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Autogenous Tooth Bone Graft-A Review

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Abstract

Tooth-derived bone graft material, which is proved to be rich in bone growth factors and bone morphogenic proteins (BMPs), have been becoming a practical substitute to bone grafting. It can also be used as a carrier for growth factors and stem cells as reported in many recent studies. Autogenous-tooth bone grafting technique is significant as this biomaterial has excellent bone regeneration capacity and also relatively non-existent chances of antigenicity, genetic diseases and disease transmission. In this article, a broad overview of the published findings with regard to the properties and uses of tooth-derived regenerative bone grafting is discussed.

Keywords: Autogenous Bone Graft, Biomaterial, Osteoconduction, Osteoinduction

Introduction

The postextraction bone loss is a physiological phenomenon which will take place with alveolar resorption and the subsequent formation of bone within the socket follows osteoblastic differentiation of osteoprogenitor cells.[1] Bone resorption will cause loss of the socket width that hampers the native alveolar ridge contour.[2] Hence, maintaining alveolar bone volume is prerequisite for ideal functional restorations and esthetics.

Bone substitutes are used, frequently to reconstruct bony defects. There are four categories of bone graft materials as follows: autograft, allograft, alloplast, and xenograft. With four available types of graft materials, the use depends on clinical applications, the volume of deficiencies, and evidence-based studies.[3] Above all, autografts are known to be the gold standard due to its osteoinductivity, osteoconductivity, and osteogenecity.[4]

The first clinical case was a sinus lifting using auto-dentin for bone augmentation (Murata, 2003). Dentin is acellular matrix, while bone include osteocytes. Very interestingly, biochemical components in dentin and bone are almost simillar. They consist of body fluid (10%), collagen (18%), non-collagenous proteins (NCPs: 2%) and hydroxyapatite (HAp: 70%) in weight volume (Fig. 1). Demineralized dentin matrix (DDM) and demineralized bone matrix (DBM) are mainly type I collagen with growth factors such as bone morphogenetic proteins (BMPs) (Urist, 1965) and fibroblast growth factors (FGFs) (Butler et al.,1977; Murata et al, 2010a,b).

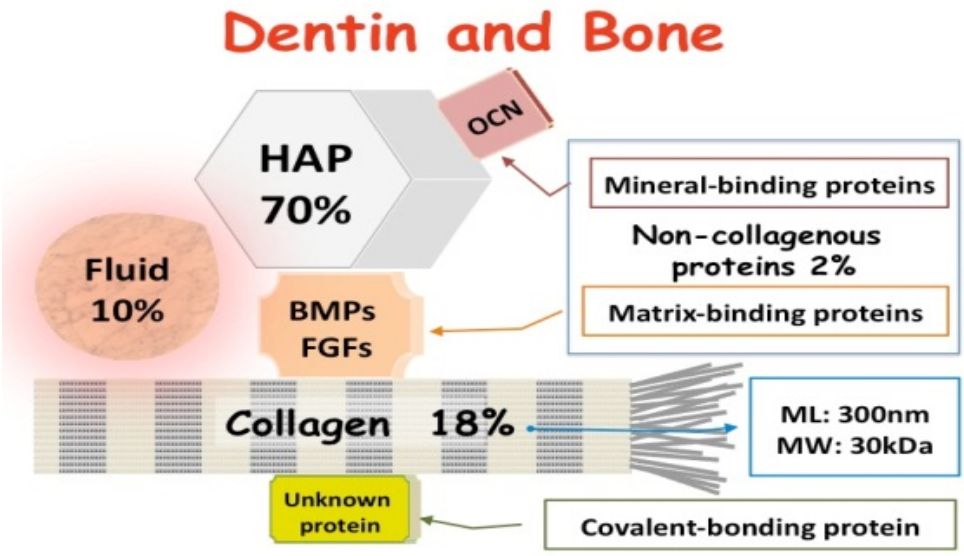

Figure 1: Chemical components (w/v%) of human dentin and bone;

With advancements in tissue engineering and reconstructive dentistry; researchers choose autogenous tooth bone graft which allows both formations of new bone and is steadily observed to be replaced by bone without compromising on the bone–regeneration capacity.[5]

Procedure

From Extracted Tooth to Autogenous Particulate Dentin

1. Mechanical cleaning of the tooth/root surface

Teeth without root canal fillings, which have been extracted due to advanced periodontal bone loss or other reasons, such as wisdom teeth extraction or orthodontic indications, can be prepared for immediate grafting.

