting materials improves or increases the longevity of implant placement, bone quality studies are not well documented (bone grafted vs natural healing) . Apical third of implants usually placed in native bone . Bone quality, quantity, and composition are important factors that influence implant longevity . Understanding of the physical and biological properties of the materials will guide treatment planning in each patient specific case . There is a need to understand graft composition and turnover rate . There is a need to establish the restoration as the end goal in mind.

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