

Socket Preservation Procedure after Tooth Extraction

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Abstract

Various materials are used in modern dental and maxillofacial surgery for bone tissue substitution and reconstruction. All osteoplastic materials can be divided into four groups by origin: autogenic, allogenic, xenogenic and synthetic.

Synthetic resorbable materials were intended as an inexpensive substitute for natural bone. Synthetic graft materials include various types of ceramics: tricalcium phosphate; bioglass; hydroxyapatite and its compositions with collagen, sulphated glycosaminoglycans such as keratan and chondroitin sulphates well as with sulphate and calcium phosphate.

Jaw deformities from tooth removal can be prevented and repaired by a procedure called *socket preservation*. The procedure begins with atraumatic tooth extraction. Every attempt is made to preserve the surrounding bone and soft tissue, with an emphasis on being careful not to fracture the delicate buccal plate. There are a number of techniques and instruments that aid in this process. In general, one never wants to elevate so that force is directed toward the buccal plate. It is important that good bleeding is established in the socket. Next, a bone graft material is placed into the socket and covered with a resorbable or non-resorbable membrane and sutured. Most importantly, socket preservation helps to maintain the alveolar architecture and significantly reduces the loss of ridge width and height following tooth removal.

Introduction

The indications for teeth extractions are different. Sometimes it is necessary because of pain, infection, bone loss or fracture of the tooth. The bone that holds the tooth in place (the socket) is often damaged by disease and/or infection resulting in deformity of the jaw after the tooth is extracted. In addition, when teeth are extracted, the surrounding bone and gums can shrink and recede very quickly after the extraction resulting in unsightly defects and collapse of the lips, and cheeks. The loss of alveolar bone may be attributed to a variety of factors, such as endodontic pathology, periodontitis, facial trauma and aggressive manoeuvres during extractions. These jaw defects can create major problems in performing restorative dentistry whether the treatment involves dental implants, bridges or dentures [1].

Jaw deformities from tooth removal can be prevented and repaired by a procedure called *socket preservation*. Socket preservation can greatly improve the smile's appearance and increase the chances for successful dental implants for years to come. Several studies, clinical case series and literature reviews in peer-reviewed journals were examined in detail to establish a rationale for using socket preservation as a therapeutic option following tooth extraction. This review describes the socket preservation, and the various techniques and materials used for extraction site grafting. In the current review of the literature, techniques for alveolar ridge preservation are discussed [2].

Biological mechanism of bone grafting [3] are based on:

- **Osteoconduction** when the bone graft material serves as a scaffold for new bone growth that is perpetuated by the native bone.
- **Osteoinduction** - involves the stimulation of osteoprogenitor cells to differentiate into osteoblasts that then begin new bone formation. The most widely studied type of osteoinductive cell mediators are bone morphogenetic proteins (BMPs).

- **Osteogenesis** - occurs when vital osteoblasts originating from the bone graft material contribute to new bone growth along with bone growth generated via the other two mechanisms.
- **Osteopromotion** - involves the enhancement of osteoinduction without the possession of osteoinductive properties. For example, enamel matrix derivative has been shown to enhance the osteoinductive effect of demineralized freeze dried bone allograft (DFDBA), but will not stimulate de novo bone growth alone.

Consequences of tooth and jaw bone loss

The importance of teeth for jaw bone health is extensively exploited in the contemporary scientific literature. When one or more teeth are missing, it can lead to jawbone loss at the site of the gap. This loss of jawbone can develop into additional problems, both with the patient's appearance and overall health. Natural teeth are embedded in the jawbone, and stimulate the jawbone through activities such as chewing and biting [2].

When teeth are missing, the alveolar bone, or the portion of the jawbone that anchors the teeth in the mouth, no longer receives the necessary stimulation, and begins to breakdown, or resorb. The body no longer uses or "needs" the jawbone, so it deteriorates [4].

Without intervention (natural healing), the results of all nine studies showed a significant loss of ridge width (-2.6 to -4.6 mm), and the results of five studies showed a statistically significant loss of bony ridge height (-0.55 to -3.3 mm). No significant reduction in ridge height from baseline was found with certain socket preservation interventions.