Immediately after extraction, restorations like crowns and fillings should be cut off or removed. Carious lesions and dis-colored dentin, or remnants of periodontal ligament (PDL) and calculus should be reduced by tungsten bur. The high-speed tungsten carbide burs are most efficient for this process. The roots could be split in case of multi-rooted teeth.

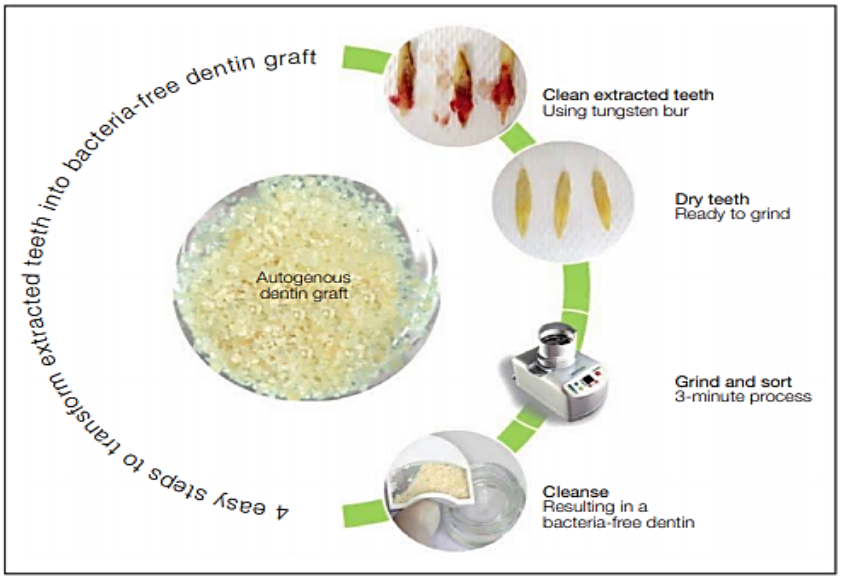

Figure 2: The SDG procedure takes less than 15 minutes to process the extracted tooth into a bioactive autogenous dentin particulate graft ready for immediate grafting into extraction sockets or bone defects. The four steps include extraction, cleaning, grinding and sorting, and cleansing.

2. Drying the clean tooth

Clean teeth, including crown and root dentin, are dried by air syringe and put into the grinding sterile chamber of the newly designed Smart Dentin Grinder).

3. Particulating the tooth

The SDG can grind the roots in 3 seconds and then uses the vibrating movement of the grinding chamber to sieve any particles smaller than 1,200µm into a lower chamber that collects particles between 300µm and 1,200µm Particles smaller than 300µm fall into a waste drawer, as this fine particulate is not considered to be an efficient size for bone grafting. This grinding and sorting protocol is repeated to grind the remaining teeth particles left in the grinding chamber, still collecting particles between 300µm and 1,200µm.

The particulate dentin from the drawer is immersed in basic alcohol for 10 minutes, in a small sterile glass container. The basic alcohol cleanser consists of 0.5M of NaOH and 30% alcohol (v/v) for defatting, dissolving all organic debris, bacteria, and toxins of the dentin particulate.

The efficiency of the cleanser to dissolve all the organic debris from dentin particulate, including dentin tubules. The scanning electron microscope (SEM) picture shows open and clean tubules after 10 minutes of cleanser treatment (Figure 1). After decanting the basic alcohol cleanser, the particulate is washed twice in sterile phosphate-buffered saline (PBS).

The PBS is decanted, leaving wet particulate dentin ready to graft into freshly extracted sockets, alveolar bone defects, or in procedures involving augmenting the maxillary sinus.

The process from tooth extraction until grafting takes approximately 15-20 minutes.

It should be noted that the efficiency of selecting the dentin particulate of specific size for grafting is more than 95%. It is also obvious that the volume of the particulate dentin is more than twice of the original root volume. Alternatively, the

wet particulate can be put on a hot plate (140ºC) for 5 minutes to produce dry, bacteria-free particulate autologous dentin that can serve for immediate or future grafting procedures.

