

Dentin Graft – The Hidden Treasure

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Abstract: Maintaining alveolar bone volume is prerequisite for ideal functional restorations and aesthetics. Bone loss entails functional alterations and decreased alveolar volume, with consequent difficulty in seating of prostheses at a later stage or placement of implants or might also be aesthetically unpleasant. Extracted teeth are considered as biomedical waste. It is a simple and easily available bone substitute material. The dentin and bone exhibit similar biochemical composition hence could be utilized as bone graft material. Demineralised dentine matrix (DDM), an organic material obtained from dentin has been shown to possess osteogenic capacity. This paper reviews the composition, preparation, and the role of DDM as a periodontal regenerative material.

Keywords: Autogenous dentine, bone graft, demineralized dentine matrix, osteo-conduction, osteo-induction, residual bone resorption.

1. Introduction

For a successful regenerative therapy in dentistry alveolar bone and periodontium have a significant role. Residual alveolar bone resorption is very rapid immediately after tooth extraction [1]. There are various condition like Trauma, periodontitis causing bone loss leads to bone grafting [2]. Such bone loss entails functional alterations and decreased alveolar volume, with consequent difficulty in seating of prostheses at a later stage or placement of implants or might also be aesthetically unpleasant [3]. Hence, maintaining alveolar bone volume is prerequisite for ideal functional restorations and aesthetics [4]. Autograft, allograft, alloplast, and xenograft are the four types of bone grafts, above all autografts are known to be the gold standard due to its osteo-inductivity, osteo-

conductivity, and osteogenicity [5]. Dentin is considered such alternative. Dentin as autogenous graft material was described by Kim et al in 2010 [6]. This review paper is an attempt to provide an overview regarding the chemical composition and re-evaluate different types of DDM as a bone graft.

2. Resemblance Between Bone and Dentin

The ratio of the organic and inorganic contents of dentin is similar to that of bone [8]. The inorganic compartments contain hydroxyapatite [HA], beta-tricalcium phosphate [beta TCP], amorphous calcium phosphate and octacalcium phosphate [OCP] which provide the tooth osteoconductive properties, making it a biocompatible graft material [9]. In 20% of organic composition 90% of which is a type 1 collagen while 10% is comprised of non-collagenous proteins [osteopontin, bone sialoproteins, dentin sialoproteins, osterix, and osteocalcin], growth factors [insulin-like growth factor–II, bone morphogenetic protein (BMP) and transforming growth factor-beta common to bone [3]. Human dentin can be classified into three groups according to the degree of demineralization; non demineralized dentin (calcified dentin), partially demineralized dentin matrix (70% decalcified) and demineralized dentin matrix, the latter being biocompatible and osteo inductive given its similarity to the demineralized bone matrix. Demineralized dentin matrix consists of 95% type I collagen and non-collagen proteins includes growth factor. For these reasons, the demineralized dentin matrix is defined as an acid-insoluble and bioabsorbable molecule, constituting a bound collagen matrix inducing bone formation [10].

Table 1
Graft Characteristics [7]

Graft	Osteo conduction	Osteo induction	Osteo genesis	Advantages	Drawbacks
Autograft	yes	Yes	yes	Gold standard. Best results. Good percentages of bone Volume and mineralization Low cost	Associated morbidity Additional surgical site is required. Greater chance of infection at the donor site resorption
Allograft	yes	Yes(DFDB)	-	Availability of large amounts of donor bone Reduced surgical time Elimination of the risk of Donor site morbidity	Expensive Risk of infection
Xenograft	yes	-	-	Good bone formation Combinable with Autogenous bone	Expensive Risk of infection Zoonotic disease transmission Ethical and religious concerns
Alloplast	yes	-	-	Good biocompatibility Unlimited availability Good bone formation	No osteogenesis No definable absorption and transformation rates

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3. Osteoinduction and Osteoconduction Properties of Demineralized Dentin Matrix

Regenerative property were first evidenced by Yeomans and Urist. According to Urist, BMP in DDM and bone possesses the osteo inductive property [11]. Non collagenous proteins of dentin such as osteocalcin osteonectin, phosphoprotein, and sialoprotein play a role in bone calcification [12], [13]. Murata et al proved that the DDM is an effective graft material which is a carrier of BMP-2 and scaffold for bone-forming cells. BMP-2 AND BMP 7 provide most promising results for the enhancement of bone repair. The property of BMP can induce de novo bone formation. Even though the BMP derived from dentin was different to BMP from bone, they exhibit same action in the body [15].

According to Boden et al., LIM mineralization proteins 1 Present in dentin has the property of regulation differentiation and maturation of osteoblast and hence bone formation and mineralization of dentin matrix [16].

Carvalho et al., and investigated the osteo promotive property of Autogenous DDM [17]. Gomes et al., also find out an increase in the osteogenic cells after implantation of ADDM in wounds [18]. Thus dentin graft possesses both osteo inductive and osteo conductive properties.

