

## **Bone Engineering Using Human Demineralized Dentin Matrix (Autotooth Bone Graft) in the Treatment of Human Intrabony Defects: A Case Report**

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**Received:** February 21, 2017; **Published:** March 08, 2017

### **Abstract**

**Introduction:** Reconstruction of lost tissues is a major goal of periodontal therapy. Various bone graft materials have been introduced in the last two decades in an attempt to rebuild the lost attachment apparatus. These graft materials contribute new bone formation through osteogenic or osteoinductive or osteoconductive mechanisms. The auto tooth graft material is a system that treats patients by manufacturing bone graft material from their own extracted teeth. It was first introduced by the Korean tooth bank R and D center and as satisfied many clinicians and patients for its osteoconduction as well as osteoinduction capacity. Autotooth bone graft material consist of 55% of inorganic hydroxyapatite and 45% organic substances.

Among the inorganic substances, hydroxyapatite which is very similar to that of bone. The organic constituents include bone morphogenic protein (BMP) and proteins which possess osteoinduction capacity and also type I collagen identical to that found in alveolar bone. It is found that the autotooth bone graft material supports excellent bone regeneration capacity and minimizes the possibility of foreign body reaction, genetic diseases and transmission.

**Materials and Methods:** A 40 year old male patient reported to the Department of Periodontology, Rajarajeswari Dental College and Hospital, Bangalore with a chief complaint of food lodgement and loose tooth in his upper right back tooth region since 8 months. On intra oral examination, a periodontal pocket measuring 10 mm in depth was found in relation to the mesial aspect of maxillary right 1st molar. Maxillary 3<sup>rd</sup> molar was diagnosed with grade III mobility and was extracted followed by all the necessary precautions while performing the surgery.

**Conclusion:** Based on the results it is found that autotooth bone graft material with osteoinductive and osteoconductive capacities can be utilized for the treatment of intrabony defects.

**Keywords:** Bone Graft; Auto Tooth Bone Graft; Intrabony Defect; Periodontal Regeneration; Osteoinduction; Osteoconduction

### **Introduction**

Reconstruction of lost tissues is a major goal of periodontal therapy. Various bone graft materials have been introduced in the last two decades in an attempt to rebuild the lost attachment apparatus. These graft materials contribute new bone formation through osteogenic or osteoinductive or osteoconductive mechanisms [1]. The auto tooth graft material is a system that treats patients by manufacturing bone graft material from their own extracted teeth. It was first introduced by the Korean tooth bank R and D center and has satisfied many clinicians and patients for its osteoconduction as well as osteoinduction capacity [2].

Bone substitutes are actively used as a treatment modality to regenerate or reconstruct bony defects. There are four categories of bone graft materials, viz autograft, allograft, alloplast and xenograft. The use of these graft materials depends on clinical applications, volume of the defect and evidence based studies. It is widely accepted that autografts are known to be gold standard as it possess the properties of osteoconductivity, osteoinductivity and osteogenicity. However, autogenous bone grafts harvested from extra oral sites have some limitations namely rhorvidity, potential resorption and high cost with advancements in tissue engineering [3]. Many researchers have extensively studied compensating the drawbacks of autografts which lead to the attention to human tooth as a substitute due to its high similarities with the bone. It is also observed that tooth has much lower fat content and no marrow compared to bone, which make it easier to be changed into graft material. Many studies reveal that autogenous demineralized dentin matrix are biocompatible and both osteoconductive, osteoinductive in nature.

Autotooth bone graft material consists of 55% inorganic and 45% organic substances. Among the inorganic substance hydroxyapatite possesses the characteristics of combining and dissociating calcium and phosphate as those of bone. The organic substances include the bone morphogenic protein (BMP) and proteins with osteoinduction capacity as well as type I collagen, which is the same as alveolar bone itself [4]. Autotooth bone graft materials are divided into block and powder types. The block type has osteoinduction, capacity via blood wettability and has osteoconduction capacity via space maintaining and creeping substitution. It is remodelled by maintaining space during a specific period. The powder type is supplied based on various sizes of particles, porosity between powders, and blood wettability, osteoconduction, osteoinduction, and creeping substitution abilities [3].

With above data, autotooth bone graft material is very useful in clinical situations because it supports excellent bone regeneration through osteoinduction and osteoconduction capacity and minimizes foreign body reaction due to genetic homogeneity.

Hence the aim of this case report was to evaluate both clinically and radiographically the regenerative potential of auto tooth bone graft in human periodontal intra-bony defects.