4. Discarding the Grinding Chamber

It is important to adequately discard the Grinding Chamber as biohazard waste. It cannot be used again for safety reasons on another patient

Graft Characteristics

Nevertheless, non-autogenous source of bone grafting materials also is present with some shortcomings. Allografts are deemed expensive; may pose risks of infection since the donor's information provided is restricted or sometimes inadequate [5,10]. In addition to similar drawbacks to allografts, xenografts could also be a source of zoonotic disease transmission [5]. The use of xenograft has raised some ethical and religious concerns, since the use of animal derived products should be considered before use with patients consent for various religions and individuals [11,12]. While synthetic or alloplastic materials lacks in property of osteogenesis and osteoinduction [5,10]. The limitations of non-autogenous source of bone, lead to finding a novel source of autogenous bone graft that is processed from human tooth. The aim of this article is to review some previous published article and summarize the resemblance between bone and tooth with the discussion of the recent use of tooth derived bone graft. The keys of tooth usage as bone graft material is its similarity to the human bone and the utilization of this autogenous source have been attempted by many researchers across the world. Keywords used to search for all related articles were tooth derived bone grafts in dentistry and tooth derived bone grafts used in humans or animals, preparation technique and viable particle sizes for bone grafting

Using the graft

Once the cleansing is completed, the graft is ready to be immediately utilized. The resulting dentin particulate graft has a sticky consistency with ideal handling properties. At this point, the clinician may use the dentin graft similarly to other bone grafting materials such as allografts for alveolar bone augmentation procedures. Because the graft is entirely derived from autogenous sources, it will undergo ankylosis fairly rapidly and exhibit a high degree of stability once implanted within the surgical site.

Clinical cases

Tooth extraction is routine daily practice for the majority of clinicians, oral surgeons, and periodontists. It is essential to stress that the patient's tooth is an excellent hard tissue source that may be utilized to generate natural bone that will functionally produce biologic connectivity with host tissues. One-third of teeth are extracted due to advanced bone loss caused by periodontal diseases. Most of these teeth are without any prosthetic or endodontic treatment, and therefore their use is optimal. Even teeth previously treated with either a root canal or prosthetic reconstruction can be used; they simply require more processing time. It should also be noted that approximately 10% of extracted teeth are third molars. After the extraction of impacted third molars, usually a signicant defect of the alveolar bone develops. Furthermore, when the impacted third molar is located close to a second molar, a bone augmentation procedure may be utilized to prevent potential defects next to the distal portion of second molar roots. The following cases illustrate use of the Smart Dentin Grinder and the SDG procedure.

The Use of Autogenous Dentin Particulate Graft for Alveolar Ridge Preservation and Augmentation Following Tooth Extraction.

Case 1: The mandibular left second premolar was extracted due to bone loss and deep caries with a very poor prognosis. The tooth was extracted and placed in the Smart Dentin Grinder (Fig 3-a). The particulate graft was then cleansed and loaded into the extraction socket (Figs 3-b and 3-c). A membrane was utilized to prevent soft tissue inltration and to keep the volume of the grafted dentin intact. After 6 weeks of healing, the ridge was preserved in optimal width and height (Fig 3-d), and an implant was inserted (Figs 3-e and 3-f). This case represents the standard protocol utilized on thousands of patients using dentin particulate as a grafting material to preserve the alveolar ridge. Typically, implants can be placed 6 to 8 weeks postextraction. This is less than half of the healing time for other known grafting materials because no foreign body reaction is produced and bone formation begins at earlier time points. (Case performed by Dr Robert Horowitz.)

Case 2: Autogenous dentin was utilized in this case to regenerate alveolar bone next to an exposed root surface. The radiograph and clinical image demonstrate progressive bone loss of the mandibular left first and second molars (Figs 4-a and 4-b). The second molar was extracted, its roots were cleaned and particulate graft was prepared using the Smart Dentin Grinder. The particulate dentin was then utilized to ll the extraction socket and grafted against the distal exposed roots of the rst molar. After 6 weeks, the bone level of that tooth was improved. This case illustrates that even in a complicated periodontal defect situation, the graft served to regenerate bone. It is important to note that this same protocol is frequently utilized when third molars are located in close proximity to second molars.