4. Preparation

A procedure was developed to process freshly extracted teeth by recycling them into bacteria free particulate for immediate grafting of autogenous dentin by using A 'Smart Dentin Grinder'TM(SDG). This device was designed to grind and sort extracted teeth into particulate size. Clean teeth put into the grinding sterile chamber of SDG which is capable in 3 seconds to grind the roots and then by vibrating movement of the grinding chamber for 20 seconds the particles of less than 1200 μm fall through a sieve to a lower chamber that keeps particles between 300-1200 μm . This grinding and sorting protocol is repeated to grind the remaining teeth particles left in grinding chamber. The particulate dentin from the drawer is immersed in basic alcohol for 10 minutes, in a small sterile glass container [19].

5. Discussion

Extracted teeth are considered as biomedical waste. It is a simple and easily available bone substitute material. The dentinal matrix obtained from demineralization of tooth and demineralized dentin matrix is highly biocompatible which shows both osteo inductive and conductive properties. As it is autogenous, the risk of immune reaction is eliminated. Autogenous dentin graft has lot of clinical application include for guided tissue regeneration, tooth socket preservation, ridge augmentation, sinus bone graft, grafts in tumor resections, traumatic injuries and cyst enucleation, etc. [20].

The better results with autogenous dentin graft are validated by various invitro and animal studies.

In 2006 Gomes et al conducted a human study using autogenous DDM. In 27 lower third molar sockets were selected and divided in to three group, The experimental

sockets were filled with autogenous DDM + PTFE membrane, control group with no material and the third group with PTFE. After 90 days, the experimental sockets showed greater homogenous bone radiopacity and faster bone formation compared to other group [21].

Kim et al., successfully contributed various studies and find out that autogenous DDM gives better results in various clinical application and is a best bone substitute. In the year 2010 Kim et al used autogenous tooth derived bone graft along with GTR at the time of implant placement. Histologic examination of Autogenous tooth grafted area reveals gradual resorption and replaced with new bone of excellent quality [9].

Lee et al. concluded after comparing the efficiency of autogenous DDM and other bone graft materials used in sinus bone graft surgeries; after four 4 months of healing, there was favorable bone formation, but autogenous DDM revealed faster rate and superior quality of bone formation [22].

Similar results were obtained by Jeong et al., in 2011 and found appropriate for the use in maxillary sinus augmentation [23].

Park et al., in 2012 performed implant placement combined with maxillary sinus augmentation on 250 patients using block type, powder type and block with powder type auto bone graft. Results showed there is significant bone gain in vertical bone defect site [20].

Lee and Kim conducted a cohort study to evaluate the clinical efficacy of autogenous DDM IN 37 patients. From this study author proved that autogenous tooth bone graft was confirmed to be a safe procedure showing excellent bone healing through 2 years [24].

Chang et al. in 2014 performed a guided bone regeneration (GBR) followed by implant placement and prosthetic restoration and results showed that no significant marginal bone loss difference radiographically immediately after GBR, implant placement, and prosthesis delivery [25].

In 2018, Schwarz et al published a prospective clinical study in which they performed alveolar crest augmentation techniques on 30 patients, using block shaped autogenous root dentin in 15 cases, and blocks of autogenous bone in the other 15. There was an increase of 5.53 mm in patients where autogenous dentin was used, and 3.93 mm in cases where autogenous bone blocks were used. In addition, homogeneous integration of both grafts which allowed the placement of implants with good primary stability, with the authors concluding that autogenous dentin appears to be a viable alternative as a graft material for bone width regeneration [26].

In 2019, Canto-Díaz et al., done a pilot study in 6 patients, in which they perform alveolar preservation with autogenous dentin on the research group and allow convention healing to occur in the control group, sealing both alveoli with a collagen membrane. The postoperative CBCT performed at 8 and 16 weeks, detecting lower dimensional contraction of the post-extraction socket among the study group than in the control group at 16 weeks following surgery thus suggesting that autogenous dentin is suitable as graft material for alveolar preservation [27].

Sánchez-Labrador Martínez de Morentín et al., in 2019

reviewed the uses of autogenous dentin as a graft material in oral surgical procedure. They concluded that Autogenous dentin possesses the properties of osteo conduction and osteo induction, which has led to its use in different regenerative procedures in implantology (alveolar preservation, guided bone regeneration, breast lifts), in isolation or in combination with other materials. Also, Dentin has been shown to yield good results in terms of bone gain and primary implant stability, and even better results when compared to other materials [3].

6. Conclusion

While discussing the key areas of using a tooth as a graft and has found that it is an important consideration for usage as a natural graft in relation to the already available conventional ones leading to the long-standing evidence of creating art from trash. This will in the long-run lead to the further development with more usage. A tooth that is extracted can be easily thrown in to the yellow bag but like the old saying goes “we do not enjoy the smell of jasmine grown in yard”. We suggest to think twice before doing that.

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