There are several reasons to consider preservation of the alveolar socket immediately following tooth extraction [4, 5]:

- One reason for placing a graft of a synthetic biomaterial is to stabilize the coagulum within the socket and avoid possible reduction of the hard tissue volume required for bone regeneration. Although vertical bone resorption can be expected as part of the physiologic pattern of bone healing after tooth extraction, in most of the cases no reduction in the vertical dimension of the alveolar ridge had occurred 9 months after tooth extraction. The ridge width (12 mm) did not change either. More studies involving larger samples, better sample standardization, more defined measurements, masking and esthetic restorative outcomes are needed.
- Another reason for placing a graft into an extraction socket is to provide a scaffold for the in-growth of cellular and vascular components to form new bone of acceptable quality and quantity.

Alveolar ridge resorption has long been considered an unavoidable consequence of tooth extraction. Atrophy of the alveolar bone may cause significant esthetical and surgical problems in implantation, as well as at prosthetic and restorative dentistry [1].

The potential consequences of tooth and jawbone loss are several: problems with remaining teeth, including misalignment, drifting, loosening and loss; collapsed facial profile, limited lip support; skin wrinkling around the mouth, distortion of other facial features; difficulty speaking and communicating; inadequate nutrition as a result of the inability to chew properly and painlessly, sinus expansion [6].

Socket preservation is an indispensable procedure, the all-important as well as fundamental is to prevent bone loss following tooth extraction. Preservation as the name has it is the maintenance of the socket, which is essentially the height and width of the gap that is left after the tooth is removed. It is done by placing a graft material or scaffold immediately into the socket of an extracted tooth to preserve bone height, width and density. [6].

After tooth extraction, the residual alveolar ridge generally provides limited bone volume because of ongoing, progressive bone resorption. Healing events within postextraction sockets reduce the dimensions of the socket over time. A reduction of about 50% in both horizontal and vertical directions has been observed over 12 months, with two-thirds of the reduction occurring in the first three months. The rate and pattern of bone resorption may be altered if pathologic and traumatic processes have damaged one or more of the bony walls of the socket. In these circumstances, fibrous tissue will likely occupy part of the socket, preventing normal healing and osseous regeneration. These morphologic changes may affect the successful placement and osseointegration of dental implants [4].

In a review of ridge preservation therapies after tooth extraction (inclusive of molars), Vignoletti et al [7] found significantly less vertical and horizontal ridge contraction. Van der Weijden et al [8] reported an average reduction in ridge width of 3.87 mm. Tan et al [9] in their research included 3954 titles and 238 abstracts. Full text analysis was performed for 104 articles resulting in 20 studies that met the inclusion criteria. The studies showed horizontal bone loss of 29-63% and vertical bone loss of 11-22% after 6 months following tooth extraction.

Several recent studies have examined resorption patterns following single-tooth extraction. Using subtraction radiography, Schropp et al [10] assessed, in a 12-month prospective study, bone formation in the alveolus and changes in the contour of the alveolar process following single-tooth extraction. The width of the alveolar ridge decreased 50% (from 12 mm to 5.9 mm, on average), and two-thirds of the reduction occurred within the first 3 months. The percentage reduction was somewhat larger in the molar compared with the premolar region. Changes in bone height, however, were only slight (less than 1 mm). The level of bone regenerated in the extraction socket never reached the coronal level of bone attached to the tooth surfaces distal and mesial to the extraction site. The bone surface becomes “curved” apically. Lekovic et al [11] evaluated the clinical effectiveness of a bioabsorbable membrane in preserving alveolar ridges following single-tooth extraction in a split-mouth prospective study. At the 6-month re-entry appointment, they found an average loss of alveolar height and width of 1.50 mm and 4.56 mm, respectively, in the healed sockets.

Materials for bone tissue substitutions

Various materials are used in modern dental and maxillofacial surgery for bone tissue substitution and reconstruction. All osteoplastic materials can be divided into four groups by origin: autogenic (the donor is the patient), allogenic (the donor is another person), xenogenic (the donor is an animal) and synthetic (on the basis of calcium salts). Successes achieved in the development of xenogenic and synthetic biomaterials, which possess osteoconductive and osteoinductive properties, allow a decrease in the use of auto- and allotransplantation methods that possess a certain number of disadvantages [12]. The demand for an ideal nonautogenous bone grafting material is increasing due to its unlimited supply, easy storage, and sterility [13].

Synthetic bone replacements (alloplasts) are *osteoconductive* - that is, they provide a scaffold for bone deposition—as opposed to *osteoinductive* materials such as autografts, which may include growth factors necessary for osteogenesis. Commercially available synthetic bone replacements have been made of hydroxyapatite, tricalcium phosphate, calcium sulfate, and combinations of these minerals, and fabrication techniques, crystal configurations, pore dimensions, mechanical properties, and resorption rates vary [3, 14, 15].