## **Materials and Methods**

### **Characteristics of auto-tooth graft material**

Autotooth graft materials are divided into the block type and powder type. Block bone graft materials are divided into rootform and roton types. The root form is suitable for the preservation and reconstruction of extraction socket because it resembles a dental root. The roton type is suitable for horizontal or vertical ridge augmentation because it resembles a general block bone. In addition, both types can be used for the preservation of the extraction socket, aesthetic restoration of the alveolar bone, restoration of perforated sinus membrane, and enhancement of initial stabilization of implant. Block type bone graft material should be hydrated with physiological saline for 15 - 30 minutes before use because it is supplied after being demineralized and dried. Properly hydrated block can be controlled by operators with surgical knife or scissors and attached and fixed firmly without any additional instrument due to its excellent elasticity and flexibility. Powder type bone graft materials are divided into crown type (Auto BT Enamel) and root type (Auto BT Dentin). Auto BT enamel is suitable for maintaining volume due to bone healing capacity derived from osteoconduction and late resorption because most of it consists of inorganic enamel. In contrast, Auto BT dentin is suitable for osteoinduction regeneration, ridge augmentation, and maxillary bone graft derived from osteoinduction and osteoconduction because it consists of dentin and cementum containing many organic substances [4].

### **Method of preparation of autotooth bone graft:**

Tooth which was indicated for extraction was extracted prior to the periodontal surgery (Figure 1-3). Extracted teeth was thoroughly cleaned to make it free of debris and any of the attached tissues (Figure 4, 5). Crown and root portions of the tooth were separated (Figure 6, 7). The teeth was grinded by using dentin grinder (Kometa bio) to obtain dentin particles of size 300 – 1200 microns (Figure 8, 9). The dentin particles were disinfected using dentin cleanser for 7 minutes (Figure 10) and phosphate buffer solution for 3 minutes (Figure 11) and the resultant particles were dried and used as bone graft material (Figure 12).



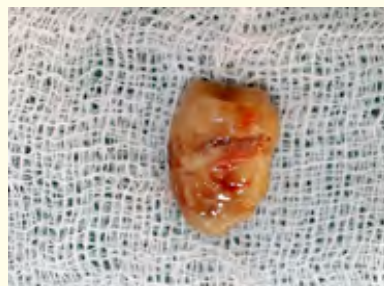
**Figure 1:** Pre-operative.



**Figure 2:** Maxillary 3<sup>rd</sup> molar was extracted.



**Figure 3:** Open flap debridement was performed.



**Figure 4:** Extracted tooth.



**Figure 5:** Extracted tooth was cleaned thoroughly to free it from debris or any other remnants.



**Figure 6:** Crown portion of the tooth was removed.



**Figure 7:** Crown and root.



**Figure 8:** Root portion was prepared for obtaining bone graft material.



**Figure 9:** Dentin particles of size 300-1200 microns were obtained.



**Figure 10:** Dentin cleanser was added for 7 min.



**Figure 11:** Dentin particles were dried and treated using PBS solution for 3 min.



**Figure 12:** Resultant particles were dried and used as bone graft material.

### Case Report

A 40 year old male patient reported to the Department of Periodontology, Rajarajeswari Dental College and Hospital, Bangalore with a chief complaint of food lodgement and loose tooth in his upper right back tooth region since 8 months. Regarding patient's medical history nothing significant was reported. The oral hygiene status was good. On intra oral examination, a periodontal pocket measuring 10 mm in depth was found in relation to the mesial aspect of maxillary right 1<sup>st</sup> molar and maxillary 3<sup>rd</sup> molar was diagnosed with grade III mobility. Pre-surgical therapy included patient education and motivation, scaling and root planning with plaque control instructions. At 1 month recall, periodontal pocket depth was measured 9 mm at mesial of maxillary right 1<sup>st</sup> molar and poor prognosis for maxillary right 3<sup>rd</sup> molar. Treatment protocol included open flap debridement along with the extraction of the 3<sup>rd</sup> molar which was to be used as graft material. The procedure was explained to the patient and written informed consent was obtained. The surgical procedure was approved by ethical committee of Rajarajeswari Dental College and Hospital, Bangalore.

After obtaining adequate anaesthesia, full thickness flap was elevated by giving intra sulcular incision followed by interdental incision. After flap reflection and thorough debridement, presuturing was done and the obtained autotooth bone graft material was placed in the intrabony defect and flaps were closed by giving sutures (Figure 13-15).



**Figure 13:** Bone graft placed.



**Figure 14:** Suturing done.



**Figure 15:** Periodontal dressing given.



## Results

The patient showed good compliance and satisfactory oral hygiene maintenance during the course of observation period. The healing was uneventful, without any signs of infections and complications, indicating biocompatibility of use of auto tooth as graft material.