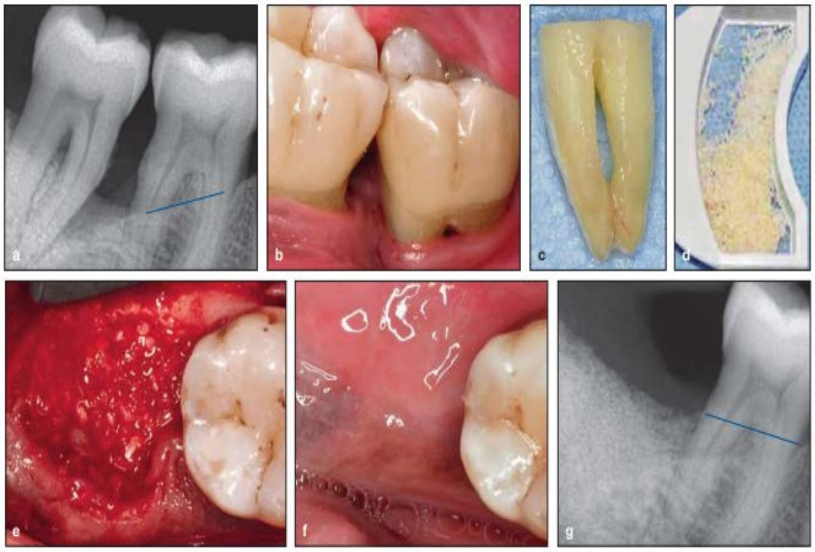

Figure 3: (a) Radiograph demonstrating progressive bone loss of the mandibular left first and second molars, which are periodontally involved. (b) Clinical view of the intrabony defects and exposure of the furcation. (c) The second molar was extracted, and the roots were cleaned. (d) Particulate was prepared using the Smart Dentin Grinder. (e) The particulate dentin was utilized in the extraction socket and grafted against the distal exposed roots of the rst molar. Observe the blood that adsorbed onto the dentin particulate graft. (f) Six weeks postextraction, a clinical site next to the rst molar shows healthy mucosa. (g) Three months after surgery, the dentin graft is stable within the extraction socket and there is better periodontal support around the First molar. (Case performed by Dr Justin Cifuni.)

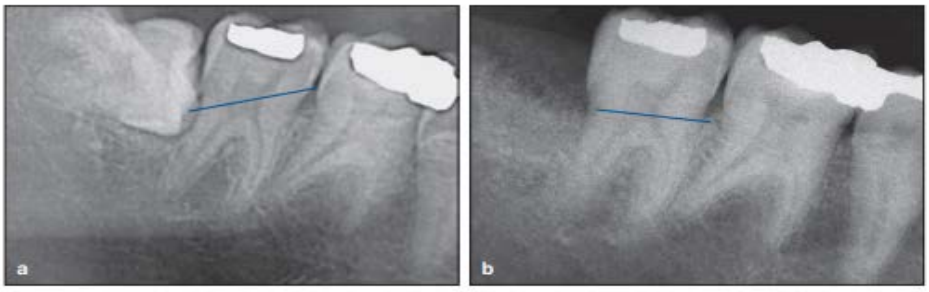

Figure 4: (a) Radiograph demonstrating a third molar in close proximity to the distal roots of a second molar. The third molar was extracted, and the SDG procedure was used to graft the extraction site. (b) Radiograph of the alveolar bone and regained bone tissues distal to the second molar 3 months after surgery. (Case performed by Dr Nardi Casap-Caspi.)

Case 3: A young adult accidently broke his maxillary right first premolar longitudinally. The split root of the tooth was extracted, cleaned, ground, sorted, cleansed, and immediately grafted into the extraction site (Figs 5 a and b). Two months later, an implant was inserted and a provisional crown adjusted (Fig 5c). Observe the height of bone achieved by grafting with the patient's tooth particulate dentin.

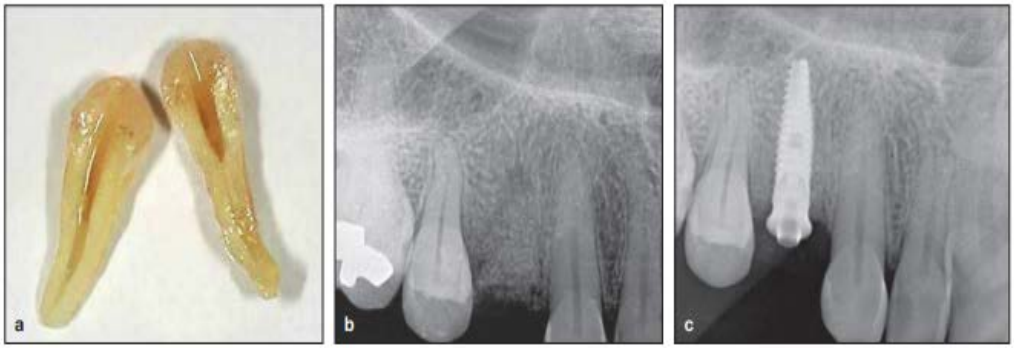

Figure 5: (a) The split root of the maxillary right first premolar was extracted and cleaned. It was ground, sorted, cleansed, and immediately grafted into the extraction site. (b) Radiograph 2 months later demonstrating bone ll within the extraction socket. (c) An implant was inserted. Observe the height of bone achieved by grafting with the patient's tooth particulate dentin. (Case performed by Dr Gideon Hallel.)