There are a variety of bone augmentation techniques presented by Byrne [16] using one or more of the following:

- bone fillers: bioactive glass with calcium sulfate (BG/CS), freeze dried bone allograft (FDBA), magnesium-enriched hydroxyapatite, organic cancellous porcine bone xenograft (CPB), calcium sulfate (CS);
- collagen sponges: bioabsorbable polylactide-polyglycolide acid sponge (BAS), absorbable collagen sponge;
- recombinant human bone morphogenetic protein-2 growth factor;
- membranes: nonabsorbable expanded tetrafluoroethylene membrane (NAM) and bioabsorbable membrane made from glycolide and lactide polymers (BAM).

Synthetic resorbable materials were intended as an inexpensive substitute for natural bone. Synthetic graft materials include various types of ceramics: tricalcium phosphate; bioglass; hydroxyapatite and its compositions with collagen, sulphated glycosaminoglycans such as keratan and chondroitin sulphate as well as with sulphate and calcium phosphate. Now, many various forms of porous nanostructured calcium phosphate ceramics, bone cements, biohybrids and biocomposite compounds have been created [17, 16].

Techniques to preserve the bone after tooth extraction

Several techniques can be used to preserve the bone and minimize bone loss after the tooth extraction. Immediate alveolar ridge prophylaxis after tooth extraction includes preservation of the alveolar process [18] by:

- Retention of endodontically treated roots (physiologically most accepted),
- Guided bone regeneration
- Immediate implant placement
- Use of root analogues.

In one common method, the tooth is removed and the socket is filled with bone or bone substitute. It is then covered with gum, artificial membrane, or tissue stimulating proteins to encourage the body's natural ability to repair the socket. With this method, the socket heals eliminating shrinkage and collapse of surrounding gum and facial tissues. The newly formed bone in the socket also provides a foundation for an implant to replace the tooth [2]. Tan et al [9] reported interventions that involve autografts, allografts, xenografts, guided bone regeneration (GBR) and growth factors which are used with varying degrees of success in an effort to maintain the anatomical dimensions of the alveolus before implantation.

Buser et al [17] suggested a strategy of immediate implant placement into an extraction socket and simultaneous GBR. Guided bone-regeneration techniques and the use of bone-replacement materials have been shown to enhance socket healing and potentially modify the resorption process. There are various recommendations regarding timing of implant placement after tooth extraction. The implant can be placed: immediately following the extraction during the same surgical procedure (immediate implant placement); following a delay of 2-6 weeks (late implant placement); or following a delay of 3-6 months (delayed implant placement). Today, the combination of anatomically oriented implant designs, new biomaterials such as zirconia ceramics, and surface technologies has resulted in dental implants that are specially designed to replace each individual tooth [19].

The use of root analogues as preimplant therapy can provide adequate quantity of bone and soft tissue for implant placement. Many authors showed that different bone substitute materials had been used as root analogues, some of them being: dense hydroxyapatite [20], polyglycolic acid [21], polylactic acid [22], bioabsorbable polylactic polyglycolic acid (PLGA) [23, 24], deproteinized bovine bone mineral integrated in a 10% collagen matrix [25], β -tricalcium phosphate (β -TCP) combined with type I collagen and β -TCP/PLGA [26] and β -TCP coated with PLGA root analogue [18].

The development of new medical technologies enables use of achievements in material science, biochemistry, molecular biology and genetic engineering while creating new combined synthetic materials for bone grafting (osteoplasty). Modification of their bulk structure, which brings their structure closer to natural bone tissue, including cytokines-growth factors and morphogens-into their composition enables to provide synthetic materials with not only osteoconductive but also osteoinductive properties. This also enables control of the speed of biodegradation, bringing it closer to the kinetics of osteogenesis [12].

Conclusion

Socket preservation is important for achieving optimum esthetics with implant restorations. Reviews generally reported improved alveolar height and width for socket preservation interventions compared with sockets that healed naturally. The data, however, were limited, and clinical significance could not be inferred. Good bone level alone does not imply improved esthetics. But, inconclusive evidence shows that although socket preservation interventions may aid in reducing the bony dimensional changes after tooth extraction, they do not prevent ridge resorption. Most importantly, socket preservation helps to maintain the alveolar architecture. Socket preservation significantly reduces the loss of ridge width and height following tooth removal.

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