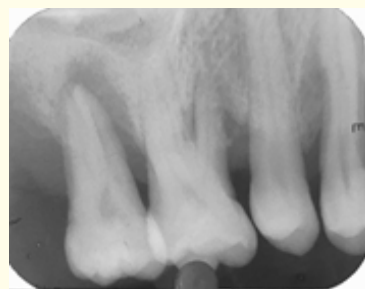
Clinical re-evaluation at 9 months after the periodontal surgery revealed PPD of 5 mm and CAL of 3 mm with no signs of bleeding on probing. Digital radiographic re-evaluations were performed at 3 months and 9 months post-operatively. The radiographic analysis of the defect revealed significant bone formation at the end of 3 months with additional crestal bone formation followed by almost complete bone fill by 9 months (Figure 16-18).



**Figure 16:** IOPA at baseline.



**Figure 17:** IOPA at 3 months.



**Figure 18:** IOPA at 9 months.

## Discussion

Autotooth bone graft material is an innovative bone graft material with all the advantages of autogenous bone, owing to the similarity with the bone. It also addresses patients' repulsion to allograft and xenograft by providing excellent biocompatibility without causing

immune response, foreign material reaction, or contagion. In addition, it has osteoinduction, osteoconduction, and creeping substitution capacities, and it can be prepared in various sizes and shapes.

No doubt, autogenous bone graft is ideal for the reconstruction of hard tissue defects. However, it is difficult to obtain a sufficient amount, and secondary defect will be developed in the donor site [5]. In case of allograft, there is some doubt regarding the amount of bone formation proteins necessary for proper osteoinduction, and contagion may develop [6]. It is observed that xenograft is not popular among operators because of immune rejection response by heterologous proteins and high cost. As a result, there have been many research studies on the development, application, and effect of allograft, xenograft, and synthetic graft. The bone graft material to replace autogenous bone has been highly anticipated [7].

In the present case report, clinical re-evaluation at 9 months after the periodontal surgery revealed PPD of 5 mm and CAL of 3 mm with no signs of bleeding on probing. Digital radiographic re-evaluations were performed at 3 months and 9 months post-operatively. Upon radiographic analysis of the defect revealed significant bone formation at 3 months with additional crestal bone formation followed by almost complete bone fill by 9 months.

Kim., *et al.* in their study proved successfully the use of artificially processed tooth as graft material, which was supported by Murata., *et al.* in Japan wherein bone was generated from demineralized tooth as the hypothesis that the components of tooth are similar to those of bone [8]. Park SM., *et al.* in a study evaluated the clinical application of auto tooth bone graft material and histological assessment concluded, formation of new bone, densified lamellated bone, trabecular bones and osteoblasts [9]. In a study conducted by Kim YK., *et al.* concluded that auto block type tooth bone graft can be considered a good alternative bone graft to a synthetic bone graft in a bone-added sinus lift, when extraction is necessary prior to the surgery [10].

Kim ES., *et al.* to evaluate the clinical usefulness of autogenous fresh demineralized tooth (auto-FDT) graft prepared at the chair side for alveolar bone grafting during dental implant surgery. They concluded that chair side preparation of autogenous fresh demineralized teeth after extraction can be a useful alternative to the use of autogenous bone or other graft materials for the immediate reconstruction of alveolar bone defects to facilitate subsequent implant placement [11]. Murata M., *et al.* first confirmed the osteoinductive property of human demineralized dentin matrix (DDM) histologically. The DDM induced bone and cartilage independently [12].

A study done by Yung CH., *et al.* concluded that auto tooth bone graft material is viable for guided bone regeneration and can yield a stable marginal bone level even after functional loading of implants. The degree of marginal bone loss after loading with auto tooth bone graft material is stable [13].

Unless contaminated by an infectious lesion, a tooth does not cause problems even when the root rest is in the alveolar bone. There are also surgeries wherein the root rest is left intentionally to preserve the alveolar bone [14]. In addition, Kim., *et al.* reported that 90% of the tooth's organic components are type I collagen, which is very important in the calcification of bone [15]. Ike and Urist proved that BMP2 included in enamel has capacity for osteoinduction, which is important in bone formation [16]. Gao., *et al.* reported that enamel has growth factors such as insulin like growth factor (IGF) II, BMP2, and transforming growth factor (TGF) beta like bone [17]. According to Saygin., *et al.* cementum and its mother cell have TGF beta, IGFI, and platelet derived growth factor. In other words, the enamel and cementum of tooth have many growth factors that help bone formation [18].

## Conclusion

In this case report, auto tooth bone graft material showed better bone formation without inflammatory reaction in the recipient site with good bone fill.

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**Volume 8 Issue 3 March 2017**

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