Case 4: A patient presented with an esthetic defect at the site of the previously extracted maxillary left rst premolar. The ridge was narrow, and there was loss in bone height from the alveolar crest (Fig 4a). The maxillary left third molar was extracted, and particulate dentin was prepared accordingly. The buccal and occlusal alveolar ridge was exposed, and the dentin particulate graft was placed to restore the defect (Fig. 4b to 4d). Three months later, the ankylosed bone to dentin created a restored alveolar ridge with adequate width and bone height (Fig. 5e). The results demonstrate an adequate esthetic and functional appearance.

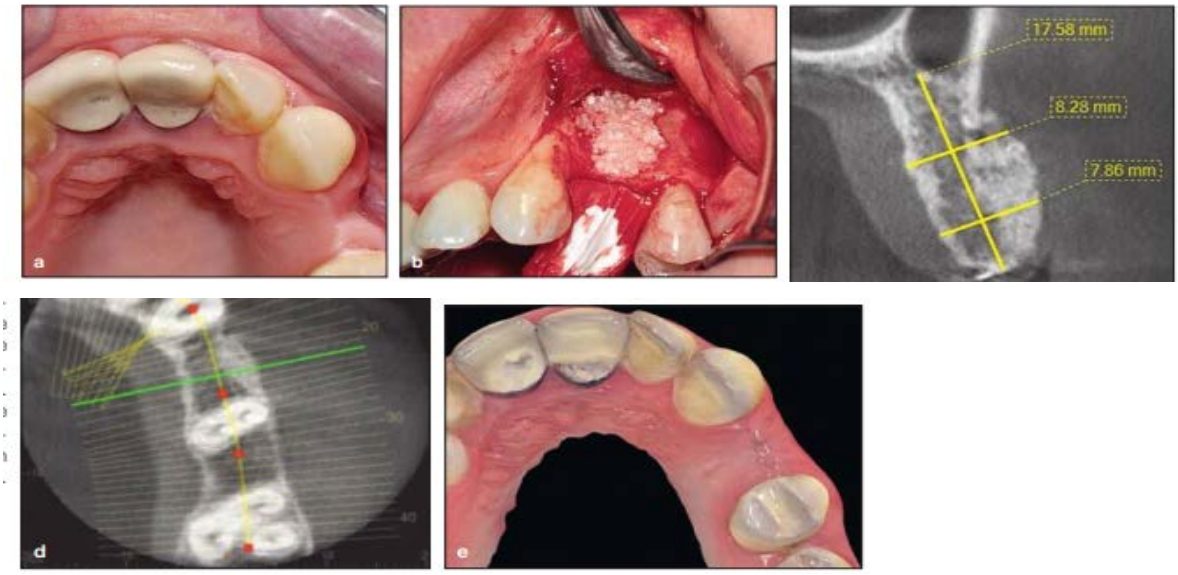

Figure 4: (a) An esthetic defect 12 months after extraction of the maxillary left first premolar. The maxillary left third molar was extracted, and particulate dentin was prepared utilizing the SDG procedure. (b) The buccal and occlusal alveolar ridge was exposed, and the dentin particulate graft was placed to restore the defect. (c and d) Cone beam computed tomography images showing the graft in place. (e) Three months later, a restored alveolar ridge was observed with better esthetic and functional appearance. The prosthetic restoration could then be performed with a dental implant. (Case performed by Dr Mariusz Duda.)

Conclusion

The use of extracted teeth as a bone grafting material offers many advantages to the clinician. The material is entirely autogenous and contains mineralized tissue similar to bone with an array of bioactive growth factors contained within its dentin matrix, yet it carries no risk of disease transmission. Based on results from preclinical data, dentin can be successfully ground into particle sizes ranging from 300 to 1,200 µm and replanted into extraction sites, where the material is gradually resorbed over time. Owing to its mineralization content, dentin particles are utilized as a low–substitution rate material that limits the dimensional changes that occur postextraction, especially when compared to faster-resorbing materials. Various studies have now demonstrated that autogenous particulate dentin is capable of restoring and preserving the alveolar ridge height and width following tooth extraction, even when the tooth was extracted several months earlier. Schwarz et al demonstrated that utilization of dentin sections grafted laterally to a bone defect restored the buccal plate as well. Future clinical studies are ongoing to further investigate the regenerative potential of dentin particulate in comparison to other standard biomaterials for various clinical indications that necessitate optimal bone and/or periodontal regeneration.

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